

# **Impacts of the SBIR/STTR Programs: Summary and Analysis**

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## EXECUTIVE SUMMARY

The SBIR/STTR programs are now used by 11 Federal agencies, with DOD, NIH, NSF, NASA, and DOE accounting for 97% of SBIR/STTR funding. In recent years, several reports have tried to quantify the impact of these programs, especially economic impacts. This report summarizes this recent work.

Congress has focused attention primarily on commercialization. The National Academies concluded that best metrics for commercialization would include both the extent to which projects reach the market; and the scale of commercialization: i.e., the amount of sales per project [NAS, 2004-2016]. These metrics have been used by other researchers - such as GAO [2105] and TechLink [2014,2016]. The Academies also noted the important of other impacts (e.g. knowledge effects) as well as additional metrics for commercialization (e.g. the acquisition of additional research funding). TechLink has pioneered use of economic modeling to further explore the programs' wider economic impact.

## KEY FINDINGS

- **Reaching the market.** The National Academies found that 40-70 percent of projects (varying by agency) report reaching the market. This undoubtedly understates the eventual commercialization rate once more recently-funded projects mature. [NAS 2014-2016] Outcomes identified by the TechLink studies also fall into this range, as does the analysis of the DOD's Company Commercialization Record (CCR) dataset provided by the Academies [NAS 2014].
- **More detailed studies at Navy and Air Force** found that a total investment in SBIR/STTR of \$6.25 billion generated [TechLink 2014, 2016]
  - Total revenues from products based on SBIR/STTR technologies of \$28.9 billion. Two projects each generated more than \$1 billion in sales.
  - \$11.4 billion in sales to DOD or DOD prime contractors
- **Economic impact** analysis by TechLink using IMPLAN economic modeling software found that the Air Force and navy SBIR/STTR programs had a substantial economic impact at a national scale. [TechLink 2014, 2016]
  - \$92.1 billion in total output
  - \$8.8 billion in total taxes generated – more than the cost of the program
  - \$31.4 billion in labor income – wages and salaries generated directly and indirectly
- **Employment effects** (identified using the IMPLAN model) shows that SBIR/STTR at Air Force and Navy generated a substantial number of jobs [TechLink 2014, 2016]
  - More than 30,000 jobs annually on average

- A total of 443,000 job-years (full time equivalent of one job for one year)
- High paying jobs: jobs related to the Air Force program averaged \$65,986 in annual pay, while Navy-related jobs averaged \$68,585
- **Additional research funding.** Many SBIR/STTR projects require more R&D, which is often hard to find. Projects that acquire additional funding from inside or outside the Federal government demonstrate forward progress:
  - The National Academies found that 60-80% of projects (depending on the agency) received additional funding (excluding NASA at 31%) [NAS 2014-2016]
  - TechLink found that Air Force and Navy projects received \$2.5 billion in further investment [TechLink 2014, 2016]
  - Little funding came from venture capital: only at NSF and NIH was their share as high as 10%. At the other agencies it averaged 2.3% of the total. [NAS 2014-2016]
- **Knowledge effects.** The National Academies concluded that SBIR (even excluding STTR) is tightly connected to universities and is a valuable pathway for the commercialization of university-based research [NAS 2014-2016]
  - 60% of firms had at least one academic founder
  - 30-70% of projects (depending on the agency) used universities as a source of technology, consulting equipment or in some other capacity on the project
  - STTR offers an especially close connection between small firms and universities
  - SBIR/STTR firms also patent at a high rate: 58-70% reported at least one patent related to their SBIR/STTR work; most claimed to have more than one
- **Building sustainable innovative firms.** SBIR/STTR is not just about specific projects: it also provides critical funding to sustain and grow firms [NAS 2014-2016 unless otherwise noted].
  - About 70% of projects would probably or certainly not have started without SBIR/STTR funding
  - At NIH and DOD (three quarters of the entire Federal program), 18% of SBIR/STTR companies were founded directly because of SBIR/STTR awards. About 1/3<sup>rd</sup> more reported that SBIR/STTR influenced company formation. This is especially important in light of the declining rate of startups in the US. [Hathaway and Litan]
  - For many firms, SBIR/STTR is transformative: about 70% of projects reported to the National Academies that SBIR/STTR had had a transformative or strongly positive impact on the firm's trajectory. Many of the case studies illustrated the impact of SBIR/STTR funding at key moments in company history (e.g. Qualcomm)

- SBIR/STTR firms are often acquired for their technology; others spin-off new firms creating new jobs and opportunities.
  - IDI's data shows that more than 1,800 SBIR/STTR firms have been acquired, at a median price of \$42 million. [IDI 2017]
  - TechLink identified 538 acquisitions at an average price of about \$16 million from Air Force and Navy SBIR/STTR firms (in a more limited time window)
  - TechLink also identified new 125 spin-off companies at Air Force alone [TechLink 2014, 2016]
- **Cost savings.** Anecdotally, SBIR/STTR has had important impacts in saving costs in Federal weapons acquisition programs. More specifically, a report from Lockheed on the F-35 identified \$500 million in savings from that program alone. [Bogan, 2016]
- **Return on investment (ROI).** SBIR/STTR generates outcomes across many dimensions, so simple input/output metrics have only limited utility. Still, the TechLink analysis indicates that the program generates economic outputs that are many times its cost: the estimated ROI is 12 for the Air Force and 19.5 for Navy. [TechLink 2014, 2016]

