Order Code RL30216

Small, High Tech Companies and Their Role in the Economy: Issues in the Reauthorization of the Small Business Innovation Research (SBIR) Program

May 28, 1999

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ABSTRACT

The Small Business Innovation Research (SBIR) program is a government-wide effort to increase that portion of the federal research and development budget provided to small firms for work associated with the mission responsibilities of federal departments and agencies. This activity is due to sunset on October 1, 2000. In anticipation of expected congressional efforts to reauthorize the SBIR program, this paper focuses on the role small high tech enterprises — those that provide high value added goods, services, and jobs — play in the nation's economic growth. It provides background on related legislative initiatives to facilitate innovation and explores issues associated with achieving the goals of the SBIR activity within the context of other federal technology development endeavors. The report will be updated if events warrant such action.

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Summary

Congress has demonstrated an on-going interest in the small business sector. Addressing issues related to economic growth and competitiveness, special consideration has been given to small, high tech firms for several reasons including data that indicate such companies tend to be highly innovative, play an important role in technological advancement, and contribute to the high standard of living in the United States. Such was the rationale behind legislation creating the Small Business Innovation Research (SBIR) program, an effort to increase that portion of the federal research and development (R&D) budget provided to small enterprises for work associated with the mission responsibilities of government departments and agencies. This activity is due to sunset on October 1, 2000.

Technological advancement is a key element of economic growth. Entrepreneurial small firms often are important to technological progress because of their role in the commercialization of R&D results. They also are instrumental in allowing economic benefits to remain within a region. Such companies create wealth through value added jobs that are long-term and require highly skilled employees that subsequently generate additional income, spending, and growth, as well as more jobs.

However, it appears that the ability of small firms to be innovative varies by industry and is dependent on the relationship between small and large companies in each industrial sector. Access to information sources also affects the contribution of these small businesses to technological progress. Despite little or no R&D, small firms can generate new products and processes by relying on work performed elsewhere. The importance of shared information is evident in the expansion of cooperative R&D among small enterprises and between small and large companies.

A review of legislative initiatives over the past 20 years indicates the implementation of programs and policies to provide both direct and indirect incentives for increased private sector investments in innovation. While not specifically targeted to small business, these efforts promote cooperative work among industry, universities, and government or between companies; provide intellectual property rights as an incentive to commercialization; and/or mandate a set percentage of federal R&D funding be awarded to small high tech firms. This has significantly affected the context within which these companies operate. Since many of these activities did not exist when the SBIR program was created, questions have been raised as to the validity of SBIR goals within this new environment and whether or not the program should be altered to reflect other on-going federal endeavors relevant to technological advancement.

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Introduction

Congress has demonstrated an on-going interest in the small business sector. There are many reasons for this approach including data indicating that small firms represent over 99% of all employers and employ 52% of all private workers.[1] Certain studies, while the subject of professional disagreement, purport to show that these establishments are responsible for the majority of new jobs created in the United States. In addition, it has also been argued that small businesses are more innovative than large firms. Such claims have led to various legislative initiatives intended to address the needs of the small business sector.

Among the legislatively mandated activities in this arena is a program designed to insure that small, high technology firms receive a specified share of federal research and development (R&D) funding. The Small Business Innovation Research (SBIR) program requires that each federal department with a R&D budget of $100 million or more set aside a prescribed percentage of the extramural portion of this budget to support mission-related work in small companies. This activity is due to sunset on October 1, 2000. In anticipation of expected efforts to reauthorize the SBIR program, this paper focuses on the role small high tech enterprises — those that provide high value added goods, services, and jobs — play in the nation's economic growth.

Entrepreneurial Firms and Economic Growth

Technological advancement is a key element of economic growth. Experts widely accept that technical progress is responsible for up to one-half the growth of the U.S. economy and is one principal driving force for increases in our standard of living. Historically, industrial expansion was based on the use of technology to exploit natural resources and early federal support of those fledgling industries was extensive. Today, such growth tends to be founded on scientific discoveries and engineering knowledge (e.g. electronics, biomedical applications), and is even more dependent than before on the development and use of technology. Technological advance can drive the economy because it contributes to the creation of new goods and services, new industries, new jobs, and new capital. It can expand the range of services offered and extend the geographic distribution of those services. The

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[1]A small business typically is defined as a firm with under 500 employees.

application of technology also can contribute to the resolution of those national problems that are amenable to technological solutions.

