

Purpose and Performance of the Small Business Innovation Research (SBIR) Program

Ronald S. Cooper

ABSTRACT. The Small Business Innovation Research (SBIR) Program is one of the most successful public programs designed to support small firm innovation. The purpose and structure of the program, however, are often misunderstood. This paper clarifies the goals and rationale for the SBIR program and reviews recent findings regarding the program's impact. The paper identifies five dimensions of the innovation capital gap and outlines a possible extension of the program to better address this finance gap.

I. Introduction

The purpose of this article is to take stock of the performance of the Small Business Innovation Research (SBIR) Program, in light of its legislated objectives and recent reviews of the program. The SBIR is a program with multiple objectives and a unique design. While the program's breadth has contributed to its ongoing success, it has at the same time contributed to some confusion about the program. The information in this report is provided to help clarify the purpose, rationale, and impacts of the program.

The article is organized as follows: Section 2 describes the structure and goals of the program. Sections 3 and 4 focus on the program's central goals: meeting federal research needs with small business and fostering commercialization of federally funded research. Section 5 elaborates on the gap in small-scale, early-stage, financing which provides a rationale for public funding of early stage innovation commercialization activities. Section 6 discusses commercialization obsta-

cles faced by some SBIR firms and describes a prospective Phase III matching grant program to ready SBIR firms for commercialization. Section 7 notes administrative improvements to the program that the SBA has planned or already underway.

II. Structure and objectives of the program

The SBIR program was created by the Small Business Innovation Development Act of 1982 (P.L. 97-219). The Act mandated that each Federal agency with an extramural R&D budget in excess of \$100 million designate a certain percentage of this budget for awards to small businesses. The set-aside was initially set at 0.2 percent of an agency's extramural R&D budget, with a legislated growth to 1.25 percent in 1987. This level continued through 1992. On October 28, 1992, the program was reauthorized (P.L. 102-564) through FY 2000 and Congress maintained the growth in the set-aside by directing that the percentage increase to 2.5 percent by FY 1997 and stay at that level through FY 2000.¹ In December 2000, Congress reauthorized the SBIR program through 2008, with the set-aside percentage to remain at 2.5 percent throughout the period.²

Under the program criteria, ten Federal agencies must currently participate in the program. Total obligations for the program in 1999 were about \$1.1 billion (See Tables I and II).

The program was established with a three-phase structure that promotes progress towards commercialization:

- *Phase I* awards of up to \$100,000 are funded for six months for research projects to evaluate the scientific and technical merit and feasibility

Office of Technology
U.S. Small Business Administration
409 3rd St. SW
Washington, D.C. 20416
U.S.A.
E-mail: ronald.cooper@sba.gov



TABLE I
SBIR awards – FY 1983 through FY 1999

FY:	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99
<i>Number of SBIR awards</i>																	
Phase I	686	999	1,397	1,945	2,189	2,013	2,137	2,346	2,553	2,559	2,898	3,102	3,085	2,841	3,371	3,022	3,334
Phase II		338	407	564	768	711	749	837	788	916	1,141	928	1,263	1,191	1,404	1,320	1,256
Total	686	1,337	1,804	2,509	2,957	2,724	2,886	3,183	3,341	3,475	4,039	4,030	4,348	4,032	4,775	4,342	4,590
<i>Value of SBIR awards (in millions of dollars)*</i>																	
Phase I	45	48	69	99	110	102	108	118	128	128	154	220	232	229	228	262	300
Phase II		60	130	199	241	249	322	342	336	371	491	474	602	646	789	804	797
Total	45	108	199	298	351	389	432	461	483	508	698	718	835	916	1,107	1,067	1,097

* Figures for 1988–1997 include award modifications. Errors due to rounding.

Source: SBA, Office of Technology.

TABLE II
SBIR agency obligations, fiscal year 1999

Agency	Obligations (millions of dollars)
Department of defense	514.1
Health and human services	314.0
National aeronautics and space administration	89.1
Department of energy	81.3
National science foundation	60.4
Department of agriculture	12.7
Department of commerce	7.4
Department of transportation	6.3
Environmental protection agency	5.5
Department of education	5.3
Total	1,096.5

Note: Award modifications not include.

Source: Small Business Administration, Office of Technology.

of an idea, and to enable the funding agency to assess the quality of the recipient firm and its project.

- *Phase II* funding is provided for the Phase I projects with the most potential to further develop the proposed idea. Phase II funding is for one or two years, and most awards are \$750,000 or less.
- *Phase III* is when commercialization takes place, when private sector investment and support brings an innovation to market. Phase III may also involve follow-up production contracts issued by a Federal agency. SBIR funds are not used for Phase III activities.

The broad purpose of the program, as stated in the 1982 Act, is to

strengthen the role of the small, innovative firms in federally funded research and development, and to utilize Federal research and development as a base for technological innovation to meet agency needs and to contribute to the growth and strength of the Nation's economy.³

The legislation listed the following more specific purposes:

- (1) to stimulate technological innovation;
- (2) to use small business to meet Federal research and development needs;
- (3) to foster and encourage participation by minority and disadvantaged persons in technological innovation; and
- (4) to increase private sector commercialization of innovations derived from Federal research and development.

These goals have been maintained throughout the program. The 1992 SBIR reauthorization bill placed added emphasis on the commercialization objective and made more explicit the objective of increasing the small business share of federally funded R&D. The 2000 reauthorization does not alter these main objectives of the program.

A unique feature of the SBIR program is the fact that it embraces the multiple goals listed above and that it maintains an administrative flexibility that allows very different federal agencies to use the program to meet their needs. While this complexity has been key to the success

of the program, it has also led to misunderstandings about the program. The following discussion is intended to help clarify the program's goals, mechanisms, and rationale.

III. How SBIR meets federal research needs with small business

As stated in the 1982 and 1992 SBIR legislation, one of the goals of the SBIR program has been to strengthen the role of small innovative firms in federally funded R&D. The program seeks to ensure that small businesses are not locked out of or discouraged from the federal R&D contract and procurement process. At the same time, the SBIR is a program that administers federal agency R&D funds and therefore has a direct interest in providing agencies with top quality research. Evidence shows that while the program succeeds in providing high quality research meeting agency requirements, the small business share of federally funded R&D remains relatively small.

Analyses of the program have shown that SBIR projects deliver high quality research that benefits the missions of the participating federal agencies. The manner in which agency research needs are met, however, depends on the particular objectives and missions of the awarding agency, which vary considerably across agencies. Some seek the development of new products, processes, or services to meet their program needs. Others focus more on building the research and science base in specific fields.