Many of the points listed above are underpinned by the excellent NAS and TechLink surveys. However, these surveys *substantially understate* the impact of SBIR/STTR. The National Academies has acknowledged that surveys fail to capture any of the sales, revenues, or other outcomes that occur after the date of the survey. An upcoming analysis from TechLink suggests that for the Air Force and Navy studies, future sales will add more than 50% to the total sales identified through their surveys.

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## INTRODUCTION

The SBIR/STTR programs have been operational since 1983 and 1991 respectively. Since 1990, they have attracted about 675,000 proposals, of which about 55,000 were funded for more than 26,000 companies, through programs run by 11 federal agencies.

Four Congressional objectives have been set for the program:

- Stimulate technological innovation.
- Meet Federal research and development needs.
- Foster and encourage participation in innovation and entrepreneurship by socially and economically disadvantaged persons.
- Increase private-sector commercialization of innovations derived from Federal research and development funding.<sup>1</sup>

These are important objectives in a national context, and Congress has repeatedly sought to find ways to determine whether the program is meeting them. There has also been considerable interest in the wider implications of the programs, including the extent to which the programs' impacts the US economy more generally.

This paper summarizes and reviews existing SBIR data and analysis, synthesizing the expanding range of reports and analysis. It begins with a review of the relevant literature and of the key data sources. It then addresses program commercialization outcomes and economic impacts, indirect impacts through the growth and success of SBIR-funded companies, knowledge effects and spillovers, and evidence about the unique role of SBIR in meeting agency mission needs.

## PREVIOUS REPORTS, THE ACADEMIC LITERATURE, AND DATA SOURCES

There have been numerous efforts to evaluate the SBIR/STTR programs over the past twenty years. Since 2004, the National Academies of Science, Engineering, and Medicine (NAS) has published a remarkably comprehensive series of reports on the five major agencies [NAS 2004-2016]). Beginning with a volume on the study's methodology published in 2004, NAS has published two volumes on each the programs run by the five major agencies, along with additional volumes on the program as a whole, the participation of women and minorities, Phase III commercialization, fast-track at DOD, venture capital at NIH, and the STTR program.

The Academies reports used surveys, case studies, and agency interviews to address program outcomes. Survey questionnaires were sent to all participating companies (although companies

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<sup>1</sup> <https://www.sbir.gov/about/about-sbir#sbir-mission>. Accessed April 27, 2017

with multiple awards answered questions about only a subset of their projects). Response rates were similar in the two rounds of surveys (one for the 2008-10 reports, another for the 2014-16 reports), at around 40% of the companies with viable contact information. More than 50 company case studies were also conducted for the more recent round of reports.

Starting in 2012, the Air Force and then Navy contracted with Montana State University to conduct intensive surveys of awards made by these agencies (TechLink 2014, TechLink 2016). Using considerably more resources and a much longer timeframe, TechLink reported that it had successfully surveyed 96% of AF contracts and 94% of Navy contracts. These response rates are remarkable in a field where the churn of small companies is high and where the movement of researchers between them is higher still.

Academic research has not in the main sought to address overall program impacts, preferring to use SBIR and STTR data as mechanisms for testing economic theories – for example, ideas about how government investment in R&D might “crowd out” private investors (Wallsten, 2000), tradeoffs between commercialization and basic research (Archibald and Finifter), public-private partnerships (Audresch, Link, and Scott 2002), procurement reform (Connell 2009), and theories of spillover effects (Griliches, 1991; Lerner, 1996) and the funding of small innovative businesses (Schell and Berente). More specialized efforts have focused on how SBIR can address perceived gaps in specialized fields such as health (Ceulemans and Kolls, 2013; Toole and Czarnitzki, 2007, Bauer and Arthanat, 2010) and defense (Held et.al. 2006).

Thus, while many academic studies *use* data collected by the National Academies (e.g. Link and Scott 2010), the substantial costs involved in acquiring outcomes data are a formidable barrier to the development of alternative data sets. A recent Ph.D. thesis by Sabrina Howell pioneered the use of administrative data for SBIR/STTR program analysis, a promising line of inquiry for the future, but her work is limited to DOE only [Howell]. The key data sources are therefore the National Academies and TechLink data sets, plus additional data points contributed by a range of specialized sources (e.g. InKnowvation, 2017) and data provided directly by DOD through the Company Commercialization Record (CCR) database (via an analysis published in the 2014 NAS report on the DOD SBIR program).