Technological progress is achieved through innovation, the process that provides new and improved products, manufacturing processes, and services. It is an activity that may involve, among other things, idea origination, research, development, engineering, commercialization, and diffusion throughout the marketplace. A concept can become an innovation without evolving through those separate steps. An invention becomes an innovation when it has been integrated into the economy such that the knowledge created is applied in production to increase productivity and quality, or results in a new or improved product or service that can be sold in the marketplace. It is only then that a significant stimulus to economic growth occurs.

Small, entrepreneurial firms have a role in technological advancement and economic growth. However, there is on-going debate over the parameters of this contribution and the extent to which small companies innovate relative to larger businesses. Studies supported by several federal agencies conclude that small, high technology companies are the source of significant innovation. An often cited 1982 study done for the Small Business Administration (SBA) determined that small firms are 2.4 times as innovative per employee as large companies.[2] More recent information provided by SBA on its web cite claims that 55% of the country's innovations originated in small firms.[3] Roland Tibbets, while at the National Science Foundation, found that such companies generate six times more net new products than larger businesses for every $1 million spent on R&D.[4] According to the SBA, innovations made by small firms include the ". . . audio tape recorder, double-knit fabric, fiber optic examining equipment, heart valve, optical scanner, pacemaker, personal computer, soft contact lenses, and the zipper."[5]

Additional evidence of the part small firms play in technological progress is provided by SBA data describing the concentration of small companies in high tech industries. According to this material, 94% of high tech companies have under 500 employees and 73% have less than 20 workers. These small firms account for 18% of the total receipts generated by high tech industries.[6] In 1996, 37.9% of workers in private sector, high technology businesses[7] were employed by small firms; 22.2% in companies under 100 persons. High tech employees comprises 3.1% of the total

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[2]National Science Board, *Science and Engineering Indicators, 1993*, December 8, 1993, 185.

[3]http://www.sba.gov/ADVO/stats/fact1.html

[4]Anne Anderson, "Small Businesses Make it Big in the SBIR Program," *New Technology Week*, June 6, 1988, 2.

[5]http://www.sba.gov/ADVO/stats/fact1.html

[6]Ibid

[7]For the purposes of these data provided by the Small Business Administration, high technology employment is defined as ". . .engineering, science, and computer occupations (excluding technicians, manufacturers, and teachers)."

number of workers in the small business community compared to 4.6% for the number of high tech employees in all companies regardless of size.[8]

Despite these data, there is on-going disagreement over how small firms contribute to the process of economic growth and industrial competitiveness. There are experts who subscribe to the idea that "[m]ost successful innovations are born, bred and brought to market entirely within well-established organisations [sic], mainly large companies."[9] Two prominent analysts in this area, Zoltan Acs and David Audretsch, argue that the relationship between company size and innovation capacity varies by industry.[10] They note that "the evidence also suggests that there tends to be more innovative activity in industries consisting of larger and not smaller firms."[11] Others maintain that there is no conclusive evidence that firm size affects the "success" of R&D.[12]

What appears to be an important factor affecting the ability of small companies to effect technological advance is the relationship between these firms and large corporations. The globalization of the economy has changed the business environment such that operating in large foreign markets may be necessary for firms to remain competitive. Big corporations have an advantage in delivering and marketing innovations in the international marketplace. While small companies may serve as the source of new products and processes, they often ". . .cannot take advantage of their initial technological lead to establish a secure foothold in the key markets [and] they will inevitably be ground down as the technology is diffused and the importance of scale grows."[13]

To meet the global challenge, many large companies are merging with other firms and concentrating financial, manufacturing, and marketing resources. At the same time, they are decentralizing their research and development activities as well as their manufacturing operations, thereby creating external technological relationships with suppliers and outsourcing work to small companies. Larger corporations spend one-half of each sales dollar on purchases from suppliers, often small firms.[14] While possibly lacking the ". . .critical mass needed to move from hot boutique to major international force,"[15] small firms can provide the innovation

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[8]Draft material provided by the Small Business Administration, Office of Advocacy, March 24, 1999.

[9]"Innovation in Industry Survey," *The Economist*, February 20, 1999, 14.

[10]Zoltan J. Acs and David B. Audretsch, *Innovation and Small Firms* (Cambridge: The MIT Press, 1990), 50-51.

[11]Ibid., 147.

[12]Charles Brown, James Hamilton, and James Medoff, *Employers Large and Small* (Cambridge: Harvard University Press, 1990), 10.