The program's project selection is a highly competitive peer review process. In 1999, over 19,000 Phase I project proposals were received, yet only 3,334 (17 percent) were funded. This relatively low award-to-application ratio has enabled the program to select consistently high quality projects. The program further selects projects and firms at the second phase. About half of the Phase I projects receive a Phase II award to continue the project.⁴

In 1999, researchers at the College of William and Mary surveyed Defense Department officials regarding the quality of SBIR project research and the benefit to the Agency's missions. The results of the survey show that 32 percent of SBIR projects provide value to agency missions that is greater than non-SBIR projects and 42 percent

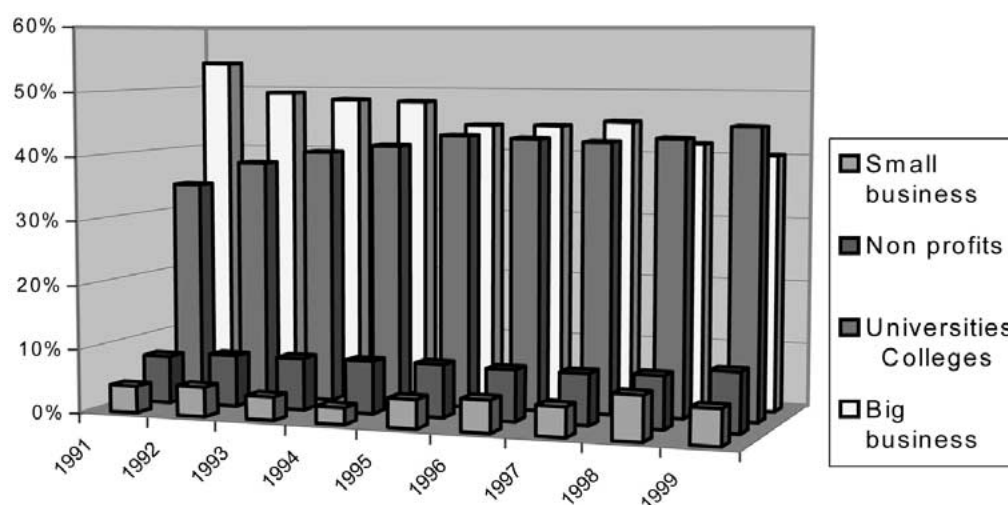
provide mission benefits comparable to agencies' non-SBIR projects. The survey found that the average quality of SBIR research was the same as that of other federally funded research.⁵

Another indication of the quality of SBIR project research is that the awards appear to be a signal to potential investors of high quality research and technology. Lerner (1996) has labeled this the *certification effect* of receiving the awards. The fact that the financial markets look favorably on firms with SBIR awards, and that directories see the awards as important information to publish, suggest that the program's project review and selection process identifies projects and firms of high quality.

National Science Foundation statistics show that the small business share of federally funded research has remained small relative to the shares of other R&D performing sectors such as large firms and universities. In 1998, the small business share of Federal extramural R&D was less than 7 percent, compared with about 42 percent for large firms, 43 percent for universities and colleges, and about 8 percent for nonprofit organizations (see Figure 1).

IV. SBIR program fosters commercialization of federally funded research

Although commercialization is only one of the program's goals, SBIR program success has usually been discussed and measured in terms of its ability to move federal research ideas into private markets, generating income and employment. The program appears to have done well when judged on this basis, even though empirical studies have been limited largely to the use of firm sales data as the indicator of success. The successful transfer of federally funded research and technology into commercial economic activity, however, may manifest in a number of other ways – such as increased productivity, development of new innovative capacity, or company start-up decisions – which can translate over time into greater competitiveness, market performance, and job creation. Future program assessments should develop indicators to capture these other effects and should try to go beyond the more broadly applicable and easily quantifiable measures.



Source: Data developed from NSF, *Research and Development in Industry, 1998*, and NSF, *National Patterns of R&D Resources: 1998*

Figure 1. Share of federal extramural R&D budget.

Reviews of the SBIR program have documented the sales and additional funds generated as a result of SBIR grants and generally conclude that the program has had a significant and positive impact on the commercialization of innovations derived from federally funded research, and on the subsequent growth of the firms.

A 1996 Harvard University study found that the SBIR program has had a positive long run impact in areas where venture capital is available. Professor Josh Lerner found that SBIR awardees grew significantly faster – whether measured by sales or employment – than a matched set of firms over a ten-year period. The study found that, from 1985 to 1995, average sales increased by \$4 million for the SBIR awardees compared to only \$1.1 million for the matched firms. Similarly, employment in the SBIR firms grew by over 26 employees on average over this time period, while the matched firms added only six employees.⁶ Lerner's study is the only study to date that has examined the performance of SBIR firms against non-SBIR firms in a time period long enough to capture potential firm-specific impacts of R&D activity.

A 1992 study by the General Accounting Office found that "the program is showing success in Phase III (commercialization) activity" and that SBIR expenditures of \$956 million over 1984–

1987 had generated \$471 million in sales of new commercial products and \$646 million in additional developmental funding as of July 1991 (GAO, 1992).

Studies by the DoD in 1996 and BRTRC Inc. in 1998 (both of which used the same methodology as the GAO study and which together cover all SBIR agencies) found that 39 percent of all respondents (representing 1,031 projects) reported actual sales resulting from the work done under SBIR grants, and 55 percent of the respondents reported either sales or additional development funding or both (BRTRC, 1999). The study also reported that over the ten-year period from 1984 through 1993, SBIR projects have generated \$2.5 billion in sales, \$2.2 billion in additional development funding, and were expected at the time of the 1998 BRTRC survey to generate about \$4.6 billion over the next two years (1998 and 1999). The study found that the average Phase II SBIR project over 1984–1993 (funded at approximately \$500,000) had generated \$950,000 in sales and attracted about \$625,000 in additional, non-SBIR funding as of 1998 (BRTRC, 1999).

Using only the last four years of the 1998 study (1990–1993), the BRTRC study was able to compare data from the 1991 GAO survey with the 1996/1998 surveys. This comparison showed that average sales for SBIR projects increased from

\$322,950 to \$767,600.⁷ Figure 2 compares these 1996/1998 reported sales to the sales in 1991, showing the distribution of average sales among the public and private markets. The greatest increase in sales was to the private sector, which almost tripled, while public sector sales have not quite doubled.