The primary data sources were designed with different objectives in mind. The Academies survey ranged across the entire set of Congressional objectives and beyond, generating data about knowledge effects, participation by selected demographics, the take-up of SBIR technologies by funding agencies and links to universities, as well as respondent views on the nuts and bolts of program operations. The TechLink surveys focused on a much more limited set of variables directly relevant to the program’s economic impact. The dual approaches act as complements: The Academies surveys covered a wider range of topics, while the TechLink



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surveys worked harder to generate a comprehensive data set focused more tightly on economic impacts.<sup>2</sup>

## COMMERCIALIZATION OUTCOMES

One key outcome is the commercialization of basic research. So a key question is whether a project generated sales and – if so – at what scale and to whom. This provides three core metrics:

- Whether a project generated any sales (the “commercialization rate”)
- The size of the sales (“commercialization scale”)
- The extent to which sales were made to the funding agency as a metric for understanding how projects support the agency mission (“agency take-up”)

## COMMERCIALIZATION RATE

The commercialization rate varies by agency, by type of technology, and by the year of award (projects maturing during recessions are less likely to be commercially successful). However, the National Academies surveys, the TechLink surveys, and data from the DOD CCR are in close agreement.<sup>3</sup> They all show that 45-60% of SBIR/STTR Phase II projects generate some sales (see Table 1) (NSF is an outlier, likely because the NSF SBIR/STTR program is focused almost exclusively on supporting firms that will be commercially successful. Other agencies have more diverse objectives).

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<sup>2</sup> Unless otherwise specified, data from the National Academies reports covers SBIR only, while the TechLink reports cover both SBIR and STTR

<sup>3</sup> All three focus approximately on awards that ended in 2000-2013 inclusive

**Table 1 Commercialization rates by agency and data source (% of projects with some sales)**

Agency		TechLink	CCR	NAS
<b>DOD</b>			50	46
	<b>Air Force</b>	58		
	<b>Navy</b>	64		
<b>NIH</b>				49
<b>NSF</b>				70
<b>NASA</b>				46
<b>DOE</b>				49

Sources: TechLink 2014 and 2016, NAS (2014-2016)<sup>4</sup>

The TechLink studies report somewhat higher commercialization rates than the NAS reports, which may reflect greater efforts at Navy and Air Force to ensure that projects are tightly aligned with agency mission needs and are tracked into acquisition road maps at an early stage.

The reported commercialization rate does not provide a complete picture. Surveys reflect outcomes at a single point in time, and many SBIR projects have long cycles that make them relatively slow to reach market, and also slow to leave the market or reach obsolescence. As the National Academies has noted, “the amount of total sales made – and indeed the number of projects that generate sales – are inevitably undercounted in a snapshot survey generated at a single point in time” (NAS, 2009 p.84). The Academies estimated that addressing this problem could determine that actual sales were on the order of 50% greater than those captured by survey instruments. TechLink is now working to develop a model for estimating full program outcomes.

## COMMERCIALIZATION SCALE

Like most technology- and innovation-related programs, SBIR/STTR projects generate a wide range of outcomes: most projects generate only small revenues, while a few are very substantial indeed.

Limitations in the NAS methodology meant that only a selected number of projects from multiple winners were surveyed, making it quite possible that major successes were not surveyed. This may help to explain some discrepancies between data from TechLink and from NAS, as TechLink found some large successes not included among NAS respondents (Table 2).

<sup>4</sup> NAS (2014) published data from the CCR used in this table

**Table 2 Sales >\$50 million (% of total responses)**

Agency	Component	Data source		
		TechLink	CCR	NAS
<b>DOD</b>			50	46
	<b>Air Force</b>	58		
	<b>Navy</b>	64		
<b>NIH</b>				49
<b>NSF</b>				70
<b>NASA</b>				46
<b>DOE</b>				49

Source: TechLink (2014,2016), NAS (2014-2016)<sup>5</sup>

The limited number of highly successful projects generate most of the commercial gains from the program (as of course they do from other high risk/high reward initiatives, such as projects funded by venture capital). Table 3 below shows how concentrated success is, drawing on the TechLink surveys. 2,224 projects reported some sales, but more than 30% of total sales were accounted for by the top 10 projects, and well over 50% by the top 50 projects. Conversely, among projects reporting sales, the bottom 78% accounted for only 7.3% of all sales revenues.

**Table 3 Distribution of sales among successful projects, Air Force and Navy SBIR/STTR 2000-2013**

	total sales	% of total sales
Top 10	6,349,488,000	30.7
Top 20	8,818,058,915	42.7
Top 50	11,859,795,952	57.4
Top 100	14,249,410,446	69.0
Top 500	19,073,082,716	92.3
Total (2,224)	20,653,367,237	100.0
No Sales (5,380)		

Source: TechLink, 2014, 2016

Clearly, big winners drive overall program success, and the importance of SBIR for these high growth firms is described in detail in numerous case studies collected for the National Academies reports – see for example Qualcomm, Invitrogen, iRobot and others.

<sup>5</sup> Note: NAS data are not directly comparable: the survey reported sales greater than \$100 million. We estimate that for sales greater than \$50 million, the NAS percentage would be similar to the TechLink estimates for Navy and Air Force. While the NAS surveys asked for a range, TechLink asked for a precise dollar figure.