[13]Clyde V. Prestowitz, Jr., "Big Versus Little," *Business Month*, April 1989, 60.

[14]Robert Howard, "Can Small Business Help Countries Compete?" *Harvard Business Review*, November-December 1990, 88.

[15]Prestowitz, *Big Versus Little*, 60.

embodied in new products and processes for the marketplace. This might account for the conclusions made by Acs and Audretsch that small companies tend to be more innovative in industries which evidence a strong concentration of large firms.[16] Thus, argues Bennett Harrison of Carnegie Mellon University, "[b]ig firms and their partner companies — *not* small, stand-alone businesses, per se — account for most of the U.S. industrial jobs, sales, and output per year in and year out, in both mature and high-tech sectors.[17]

However, it appears evident that ". . .small high-tech companies play a critical and diverse role in creating new products and services, in developing new industries, and in driving technological change and growth in the U.S. economy," as concluded by a study conducted under the auspices of the National Academy of Engineering.[18] The reasons for this include the ability of these firms to rapidly develop markets, generate new goods and services, and offer product diversity. Small businesses tend to be willing to take technological risks that may not be amenable to large, established corporations. They also may be in a position to quickly exploit market opportunities; opportunities that may be determined by large companies as a result of spin-off from corporate R&D or by university research. As a result, small businesses, which are often start up firms, tend to generate incremental innovations that respond to market needs rather than produce breakthrough innovations that develop entirely new markets.[19]

Small, technically-oriented companies are found more commonly and in greater numbers in industries that have fragmented, fast growing, and technologically changing markets; offer few obstacles to entry; and have a history and culture of entrepreneurship. In addition, the availability of venture capital, customer access, and a developed technical and business infrastructure provide an environment conducive to the establishment of such firms.[20] Thus, according to the National Academy of Engineering, ". . .the specific contributions of small technically oriented companies in an industry depend on the following factors:

- The size of markets, current and prospective, that make up the industry.
- The degree of technical uncertainty in current or prospective markets.
- The economies of scale and scope in production for a market.
- The dominance (or lack thereof) of larger companies in both final and intermediate markets in the industry."[21]

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[16]Acs and Audretsch, *Innovation and Small Firms*, 147.

[17]Bennett Harrison, "The Dark Side of Flexible Production," *Technology Review*, Many/June 1994, 40.

[18]National Academy of Engineering, *Risk & Innovation, The Role and Importance of Small High-Tech Companies in the U.S. Economy* (Washington: National Academy Press, 1995), 37.

[19]Ibid., 5, 18.

[20]Ibid., 5.

[21]Ibid., 38.

Economic benefits remain within a region through the creation of new firms.[22] Half of the economic growth in the U.S. is generated by industries that were just forming a decade ago.[23] These companies create wealth through value added jobs that are long term and require highly skilled employees who generate additional income, spending, and growth, as well as more jobs. The regions that display an active entrepreneurial environment embody distinctive, and similar, characteristics. These areas typically have a knowledge source, generally a university that can provide a supply of ideas and employees, and on-going R&D. Venture capital is available as is skilled labor. There are clusters (or agglomerations) of similar entrepreneurial firms and opportunities for generating new businesses through science parks or incubators. Good transportation and a high standard of living are also complementary to entrepreneurial activity.

A critical mass of high technology companies is necessary to sustain indigenous economic growth. "An existing agglomeration of firms in similar or related sectors is a principal determinant of both birth rates and the distribution of small technology-based firms."[24] Clusters are groups of interrelated companies and institutions (including suppliers, service providers, universities, and trade associations, etc.) located in a specific area that cooperate as well as compete.[25] As such, clusters provide the opportunity for on-going innovation to meet new demands for products and processes generated by the dynamic relationships among the players. Diversity within the types and sizes of businesses contributes to a good entrepreneurial environment.[26] A varied, educated, and skilled workforce also facilitates technological advancement in and around the cluster.

Clusters are important not primarily because of production but because of the opportunities for knowledge spillovers.[27] "[I]nnovative activity is more likely to occur within close geographic proximity to the source of . . . knowledge, be it a university research laboratory, the research and development department of a corporation, or exposure to the knowledge embodied in a skilled worker."[28] Innovation tends to cluster around industries where knowledge plays an important

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[22]Edward J. Malecki, "Technological Innovation and Paths to Regional Economic Growth," in *Growth Policy in the Age of High Technology, The Role of Regions and States*, ed. Jurgen Schmandt and Robert Wilson (Boston: Unwin Hyman, 1990), 99.