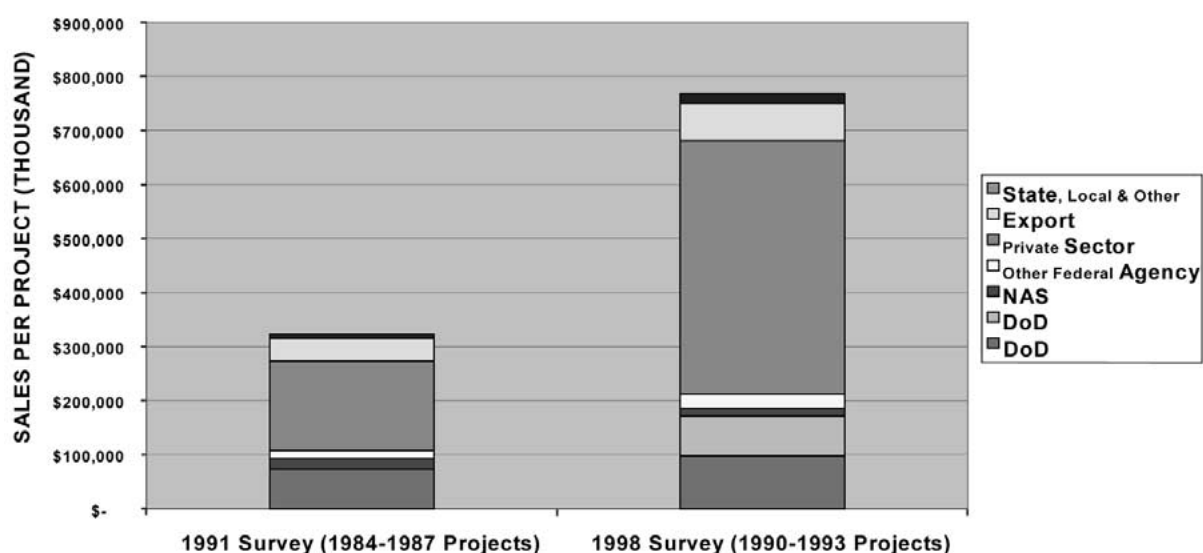
In the recently released NRC review of the SBIR program (Wessner, 2000), researchers report that the program has enabled entrepreneurs to start new firms and has had the effect of inspiring other inventors to seek means of developing commercial applications of their ideas. Studies in this report found that a significant number of SBIR awardees would not have started their company at all if it had not been for the SBIR program. In one of the studies, Dr. David Audretsch et al., using both case study and survey methods, found that half of the case studies and over half of the firms surveyed said that the existence of the SBIR program influenced their decision to start their company. They found that about half of the firms would not have started or continued their firms if

the SBIR program had not been available to them.⁸ These findings are consistent with those of the earlier BRTRC and DoD surveys which concluded that 73 percent of the SBIR projects would probably not, or definitely not, have been undertaken without assistance from the SBIR program.⁹

Another beneficial impact of the SBIR program that is not often recognized is called the *demonstration effect*. In the Audretsch et al. study, one-third of the cases were able to name someone else who had started a firm or commercialized his or her knowledge as a result of the example of the SBIR firm. The authors report that “there is at least some evidence to suggest that the entrepreneurial behavior exhibited by the SBIR firm has an externality in that the career paths of other scientists are influenced toward commercialization.” This effect multiplies the beneficial impact of the SBIR program by stimulating additional entrepreneurial activity.

The SBIR program contains intellectual property rights provisions that provide an additional incentive for participating firms to com-

COMPARISON OF AVERAGE SALES FROM FOUR YEARS OF SBIR PHASE II PROJECTS AS MEASURED IN THE 1991 AND 1998 SURVEYS



Source: BRTRC (1999)

Figure 2. Increase in average sales.

mercialize their technology. The federal agencies that participate in the program are required to protect technical data and software generated by firms under SBIR grants for at least four years following the completion of the project from which the data were generated.¹⁰

During this period, the government agency is prohibited from disclosing technical information produced under the grant and from using the data for commercial purposes or in ways that could harm the prospects of the small business concern to commercialize the technology. The awarding agency retains a royalty-free license to use the data for government purposes. After the data rights period has expired, the government retains the royalty free license for government purposes, may authorize others to use the technology on its behalf, and is relieved of all disclosure restrictions.

The period of *SBIR data rights* is offered to give SBIR companies time to secure intellectual property protection in the form of patents, copyrights, or other means. The intention of the program's enabling legislation is for the intellectual property rights – the rights to use technology developed under the program for commercial purposes – to reside with the small business concern, not the federal government. This serves the program objective of improving the transfer of federally funded R&D into the marketplace by providing an incentive for the small firms to develop commercial applications of the agency research or technology.

Most SBIR evaluations to date have relied on program-related firm sales and additional investment as indicators of the program's commercialization success. However, the successful transfer of federally funded research into the economy often follows a more indirect path, producing intermediate impacts such as increased technical knowledge, intellectual capital, and new innovative capacity. In addition, longer term effects may take the form of increased firm productivity or innovation activity rather than actual sales.

The effect of SBIR grants on the winning firms varies widely according to the nature of the research project and the needs of the funding agency. Some SBIR grants seek to enable firms to develop new ideas into products that are produced and sold, forming new lines of business and creating income and employment. Other

grants are better characterized as basic science or research and have the effect of establishing a firm's scientific and technological base in a new technology area where the firm may or may not later innovate.

Examples of ways the SBIR program can affect the commercial success of small firms, that may not be reflected in the sales data, include:

- increasing the scope and/or level of risk of the firms' R&D activities
- increasing staff skills
- increasing the financial credibility of the firm (the *certification* or *halo* effect)
- increasing the capacity of the firm to take on long-term research

The SBA's Office of Technology and the agencies participating in the SBIR program are currently assessing means of measuring these impacts for the purpose of improving program evaluation methodology.

V. SBIR grants support innovation by addressing a gap in early-stage financing

An additional rationale for the SBIR grant program is that it directly addresses a failure of the private capital markets to adequately fund early stage small business innovative activity. It is now widely accepted that private capital markets provide insufficient incentive to provide a socially optimal level of early stage research and innovative activity in the economy. This market failure leads to a general underinvestment in such activities. There are, however, additional elements of market failure that apply specifically to small firms, further limiting the innovative potential of these firms.

The SBIR program acts to directly offset these market failures, and the resultant finance gap, by funding small business R&D projects in their early stages. The SBIR program's Phase I and Phase II grants are often the only source of funding available to new innovative entrepreneurs. For some companies, this has been sufficient to get them from the idea to a commercially viable innovation. Other projects that have a longer development time may not, by the end of SBIR Phase II, be to the point where private capital markets are willing

to invest. This section discusses the nature of the capital funding gap and what the SBIR program does to offset it.

As new firms and projects progress through the stages of their development, they rely on different sources of financing. Figure 3 shows the sources of capital new firms use at various developmental stages, from the early high-risk seed financing to the low risk capital available to the established firm and the advanced-stage technology venture. The gap is at the seed and start-up stages where many new ventures must rely on their own money or on personal contacts, and before the project has developed to the point that an angel or venture capitalist is interested.