It's worth pointing out that just as companies continue to commercialize for years after the award, the amount of commercialization – total sales – also continues to grow. Preliminary results from an upcoming analysis of TechLink data suggests that because a survey captures sales made by the time of the survey, at least 30% of the total sales generated from the average project are not counted in any single point-of-time survey. Estimated total sales are therefore at least 50% greater than the amounts that can be identified using the TechLink and NAS surveys.

Air Force and Navy projects both reported around \$14 billion in direct sales (see Table 4). The TechLink studies included all identified sales, including both follow-on R&D contracts and royalties as well as sales by spin-out companies and licensees (although the latter are as TechLink notes likely to substantially understate results as funded companies have limited access to sales data for their licensees).

**Table 4 Total company sales related to surveyed SBIR/STTR projects at Air Force and Navy, 2000-2013 (\$ million)**

Sales Category	\$ millions	
	Navy	Air Force
Commercial products/services	2,992	6,329
Military products/services	6,960	4,386
Follow-on R&D contracts	3,489	3,545
Royalties	136	60
Sales by licensees	382	268
Sales by spinout companies	215	104
Total (\$m)	14,174	14,692

Source: TechLink Air Force and Navy economic impact reports<sup>6</sup>

## AGENCY TAKEUP AND MARKETS BY SECTOR

Sales from awards at DOD and NASA were heavily focused on sales to agencies and agency primes. This is not surprising: while commercialization is an important outcome for all SBIR agency programs, the DOD and NASA programs have an additional objective: directly supplying technologies and tools for use by the agencies. Indeed, for these agencies, developing technologies for agency use is clearly the highest priority.

Both the NAS and TechLink surveys addressed this issue. The Academies surveys found that DOD awardees generates 59% of their sales revenues from DOD or DOD prime contactors, unmistakable evidence that the program is closely tuned to the specific needs of the agency.

<sup>6</sup> Licensee sales have been excluded as data about licenses is not sufficiently reliable to be included.

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Given the much smaller size of the NASA procurement market it's not surprising that only 14% of NASA project sales went to NASA or NASA primes. The TechLink studies found that 49% of Navy sales and 31% of Air Force project sales went to those agencies or their primes, and that overall these projects generated \$11.4 billion in sales to DOD or DOD prime contractors.

This may reflect the booming market for civilian aerospace, offering greater commercial opportunities for Air Force projects in the private sector. Navy has also been working hard for years to align SBIR topics with Navy acquisition needs, which may well have encouraged tighter links between SBIR awards and agency acquisitions.

For NIH, NSF, and DOE sales to the agency or its primes are not a priority; few SBIR/STTR technologies end up in use at the sponsoring agency. Instead, these projects focus on the commercial private sector: as NIH for example, 58% of sales by value were to the domestic private sector, with another 17% to export markets [NAS, 2015] These shares were essentially identical for NSF [NAS, 2016b].

#### FURTHER INVESTMENT

While the three phase SBIR program makes it tempting to expect that innovative products will emerge at the end of a simple linear trajectory: feasibility → research → development → sales. The reality is different. Many – perhaps most – SBIR/STTR projects require further investment before they can reach the market, after the SBIR/STTR funding. These further investments from outside the company are a significant sign that the project has created something of value, and that it is on the road to commercialization.

The National Academies studies reported that at 4 of the 5 major SBIR agencies, 60-80% of projects received additional investment after the SBIR/STTR award (NASA was at 31%). The Academies studies found that the amounts of investment were, like sales revenues, highly skewed: most investments were quite small, and a limited percentage accounted for much of the total investment into the program: 5-9% of projects with investment received at least \$10 million.

The TechLink studies found that 35% of projects received additional investment, totaling \$6.8 billion. Four projects accounted for \$480 million of this investment. The average among projects that did receive some additional investment was \$2.9 million, and 5% reported investments of at least \$10 million. These investment dollars are included by TechLink in the economic impact analysis (see below).

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## METHODOLOGICAL CHALLENGES

Drawing tight connections between Federal awards and their impacts is often difficult. For SBIR/STTR, the difficulties multiply for many reasons.

- **Small business churn.**
  - companies go out of business or are acquired, and institutional memory is limited in small firms (a large majority of SBIR awardees have fewer than 20 employees)
  - memories fade and there are no shrines to SBIR/STTR awards at participating companies even where the company and senior staff are still in place.
- **Self-reported outcomes data.** Almost all the data used to assess program impacts is self-reported, collected either via ad hoc surveys (such as those deployed by the National Academies and TechLink), or through data collected by the agencies during the application process. Self-reported data may be unreliable both because companies can easily make mistakes in recollecting activities from years ago, and because they may also have incentives to inflate reported outcomes.
- **Quantifying impacts.** Surveys are asked respondents to measure – in dollars – commercial outcomes from individual projects. For very small companies this is hard, but for big successful companies it is much harder. QUALCOMM for example used SBIR money at a critical early stage in its development. But how much of the \$23 billion in revenue from 2016 is a “result” of SBIR awards 20 years earlier? Is there a point after which impacts are deemed to have ended?
- **Allocating impacts to individual projects.** Similarly, how much of the company’s total commercialization should be allocated to a specific project; sometimes, companies use a number of awards to reach commercialization?
- **Survey limitations.** As the National Academies has noted, there are significant limitations when using survey-based data to quantify program outcomes. Aside from some of the difficulties identified above, surveys always measure outcomes at a single point in time – but actual outcomes continue into the future. Preliminary analysis by the TechLink team of results from their 2014 and 2016 surveys suggests that an estimate of future sales would add at least 50% to the sales-related outcomes captured at the time of the survey.