[23]"Innovation in Industry Survey," 6.

[24]Patricia M. Flynn, "Technology Life Cycles and State Economic Development Strategies," *Federal Reserve Bank of Boston, New England Economic Review*, May/June 1994, 24.

[25]Michael E. Porter, "Clusters and Competition: New Agendas for Companies, Governments, and Institutions," *Harvard Business School, Division of Research Working Paper*, September 1997 (revised 25 March, 1998), 1.

[26]Edward J. Malecki, "Entrepreneurs, Networks, and Economic Development: A Review of Recent Research," *Advances in Entrepreneurship, Firm Emergence and Growth* (1997): 68.

[27]David B. Audretsch and Maryann P. Feldman, "R&D Spillovers and the Geography of Innovation and Production," *American Economic Review*, June 1996, 631.

[28]Ibid., 638.

role[29] as evidenced by the biotechnology, computer, advanced materials, and telecommunications sectors, among others.

Access to information sources affects the ability of small firms to innovate. Despite little or no R&D, small businesses can generate new products and processes by relying on work performed elsewhere. Research has shown that firms with a large number of sources for information about markets, competitors, and new technologies generate a larger number of new goods and services.[30] The importance of shared information is evident in the expansion of cooperative R&D activities, particularly among small firms and between small and large companies. Such activities have been promoted by several laws including P.L. 96-480, the Stevenson-Wydler National Technology Innovation Act of 1980, as amended; P.L. 96-517, the Bayh-Dole Act (addressing dispensation of patent rights arising from federally funded R&D); P.L. 98-462, the National Cooperative Research Act; P.L. 103-42, the National Cooperative Production Act; P.L. 97-219, the Small Business Innovation Research Act; and P.L. 100-418, the Omnibus Trade and Competitiveness Act.[31] In response to congressional legislation, over 700 joint R&D projects have registered under the National Cooperative Research Act and the National Cooperative Production Act. Over 5,000 cooperative research and development agreements (CRADAs) have been signed with federal laboratories. One-third of the awards for R&D made by the Advanced Technology Program went to joint R&D ventures, 48 of which were led by small companies.

Legislative Initiatives to Assist Small, High Tech Firms

The small business sector is often given particular consideration in addressing policy issues related to economic growth and competitiveness. A review of legislative initiatives over the past 20 years indicates the implementation of programs and policies providing both direct and indirect incentives to encourage increased private sector investments in innovation.[32] While not all specifically targeted to small businesses, many of these efforts promote cooperative work among industry, universities, and government or between companies; provide intellectual property rights as an incentive to commercialization; and/or mandate a set percentage of federal R&D funding be awarded to small, high tech firms.

Traditionally, the federal government has supported basic research and other R&D to meet the mission requirements of the departments and agencies. In the late 1980s, this role expanded toward advancing the development of technology to meet

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[29]Ibid., 635, 637.

[30]Edward J. Malecki and Marlies E. Veldhoen, "Network Activities, Information and Competitiveness in Small Firms," *Geografiska Annaler*, 1993, 138.

[31]For additional information on these programs see: Congressional Research Service, *Industrial Competitiveness and Technological Advancement: Debate Over Government Policy*, by Wendy H. Schacht, CRS Issue Brief 91132, updated regularly.

[32]For a more detailed discussion see: Congressional Research Service, *The Federal Role in Technology Development*, by Wendy H. Schacht, CRS Report 95-50, October 6, 1998.

other national needs, including the economic growth that flows from the commercialization and use of new products and production processes. This approach involves creation of an environment within which collaborative efforts among industry, government, and academia can be fostered. The idea of such partnerships reflects the thesis that while commercialization is the responsibility of the private sector, the different communities often have complementary functions and can contribute to the goals of generating new goods and services for the marketplace. Joint projects allow for the sharing of costs, risks, facilities, and expertise.

A bipartisan legislative approach has evolved that is intended to foster innovation. This includes the creation and support of various programs that offer *direct* federal funding, often on a cost-shared basis with the private sector, for government-industry efforts. The Small Business Innovation Development Act (P.L.97-219, as amended) established Small Business Innovation Research programs within the major federal research and development agencies.[33] The intent of the activity was to increase government funding of small, high technology companies for the performance of R&D relevant to agency missions and with commercial potential. Each federal department with an R&D budget of $100 million or more is required to set aside part of this amount to finance the SBIR effort. From its inception in FY1983 through FY1997, approximately $7.6 billion in awards have been made for 46,126 projects. The original program has been extended several times. The Small Business Technology Transfer pilot program, implemented in FY1994, provides federal support for research proposals that are developed and executed cooperatively between a small company and a scientist in a university, government laboratory, or non-profit institution. Through FY1997, $186.2 million has been awarded for 1,133 projects.