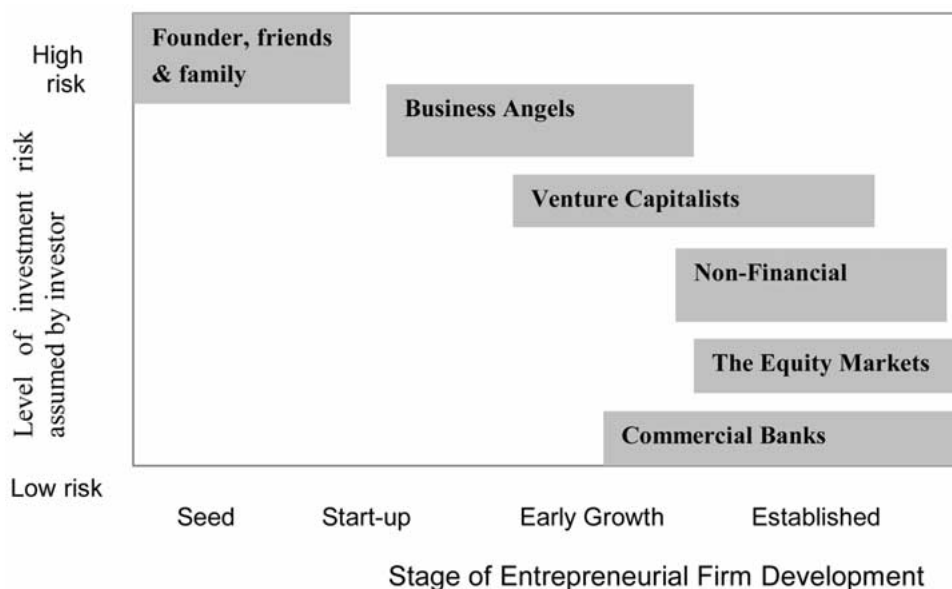
The problem is not unique to the United States. A recent survey of the 100 fastest growing unquoted firms in the U.K., for example, found that financing is the most frequently self-reported obstacle to growth. Another study of U.K. firms found that only 23 percent of small high-growth firms heavily utilize outside funding in their earliest stages, while 27 percent use a mix of self and outside funding, and the remaining 50 percent are primarily self-funded.¹¹ The picture for more established small firms seeking funding for new innovative projects is likely to be similar except

that they may have the option of using internal cash flow to finance the early phases.

The financing gap that confronts small firm, early stage, innovation exists because private capital markets have insufficient information on small firm projects, look for larger ventures, require a shorter time to exit, focus on only a few technologies at one time, and cluster in a few geographic areas. There are, therefore, five main dimensions to the gap: Information, Size of financing, Time frame, Technology area, and Location.

Potential suppliers of risk capital lack information on small entrepreneurs and entrepreneurs lack information on the available sources of finance capital. This inadequate information flow means that the information on which investment decisions are based is skewed towards the larger deals and larger firms on which information is more readily available. Many venture capital funds feel they cannot afford to spend the resources to learn of and monitor possible ventures that are small in scale. This is because much of the cost of learning about a new prospective venture is fixed, that is, it does not vary with the size of the possible financing.

It is also the case that entrepreneurs and small



Source: Van Osnabrugge, M. and Robinson, R. J. (2000, forthcoming). *Angel Investors in America*. Jossey-Bass, San Francisco

Figure 3. Providers of external finance through the stages of entrepreneurial firm development.

firms suffer from inadequate information on financing sources and often do not know how to approach venture capitalists or other potential investors. The fact that most business angels prefer to maintain their anonymity makes it even more difficult for entrepreneurs to learn of them.

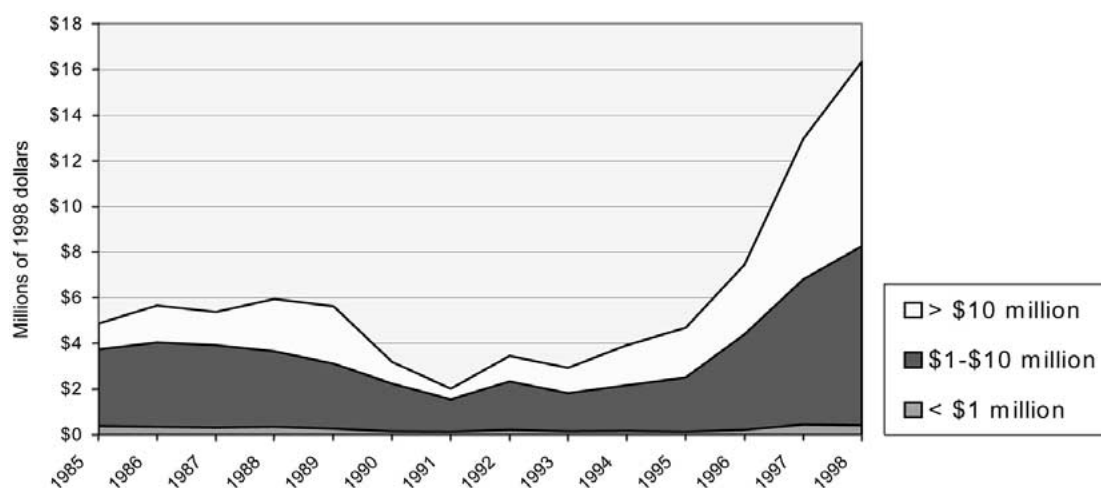
The SBIR program addresses this information gap in two ways. First, the firms that win SBIR awards receive recognition for this that is helpful in raising follow-on financing. This is referred to above as the *certification effect* of the awards. Second, the SBA and agency SBIR programs are developing new ways to provide information on SBIR firms to the risk capital community; including SBICs, venture capital networks, and angel capital networks.

Venture capital is interested in larger investments than is appropriate for many small innovative technology firms. The average SBIR Phase III project, for example, requires between \$400,000 to \$1 million, whereas the average venture capital deal is about \$9 million.¹² Data on the distribution of U.S. venture capital disbursements by size of financing round show that only 3 percent of the funds are now used in deals under \$1 million. This share has been falling steadily from 6 percent in the early 1990s. The bulk of venture capital (the other 97 percent) is divided evenly between deals in the \$1 million to \$10 million range (48 percent), and those that are larger than \$10 million (49

percent). Figure 4 shows the rapid increase in total venture capital disbursements, in inflation-adjusted dollars, since the mid-1990s.¹³ While deals under \$1 million have increased during the last few years, they have only recovered to the levels of the mid-1980s (3 percent), and have not been a part of the rapid expansion in larger-scale venture capital financing.