It is fair to conclude that the surveys carefully undertaken by the National Academies and TechLink have, despite these challenges, provided a wealth of insight into program outcomes, and that program evaluation and assessment would be impossible without these data. Efforts to provide improved data are now under way at SBA, but until they become available, the data presented in this summary are the best available – and should be used to guide program design and improvement.

## ECONOMIC IMPACTS

While the TechLink surveys were comprehensive and generated important results in their own right, the resulting reports broke new ground in other ways by seeking to estimate the overall economic impacts of the programs on the US economy as a whole. To do this, they utilized the IMPLAN economic model to estimate the wider economic impact of SBIR awards.<sup>7</sup>

## THE IMPLAN MODEL

IMPLAN draws on a mathematical input-output framework originally developed by Wassily Leontief, the 1973 Nobel laureate in economics, to study the flow of money through a regional economy. IMPLAN assumes fixed relationships between producers and their suppliers, based on demand, and that inter-industry relationships within a given region's economy largely determine how that economy responds to change. Increases in demand for a certain product or service causes a multiplier effect—a cascade of ripples across the regional and then national economy. This increased demand affects the producer of the product, the producer's employees, the producer's suppliers, the supplier's employees, and others. It ultimately generates a total impact on the economy that significantly exceeds the initial change in demand.

In the case of the SBIR/STTR programs, there are two inputs into the economy to consider: the immediate injection of SBIR/STTR funding into the economy via SBIR/STTR award recipients; and the sales and other revenues generated by SBIR/STTR firms as a result of SBIR/STTR awards.

Each of these components generates three kinds of economic impact:

- **Direct effects** represent the initial change in the industry in question (the direct expenditures of SBIR/STTR firms using SBIR/STTR award funding).
- **Indirect effects** are changes in inter-industry transactions when supplying industries respond to increased demands from the directly affected industries (sales by vendors who supply SBIR/STTR firms), estimated using IMPLAN's NAICS-based input-output model for the national and regional economies.
- **Induced effects** reflect changes in local spending that result from income changes in the directly and indirectly affected industry sectors (e.g., impacts from wage expenditures).

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<sup>7</sup> See <http://www.implan.com> for a detailed description. IMPLAN is used by more than 1,500 clients in government, the private sector, academia, and foundations.

These are household expenditures as workers spend their payroll checks on goods and services across a wide spectrum of the economy.<sup>8</sup>

## ECONOMIC IMPACTS

Using the IMPLAN model, the TechLink team estimated that the overall economic impact for the Navy and Air Force programs (for projects completed in 2000-2013), was \$92.1 billion. Based on original SBIR/STTR expenditures of \$6.25 billion, that equals an overall return on investment (ROI) of 14.7:1 in economic impacts (Table 5).

**Table 5 Economic outputs from the Air Force and Navy SBIR/STTR programs, 2000-2013 (\$ billion)**

	Air Force			Navy		
	SBIR contracts	product/ services sales	total impacts	SBIR contracts	product/ services sales	total impacts
Direct effect	3.99	14.69	18.68	2.26	14.17	16.43
Indirect effect	2.85	11.6	14.45	1.65	11.77	13.42
Induced effects	3.67	11.07	14.74	2.19	12.23	14.42
Total	10.51	37.36	47.87	6.1	38.17	44.27
ROI (total return/cost of awards)			12.0			19.6

Source: TechLink

Navy ROI may be higher in part because the survey covered the same award years, but the Navy survey data were collected in 2015-2016 while the Air Force data were collected in 2014, giving Navy awards longer to reach commercialization and then grow sales.

<sup>8</sup> "Research on the Economic Impact of Cooperatives: IMPLAN Methodology" (University of Wisconsin, June 2009), <http://reic.uwcc.wisc.edu/implan/>.



**Box 1 Extremely preliminary estimates for program wide economic impacts**

Given that Navy and Air Force together account for about 20% of the entire SBIR/STTR program, we can consider extrapolating the results and applying the modeling methodology from these studies to the entire SBIR/STTR program. If projects at other agencies (and DOD components) generated results similar to Air Force and Navy, the total economic impact of the program for awards that completed between 2000 and 2013 would be on the order of \$250 billion, generating about \$18 billion in taxes, and supporting more than 1 million job-years (one full time job for one year).