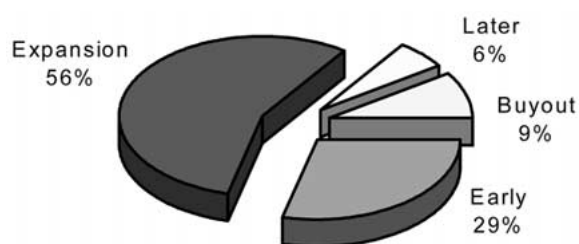
Venture capital (including SBICs) tends to require a shorter time to exit than is appropriate for many small firm innovation ventures such as the projects funded by the SBIR program. Venture capital funds are now generally looking for deals with a likely exit (through, for example, a buy-out or IPO) in 6 months to 2 or perhaps 3 year's time. The shorter time horizon means that venture funds are more interested in the later stages of project development and less interested in the higher risk, early innovation stage that is the focus of the SBIR program. Figure 5 shows that less than one-third of venture capital disbursements went to *early stage* ventures which includes not only seed and start-up financing, but also first-stage financing for companies ready to initiate full-scale manufacturing and sales. The recent availability of relatively large and fast-maturing internet-related and other high-tech investment opportunities appears to have exacerbated this problem.

At any one time, venture capital is concentrated in a few industries considered to have extremely



Source: NVCA and Venture Economics, special tabulations

Figure 4. U.S. venture capital disbursements by size of financing round.



Source: Venture Economics and NVCA, 1999 *National Venture Capital Association Yearbook*

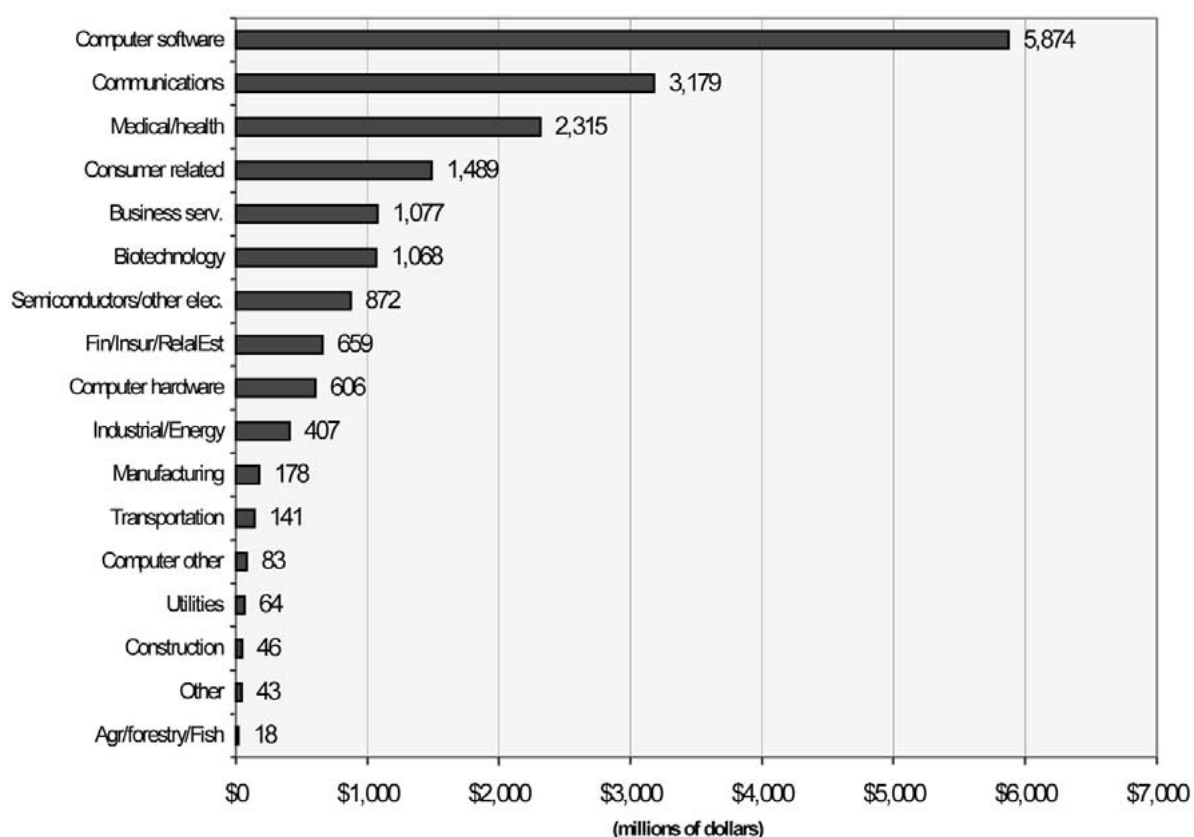
Figure 5. Venture capital disbursements, 1998 by company stage.

high potential. Figure 6 shows the concentration of venture capital financing in computers and information technologies for 1998. The tendency of venture capital to follow technology investment fads that concentrate in a few sectors, leaves gaps

in the financing of viable innovation projects with significant payoff to society. This inefficient use of available information constitutes a failure of the market to allocate such funds efficiently and creates a role for public investments such as the SBIR program grants.

The technology areas of SBIR projects are, by contrast with venture capital, selected by federal agencies to further public program goals. Table III shows the distribution of SBIR grants by technology area for 1998. While the technology categories are not the same, a comparison with Figure 6 shows that SBIR projects are not as heavily concentrated as venture capital financing and have a greater share in areas of public interest such as energy and transportation.

In a recent interview of SBIR award winners firms were asked to identify their principal industry or business area. The results were



Source: NVCA Venture Economics

Figure 6. 1998 Venture capital disbursements by industry.

TABLE III
Distribution of SBIR awards by technology area, FY 1998

SBA technology areas	Percent of total		
	Phase I	Phase II	Ph.I + Ph.II
Electronics	7.5%	31.7%	39.3%
Microelectronics	0.4%	2.0%	2.4%
Electronics device performance	5.4%	14.9%	20.2%
Electronic equipment and instrumentation	0.4%	1.8%	2.2%
Electromagnetic radiation/propagation	0.4%	9.2%	9.6%
Microwave and millimeter wave electronics	0.1%	0.3%	0.4%
Optical devices and lasers	0.9%	3.6%	4.5%
Materials	6.1%	17.4%	23.4%
Advanced materials	5.4%	14.9%	20.2%
Materials processing and manufacturing	0.3%	1.1%	1.4%
Coatings, corrosion and surface phenomena	0.3%	0.9%	1.1%
Materials performance	0.1%	0.4%	0.5%
Fundamentals and instrumentation	0.0%	0.1%	0.2%
Computer, information processing, analysis	2.2%	9.7%	11.9%
Computer and communication systems	1.1%	4.9%	6.0%
Information processing and management	0.6%	2.3%	2.9%
Signal and image processing	0.4%	2.2%	2.6%
Systems studies	0.0%	0.2%	0.2%
Mathematical sciences	0.0%	0.2%	0.2%
Life sciences	1.7%	6.4%	8.2%
Medical instrumentation	0.5%	2.2%	2.7%
Biotechnology and microbiology	0.6%	1.9%	2.5%
Behavioral sciences	0.5%	2.1%	2.5%
Physiology and miscellaneous	0.1%	0.3%	0.4%
Mechanical performance of vehicles, weapons, facilities	1.4%	5.8%	7.2%
Hydrodynamics	0.0%	0.0%	0.1%
Aerodynamics	0.4%	1.6%	2.0%
Acoustics	0.0%	0.2%	0.2%
Mechanical performance of structures and equipment	0.6%	2.1%	2.7%
Control	0.2%	0.8%	1.0%
Mechanical measurements	0.2%	1.0%	1.2%
Energy and conversion use	1.9%	4.7%	6.6%
Transport Sciences	0.5%	1.9%	2.4%
Propulsion/Combustion technology	0.6%	2.1%	2.6%
Large scale energy usage	0.6%	0.2%	0.8%
Energy conversion/electric power	0.2%	0.5%	0.7%
Environment & natural resources	0.9%	2.7%	3.5%
Ocean science	0.0%	0.0%	0.1%
Environmental protection technology	0.4%	1.3%	1.6%
Water management	0.3%	0.7%	1.0%
Earth sciences	0.1%	0.5%	0.6%
Environmental protection	0.1%	0.1%	0.2%

Note: Multiple technology areas were assigned to the awards.

Source: SBA, Office of Technology.

extremely diverse. The areas most frequently identified were:

Electronics (44)	Opto-electronics (21)
Computers and Software Development (44)	Environmental Services (20)
Instrumentation (40)	Engineering (18)
Aerospace (27)	Machinery (14)
Materials (27)	Chemicals (13)

Source: BRTRC, 1999.

Venture capital has developed in several high technology regions, tends to be invested locally, and is therefore concentrated geographically in a handful of clusters across the country. This development pattern creates gaps in venture capital availability in rural areas and regions without high technology clusters. By contrast, the SBIR program is available nation-wide and SBA administers an SBIR Rural Outreach Program that focuses on areas outside the venture capital clusters. In addition, the recent SBIR reauthorization bill establishes the Federal and State Technology Partnership (FAST) program to help small high technology firms that may be interested in participating in the SBIR program. This matching grant program includes varying matching requirements to provide added incentive for States with historically low levels of SBIR involvement, which are typically the more rural states.

As noted above, case studies presented at the NRC project on the DoD SBIR program's Fast Track initiative provided new evidence that SBIR grants are often the only source of funds available to innovators.¹⁴ Several of the presenters reported that the SBIR awardees they interviewed said they could find no other source of capital and that the project would not have occurred without the program. This may reflect any of the five dimensions of the funding gap described above, or a combination of the factors.

In addition to the capital market gap, it is widely recognized that there is a tendency for the national level of investment in innovation, research, and new technologies to be below the socially-optimal level. This general underinvestment exists because firms engaged in research and innovation can rarely capture all the economic benefits created from their innovative activity. As other firms learn from the results of the research or apply some aspect of the new technology, they may capture some of the economic returns in the form of enhanced productivity or innovative capacity (leading to growth in jobs and income). These economic benefits are said to *spill over* from the innovating firm to other firms in the economy.

Innovation spillover effects cause the private incentive to invest in new innovative activity to be lower than it would be otherwise. The lower market incentive leads to lower levels of private

Summary: SBIR program addresses each of the dimensions of the finance gap

Dimensions of the gap	How the SBIR program addresses the gap
1. Inadequate information on small firm innovation ventures	An SBIR award offers valuable recognition for the recipient firm (certification effect)
2. Size of financing-venture capital ignores small projects	The program provides small amounts of capital appropriate for new start-up innovative activities
3. Time frame-venture capital requires exit in 1–3 years	The capital does not have to be paid back, exit is not an issue
4. Technology areas invested in by venture capital is narrow	SBIR grants are awarded in a broad range of technology areas
5. Location – venture capital is geographically concentrated	SBIR program serves firms in geographic areas that have been ignored by venture capital and administers outreach programs

investment and creates a situation where additional outside investment in innovative activity, such as federal R&D spending, will produce higher rates of return in the form of new jobs, increased income, and new innovative activity.

This characteristic of R&D investment is likely to be more severe for small firms than for large firms. Small firms do not have the same level of market power or legal resources to protect the economic returns to new innovations.

VI. Prospective SBIR Phase III program to Enhance SBIR commercialization

SBA is currently assessing the merits of a prospective Phase III seed and assistance program to help promising SBIR projects move successfully towards commercialization. This section offers a preliminary discussion of the need for and design of such a program. Phase III of the SBIR program refers to the innovation stage where small firms develop commercial applications of technologies they developed under SBIR grants. For the SBIR firm, it signifies the end of direct SBIR financial support for a project and the necessity of finding other sources of financing to continue the project and commercialize or further develop the technology.

For some SBIR firms, Phase III can come too soon. Phase II funding may end before the business side of the project is sufficiently developed, and the project dropped due to an inability to raise the needed early stage financing. These firms, while having top quality technological innovations, often require business assistance to move them to a point where private markets – venture and angel capital – are willing to invest in them. While the SBIR program supports the invention and early R&D phases, effectively increasing the supply of small businesses seeking to develop new markets for their innovations, it does not currently provide the coordinated and direct business assistance needed to help these projects realize their commercial potential. A number of state-level programs provide business assistance to small businesses, including SBIR firms. However, there is currently no program to provide or coordinate such support nationwide.

A recent study of SBIR awardees found that insufficient funding was the primary reason that