Such an extrapolation provides only the most approximate order of magnitude estimates. Much more work would need to be done before firmer estimates are possible. Upcoming TechLink studies of the entire DOD SBIR/STTR program and of a large component of NIH (NCI) are planned for 2017-2018. SBA has also initiated a project to use administrative data to study outcomes which would allow estimates to be extended to other agencies. Both may provide opportunities to refine these estimates and ground them in larger data sets.

However, such an approximate order-of-magnitude calculation does provide some perspective on the depth and reach of the program across the economy as a whole.

**EMPLOYMENT**

The TechLink surveys simply asked for the number of employees at the time of the survey. The IMPLAN economic model then allowed for an estimate of economic impacts in terms of full-time equivalent (FTE) jobs. The model estimates FTE job years, which is one full time job for one year (see Table 6).

**Table 6 Aggregate job-years created by Navy and Air Force SBIR/STTR programs, 2000-2013**

	Air Force			Navy		
	SBIR contracts	product/ services sales	total impacts	SBIR contracts	product/ services sales	total impacts
Direct effect	17,978	47,359	65,337	8,377	49,711	58,088
Indirect effect	17,806	55,312	73,118	10,076	53,358	63,434
Induced effects	23,931	72,125	96,056	13,372	74,734	88,106
Total	59,715	174,796	234,511	31,825	177,803	209,628
ROI (total job years/\$1M in award costss)			58.8			92.8

Source: TechLink

Together, the AF Force and Navy programs generated more than 440,000 job years. This represents an average return on investment of about 71 job-years per \$1 million in program investment.

Another way to look at employment outcomes is the average number of jobs generated by the programs in each year across the 2000-2013 timeframe. Table 7 shows that on average, the programs generated an average of more than 31,000 jobs per year during this period (5 jobs per \$1 million expended). To put this in context, the Federal Reserve estimated that the Mercedes Benz plant in Alabama cost the state about \$50 million in direct costs, and \$300 million in tax breaks, to attract 1,500 jobs [Zaretsky, 1994] – equivalent to 4.3 jobs per \$1 million invested. SBIR-derived jobs also pay much better, and the program is more scalable.

**Table 7 Jobs per year generated by Air Force and Navy SBIR programs, 2000-2013 (jobs)**

	<b>SBIR contracts</b>	<b>product/ services sales</b>	<b>total impacts</b>
Air Force	4,265	12,485	16,750
Navy	2,273	12,700	14,973

Source: TechLink

The National Academies surveys asked firms to report the number of employees at the time of the award and at the time of the survey, and focused only on direct impacts at recipient companies. Based on that data, the National Academies did not find that there had been substantial employment growth, although some firms had grown substantially: Qualcomm for example had grown from a small firm to a behemoth with more than 30,000 employees.

## LABOR INCOME

The jobs created through the SBIR/STTR programs translate into substantial income for workers, known as labor income. About 1/3<sup>rd</sup> of all the economic outputs generated by the programs took the form of labor income, and that the \$6.25 billion in investment generated \$30 billion in labor income overall.

**Table 8 Labor income generated by Air Force and Navy SBIR programs, 2000-2013 (\$ billion)**

	Air Force				Navy		
	SBIR contracts	product/ services sales	total impacts		SBIR contracts	product/ services sales	total impacts
Direct effect	1.64	4.45	6.09		0.87	4.76	5.63
Indirect effect	1.06	3.59	4.65		0.63	3.63	4.26
Induced effects	1.15	3.47	4.62		0.68	3.80	4.48
Total	3.85	11.51	15.36		2.18	12.19	14.37
ROI (total labor income/total costs)			3.8				6.4

Source: TechLink

These are jobs that pay well above the national average. Jobs at the SBIR firms themselves averaged close to \$100,000 annually, while those at direct suppliers averaged over \$60,000. To provide some context, average annual earnings are about \$50,000 in manufacturing.<sup>9</sup>

## TAX EFFECTS

The economic activity flowing from the SBIR/STTR programs also generates substantial tax revenues, which are also estimated in the TechLink studies using the IMPLAN economic model. The \$6.25 billion investment in these programs led to economic activity that generates a total of \$8.8 billion in total tax revenues (Table 9).

**Table 9 Tax revenues generated directly and indirectly by Navy and Air Force SBIR/STTR programs, 2000-2013 (\$ billion).**

	Air Force	Navy
Direct effect	1.25	1.57
Indirect effect	1.24	1.48
Induced effects	1.41	1.85
Total	3.90	4.90

Source: TechLink

In strictly financial terms, the Air Force and Navy SBIR/STTR programs cost a total of \$6.3 billion during the period covered by the TechLink studies, so the tax revenues generated directly and indirectly by the programs more than covered their cost.

<sup>9</sup> BLS "Manufacturing at a glance," accessed May 8 2017, <https://www.bls.gov/iag/tgs/iag31-33.htm>

## OTHER IMPACTS

### KNOWLEDGE EFFECTS AND THE UNIVERSITY CONNECTION

Not all important impacts of the SBIR/STTR program translate directly into dollars and cents. One of the Congressionally mandated objectives is to stimulate technological innovation, which in turn expands economic activity. The National Academies reports explored these effects in some detail.