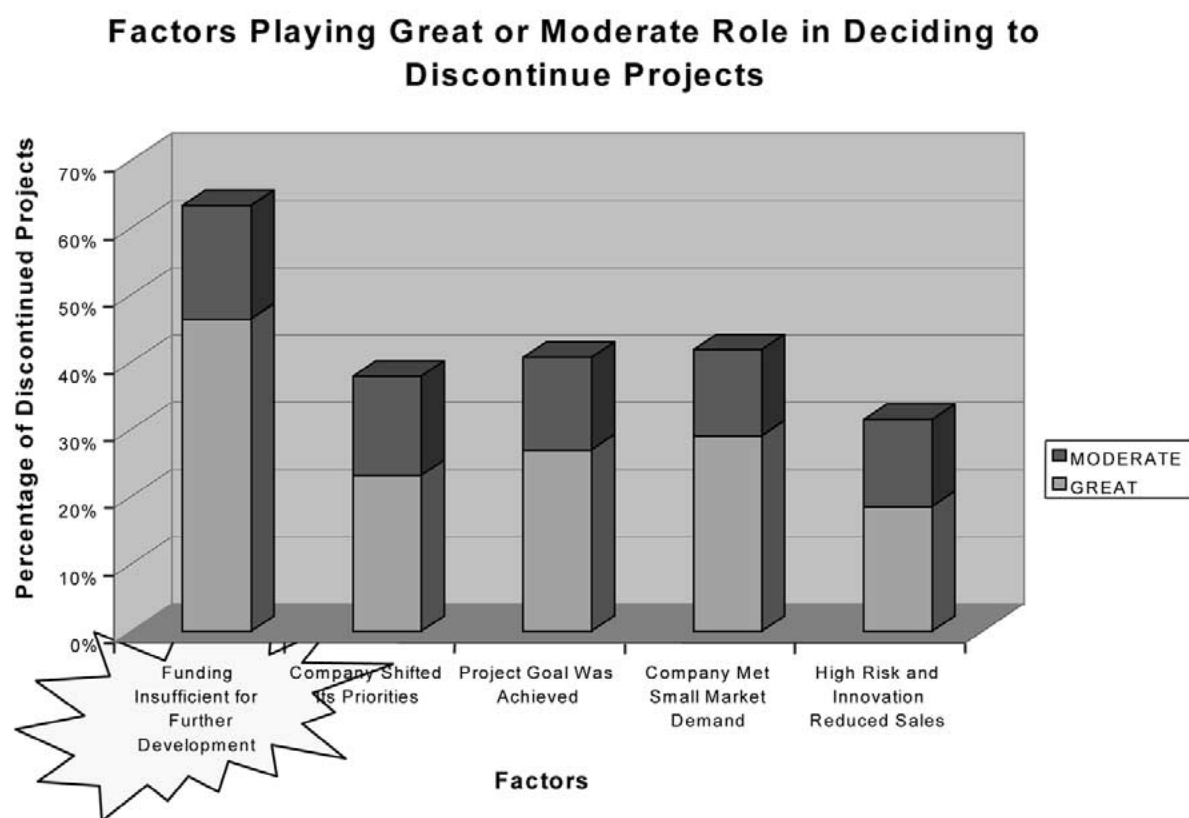
SBIR projects were discontinued after Phase II (see Figure 7). The study found that the *lack of market knowledge or marketing skills* was the most frequently cited obstacle to commercialization (see Figure 8). This was corroborated recently by a new survey of SBIR firms which shows that 63 percent of SBIR firms say they need business assistance to commercialize their new technology. Among the types of assistance mentioned most frequently are: marketing, raising capital, and forming commercial partnerships.¹⁵

Survey results have shown that, on average, only 3 percent of SBIR projects have received financing from venture capital firms.¹⁶ This low rate is most likely due to two factors: (1) SBIR firms often do not have the business side of the project adequately developed by the end of their Phase II grant, and (2) the venture capital community has not had adequate and timely information on the projects. Preliminary results of a more recent survey of SBIR winners suggests that a larger percentage of SBIR firms may now be attracting venture capital (Innovation Associates, 2000).

In his 1996 study, Dr. Lerner found that the beneficial long-term impacts of the SBIR program on firm growth and employment occurred only in proximity to venture capital concentrations (Lerner, 1996, 1999). Lerner found that SBIR awards did not have appreciable impact in areas without well-developed venture capital and innovation financing infrastructure.

The SBA is currently assessing the merits of a possible Phase III seed capital program to help improve the commercialization success of SBIR technologies by better preparing them for angel and venture capital. The program would seek to stimulate new job creation in small innovative companies by (1) addressing the gap in innovation financing by providing early-stage seed capital to firms that have completed Phase II, and (2) helping these firms meet their business development needs through state-level organizations providing small business development services.

One program structure currently under consideration is a matching grant program in which federal funds would be provided directly to a business assistance organization from each state. State agencies, non-profit organizations, or private entities would be eligible for participation. One-



Source: BRTRC (1999)

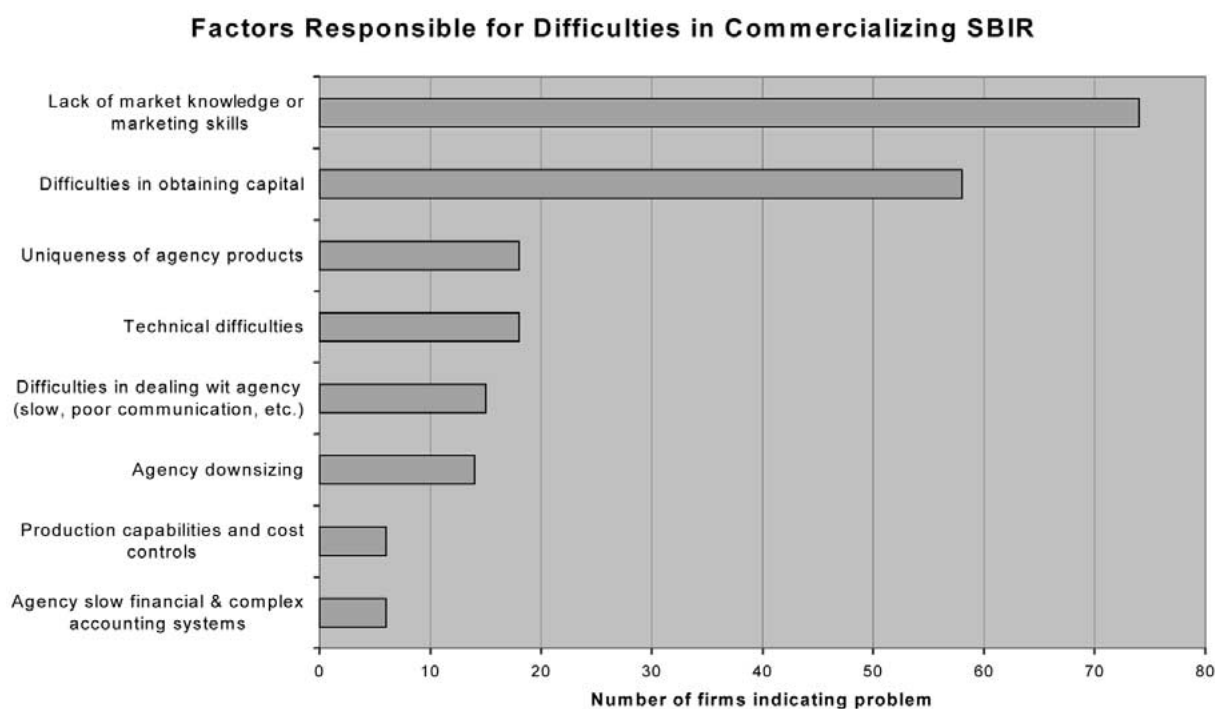
Figure 7. Why projects fail to commercialize.

half of the state-level matching contribution would come from a commercial partner, the other half from the business assistance organization submitting the application. In-kind contributions of up to 50 percent would be allowed. The federal and state cash contributions would be placed in escrow accounts for each of the firms receiving assistance. Seed investments in the firms would be made from these accounts only as firms reach pre-established, company-specific, commercialization milestones established by the proposing organization.

To begin establishing the program as self-financing at the state level, a payback provision could be used. Participating firms would be required to agree to a royalty-type payback provision to help replenish state level funds. The specific structure of the payback would be determined by each state, however broad guidelines and technical assistance would be available. Possible

guidelines include (1) that the payback begin when the company receives sales resulting from the project, and (2) that it be designed so that it does not deter future venture capitalists from investing in the project and does not bias the program against the longer-term higher-risk projects the SBIR program is mandated to support.

SBA estimates that there are currently over 1,200 firms nation-wide that are likely candidates for such Phase III seed and assistance funds. This estimate is based on program records, which show that about 1,000 firms complete Phase II projects each year, and on survey data that shows that about 60 percent of Phase II recipients confront barriers to commercialization and indicate they need business assistance. A recent survey of SBIR Phase II recipients found that over 60 percent of the firms said they needed business, management, and/or technical assistance to help develop or



Source: BRTRC, 1999

Figure 8. Leading obstacles to commercialization.

produce SBIR-related products, processes, and services. About half of these firms said they needed help with patenting and licensing, partnering with other firms, commercialization planning, and market assessments.¹⁷

VII. Challenges ahead for the program

SBA faces several important administrative challenges to continued improvement of the SBIR program. The SBA's Office of Technology is currently working on improvements in the following areas:

1. *Improving program monitoring and evaluation.* SBA's Office of Technology is developing an on-line reporting system for the SBIR and STTR programs that will utilize Tech-Net – a web-based system linking small technology businesses with Federal technology program opportunities. The new on-line system is designed to collect essential commercialization

and other impact data, and to minimize the reporting burden on participating firms.

2. *Preparing awardees for commercialization.* New mechanisms for providing assistance to awardees and other applicants are being explored. These include training or referrals and means of providing SBICs and other venture and angel capital funds with up-to-date information on SBIR firms seeking Phase III financing.
3. *Providing federal seed funding for commercialization.* The SBA is assessing a prospective pilot SBIR Phase III seed capital program to provide funding and support training and assistance for SBIR firms.
4. *Expanding outreach assistance.* The SBA's Office of Technology is administering the new Federal and State Technology Partnership program, supports full financing of current outreach grants to states, and is promoting greater support for partnering.

Notes

¹ Senate Bill 2941 became Public Law 102-564, titled the “Small Business Research and Development Enhancement Act of 1992.”

² The SBIR is currently reauthorized under Title I of the *Small Business Reauthorization Act of 2000*, Public Law 106-554 (see pages H12428 through H12432 of the Conference Report).

³ Small Business Innovation Development Act of 1982, PL97-219.

⁴ The award/application ratio for 1999 Phase II projects was 51 percent.

⁵ Presentation by David Finifter at the National Academy of Sciences, May 5th 1999; also in Wessner (2000), p. 214.

⁶ Lerner (1999), p. 301.

⁷ To make such comparisons possible, the BRTRC survey was conducted in a manner that paralleled the effort by the General Accounting Office in 1991, documented in their 1992 Report (RCED-92-37). Using the sales of those projects awarded in the last four years of the 1998 study (1990–1993) provide a comparable period of awards followed by five years of sales. 1,363 of the 2,674 projects were awarded from 1990 to 1993. The average sales for these projects were \$767,600.

⁸ David Audretch, Juergen Weigand, and Claudia Weigand, “Does the Small Business Innovation Research Program Foster Entrepreneurial Behavior? Evidence from Indiana,” in Wessner (2000), pp. 160–189.

⁹ BRTRC, 1999, pp. 5–10.

¹⁰ The DoD, which accounts for almost half of the program, offers this protection for five years.

¹¹ van Osnabrugge (1998).

¹² The PriceWaterhouseCoopers’ MoneyTree report shows that the average deal size in 1999 was \$8.9 million, an increase of 71 percent from the previous year.

¹³ Figure 4 data are in constant (1998) dollars to show the real increases over time.

¹⁴ NRC, STEP Board, *Research Team Meeting for the Assessment of the SBIR Fast Track Program*, December 18, 1998.

¹⁵ Innovation Associates (2000).

¹⁶ BRTRC, 1999, p. 18.

¹⁷ Op. cit.

References

- BRTRC, Peter Cahill et al., 1999, *Commercialization of Small Business Innovation Research (SBIR)*, Washington, D.C.: BRTRC Technology Research Corporation.
- GAO, 1992, *Small Business Innovation Research Shows Success But Can Be Strengthened*, GAO/RCED-92-37, Washington, D.C.: General Accounting Office.
- Innovation Associates, 2000, *Commercialization Needs of Small Business Innovation Research Firms*, Reston, VA: Innovation Associates Inc.
- Lerner, Josh, 1996, ‘The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program’, *Working Paper 5753*, Cambridge: National Bureau of Economic Research.
- Lerner, Josh, 1999, ‘The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program’, *Journal of Business* 72(3), Chicago: University of Chicago Press, pp. 285–318.
- NSF, 1999, *Research and Development in Industry, 1997, Early Release Tables*, Washington, D.C.: National Science Foundation (<http://www.nsf.gov/sbe/srs/srs99411/start.htm>).
- NSF, 1999, *Will Small Business Become the Nation’s Leading Employer of Graduates with Bachelor’s Degrees in Science and Engineering?*, NSF 99-322, Washington, D.C.: National Science Foundation (<http://www.nsf.gov/sbe/srs/nsf99322/start.htm>).
- PriceWaterhouseCoopers, 1999, *MoneyTree Survey Report*, Quarter 3.
- SBA, 1991, *Results of a Three-Year Commercialization Study of the SBIR Program*, SBA 90-00.147, Washington, D.C.: U.S. Small Business Administration.
- van Osnabrugge, Mark, 1998, *Comparison of Business Angels and Venture Capitalists: Financiers of Entrepreneurial Firms*, Oxford: Said Business School, University of Oxford.
- Wessner, Charles (ed.), 2000, *The Small Business Innovation Research Program: An Assessment of the Department of Defense Fast Track Initiative*, National Research Council, Washington, D.C.: National Academy Press.

Copyright of Small Business Economics is the property of Springer Science & Business Media B.V. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.