### THE UNIVERSITY CONNECTION

SBIR/STTR connects companies to universities and research centers. STTR projects are required to have a university connection (there are a few with partners from foundations, but an overwhelming majority partnered with universities). But the detailed analysis in these reports showed that SBIR connections reached across hundreds of institutions, and that in fact SBIR may provide more support – certainly more support for commercialization – than direct Federal funding for universities, which is heavily concentrated in a small number of institutions.<sup>10</sup>

The SBIR link is also surprisingly strong. There are many different ways in which SBIR projects involve universities, and the Academies surveys found that at every agency more than 60% of SBIR firms had at least one academic founder, and many had more than one (see Table 10). This illustrates SBIR linking academic research and commercial activity.

**Table 10 Academic founders at SBIR-winning firms**

	<b>DoD</b>	<b>NIH</b>	<b>NSF</b>	<b>NASA</b>	<b>DOE</b>
% of companies reporting at least one academic founder	61	86	81	63	68

Source: NAS (2014-2016)

On many projects, university faculty or adjunct faculty acted as the principal investigators or consultants. Often, the university was the original source of the technology being developed through the SBIR award. And as with other scientific research programs, graduate students were in many cases paid to work on the project. Table 11 shows the varied patterns of university connections at the different agencies.

<sup>10</sup> See National Center for Education Statistics, Federal Obligations for Research and Development by Academic Institution, <https://ncesdata.nsf.gov/webcaspar>, accessed 4/17/2017

**Table 11 University connections (% of survey responses)**

	<b>DoD</b>	<b>NIH</b>	<b>NSF</b>	<b>NASA</b>	<b>DOE</b>
Faculty worked project (not PI)	19	38	36	15	26
Subcontractor	20	37	23	21	29
Graduate students	18	22	31	14	21
Technology originally from university	8	20	19	5	6
PI was adjunct faculty	3	10	3	2	2
Licensed from university	3	16	13	2	3
PI was faculty member	2	17	4	1	0
At least one connection	35	70	58	31	43

Source: NAS (2014-2016)

Links to universities were much stronger at the granting agencies – in particularly NIH – and weaker at the DOD and NASA. The reality is that faculty are used to applying for grants, not contracts; DOD and NASA are significantly focused on ensuring that the winning firm can actually deliver on contract requirements; and at NIH in particular, the cross-over between academic research in the life sciences and biotech commercialization is particularly strong.

For all the agencies, about half of the projects with a university connection involved a faculty consultant, and an even higher percentage reported use of the university as a subcontractor (most likely in many cases as the source of equipment or lab space). Except at NIH, few faculty directed projects.

The Academy reported that SBIR flowed to a wide range of universities. While Federal funding for university research is heavily concentrated in a few universities, SBIR connections were widely distributed. At NIH for example, 488 projects reported a university connection of some kind, and these connected to 255 different universities. [NAS, 2015].<sup>11</sup>

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## PATENTING ACTIVITY

Patents are another important metric for assessing the creation of commercially valuable intellectual property (IP). They are costly to acquire and defend, and hence represent a more commercial aspect of knowledge than some of the other metrics discussed below.

The Academies surveyed asked companies to report on both the number of patents related to the specific project being surveyed, and also related to all the SBIR/STTR awards received by the firm. At least 32% of projects reported at least one patent related to the surveyed project, with

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<sup>11</sup> For context, North Carolina Central University received the 255<sup>th</sup> most federal R&D funding in 2015 - \$7,011.

both NIH and NSF awardees reporting much higher numbers (53% and 70% respectively). Well over 50% of respondents reported that SBIR/STTR awards were related to at least one patent across the firm as a whole (see Table 12).

**Table 12 Patenting activity at SBIR/STTR awardees, by agency, 2000-2012**

	DoD	NIH	NSF	NASA	DOE
At least one patent related to the surveyed project	32	53	70	45	38
At least one patent related to all SBIR/STTR projects	58	64	71	76	68

Source: National Academies (2014-2016)

Table 12 shows the incidence of patenting; Table 13 shows the scale – at least 10% of respondents at every agency claimed to have acquired 10 or more patents related to SBIR/STTR awards, while at least a third of respondents reported acquiring at least 3 related patents.

**Table 13 Number of patents acquired related to all firm SBIR/STTR awards, by agency**

No. of patents	% of responding companies				
	DoD	NIH	NSF	NASA	DOE
0	42	34	29	24	32
1-2	25	24	31	39	20
3-4	12	14	17	13	18
5-9	11	15	11	11	14
10+	10	13	12	14	17

Source: National Academies (2014-2016)

The patenting numbers are strong. Overall, SBIR/STTR awards connect directly to resulting patents at rates ranging from almost 60% at DOD to 76% at NASA. And while there are no comparable estimates for similar firms outside SBIR, the numbers at DOD are especially worth noting as DOD firms typically rely more on data rights and less on patents to protect their IP.

## COMPANY IMPACTS AND COMPANY FORMATION

SBIR/STTR doesn't just fund projects – it helps to support an entire ecosystem of small innovative companies. More than 60% of NAS respondents claimed that the award had had a transformative or substantially positive effect on their company - a remarkably high level of impact.

Remarkably, the National Academies found that over 70% of projects would probably or certainly not have gone ahead without SBIR (Table 14).

**Table 14 Percentage of NAS respondents reporting that project would certainly or probably not have gone ahead without SBIR/STTR funding**

DoD	NIH	NSF	NASA	DOE
80	74	68	63	71

Source: NAS [2014-2016]

And SBIR/STTR seems to have had a significant effect on the decision to form a company in the first place. At both DOD and NIH (accounting for three quarters of the program) about 18% of respondents said that the company had specifically been founded to pursue SBIR/STTR awards; and many more indicated that this was at least in part the reason for company formation [NAS 2014, 2015].

This is especially important in the context of the long and steep decline in the rate at which startups are formed in America. Hathaway and Litan show that this decline is both prolonged and affects high tech sectors as well as others. Given the importance of these sectors for job and wage growth, SBIR/STTR's role is especially important [Hathaway and Litan, Hathaway].

About half of SBIR/STTR recipients reported to the Academies that the availability of SBIR/STTR seed funding made a difference to the founders' decision to form a company. This indicates that while SBIR/STTR programs try to identify good prospects for commercialization, the existence of the programs in itself changes the environment for very early stage firms.

Once formed, SBIR/STTR is transformative for many firms: about 70% of projects reported to the National Academies that SBIR/STTR had had a transformative or strongly positive impact on the firm's trajectory. Many of the case studies illustrated the impact of SBIR/STTR funding at key moments in company history (e.g. Qualcomm). [Jacobs 2011]

## ACQUISITIONS AND MERGERS

Because they generate innovative technologies, SBIR firms are often good targets for acquisition as their technology improves. This can benefit both sides: the acquiring company gets access to the technology and often the team that developed it; the selling company receives money (which often goes primarily to founders and investors), and also often finds that the acquiring company has much better marketing mechanisms and hence can provide a substantial boost to the commercial prospects for the technology.

Data on acquisitions are available but their accuracy is hard to determine. 6-10% of companies reported through the Academies surveys that the company was completely or partially sold (numbers vary by agency); IDI claims that 8.5% of all SBIR/STTR firms have been acquired, and that the median acquisition price was \$42 million [InKnowvation]; and the TechLink studies claim that 18% of the companies in their surveys were acquired or merged, with a total value of \$8.6 billion. The TechLink studies thus identify a higher percentage of companies involved than either the Academies or IDI, but a lower median value than IDI (the Academies did not ask that question).<sup>12</sup>

As firms are acquired they typically become ineligible for further awards and harder to track down, so it is certainly possible that the TechLink numbers are more typical (although it may also be that firms serving the Air Force and Navy generate commercial results that make them more attractive as takeover targets than firms serving the commercial private sector, while the limited size of many military markets could reduce the transaction price).

We can conclude that somewhere between 8% and 18% of SBIR/STTR winners are acquired at some point, and that these firms are valuable, with a median value of at least \$15m. Large acquisitions are worth much more.

#### TECHNOLOGY-DRIVEN COST SAVINGS FOR ACQUISITION AGENCIES

Sales to military acquisition programs are important, but the savings that SBIR/STTR technologies generate can be even more important. Although the CCR has been used to track cost savings, the companies that report through the CRR don't have the data to track savings effectively, making the CCR an unreliable source for this data.<sup>13</sup> And agencies don't have data tracking in place to identify cost savings systematically and then to link those savings to specific SBIR/STTR awards and technologies.

That said, there have been some preliminary efforts to understand savings impacts, especially at DOD:

- **The F-35 Lightning II fighter plane program** has realized more than \$500 million in cost savings/cost avoidance to date through use of SBIR/STTR technology and manufacturing solutions. [Bogan, 2016]
- The **MRAP vehicle** that saved lives in Iraq and Afghanistan realized a 90% savings in live-fire testing through use of SBIR/STTR technology.

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<sup>12</sup> IDI claims total acquisitions of more than \$474 billion for the entire SBIR program, since 1983. [IDI, 2017]

<sup>13</sup> Savings data have to be identified by the agencies, but they have in the past found that tracking savings is very difficult.



- The **Virginia-class submarine** realizes cost savings and avoidance of about \$1million per hull by using SBIR/STTR technology in the boat’s communications system alone, and millions more with SBIR/STTRs in additional submarine systems. [NAS, 2014]

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### About Incumetrics

[Incumetrics](#) is a small company focused on measuring, evaluating, and assessing innovation and developing policy for companies, nonprofits, regions, and national governments. It is led by [Dr. Robin Gaster](#), who was the lead researcher on the National Academies series of reports on the SBIR program, and who is also publisher of the [Great Disruption](#) blog, focused on the impact of technology and globalization on the future of work.

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