Created by the Omnibus Trade and Competitiveness Act of 1988 (P.L. 100-418), the Advanced Technology Program (ATP) of the National Institute of Standards and Technology (NIST), Department of Commerce, provides federal seed financing, matched by private sector investment, to companies or consortia of universities, businesses, and government laboratories for development of pre-competitive, generic technologies that have potential application within a range of industries. Awards are made on technical, scientific, and business merit. Over half of the awardees (including 68% in the latest round) are small businesses or cooperative efforts led by such firms. New selection requirements encourage joint ventures that include both small and large firms. Also managed by NIST, the Manufacturing Extension Partnership (MEP) is a program of regional centers designed to facilitate the movement to the private sector, particularly to small and medium-sized firms, of knowledge and technologies developed under the auspices of NIST and other federal agencies in pursuit of mission requirements. The centers receive at least half their funding from U.S.-based, non-profit institutions or organizations.

In addition, Congress has enacted various laws that offer *indirect* measures to encourage activities leading to technology commercialization. Included in this is the research and experimentation tax credit which provides a credit for incremental

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[33]For more information see: Congressional Research Service, *Small Business Innovation Research Program*, by Wendy H. Schacht, CRS Report 96-402, September 11, 1998.

increases in a company's R&D expenditures as well as for payments to universities for basic research. Changes to the antitrust laws made by the National Cooperative Research Act (P.L. 98-462) and the National Cooperative Manufacturing Act (P.L. 103-42) are designed to clarify their application in regard to collaborative research and manufacturing ventures thereby removing certain barriers to such activities. Other laws, including the Stevenson-Wydler Technology Innovation Act (P.L. 96-480) and the Federal Technology Transfer Act (P.L. 99-502), facilitating technology transfer and establishing patent ownership incentives, were enacted to stimulate private sector use of the results of federally-funded R&D. Preference for entering into cooperative research and development agreements is given to small companies and consortia involving small firms. Similarly, the Bayh-Dole Act (P.L. 96-517) has been of major significance to the evolution of R&D in small, high tech companies and academia. Providing title to inventions made under federal financing to small business, university, or non-profit contractors has encouraged efforts to further develop products and processes based on these patents and bring them to the marketplace.[34]

Issues and Implications

Given past congressional interest in the small business sector, it might be expected that the 106th Congress will explore the reauthorization of the SBIR program now scheduled to sunset on October 1, 2000. Future discussion could involve identification of program goals and examination of their relevance within the broad context of federal efforts to promote technology development. The following issues might be reviewed and considered.

The Small Business Innovation Research program was originally mandated to increase the participation of small, high technology firms in the federal R&D endeavor. Congressional support was predicated upon several conclusions. While technology-based companies under 500 employees tend to be highly innovative, and innovation is essential to the economic well-being of the United States, sponsors of the original legislation believed these businesses were not receiving a sufficient share of government research support. It was necessary, therefore, to guarantee this sector a predetermined portion of the federal budget. To achieve this, each applicable agency was instructed to create an SBIR program to ensure expanded research and development funding for small businesses and to facilitate commercialization of new products and processes by these firms. The efforts are financed by a mandatory set-aside, a provision considered necessary due to what was viewed as a federal preference for financing R&D in large corporations.

The legislatively mandated goals of the SBIR program include stimulation of technological innovation in the small business sector, increased use of this community to meet the R&D needs of the government, and expanded commercialization of the results of federally funded R&D. These objectives were developed at a time when

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[34]See: Congressional Research Service, *R&D Partnerships and Intellectual Property: Implications for U.S. Policy*, by Wendy H. Schacht, CRS Report 98-862.

many of the current government policies and programs to assist small, high tech companies in pursuit of innovation were not available. This raises questions as to whether or not the goals of the SBIR program remain valid. Is the rationale behind the effort still sound given other, on-going federal activities? Should the SBIR program be continued and/or expanded? Should changes be made in the activity to reflect the changes brought about by other congressional initiatives in the technology development arena?

There is agreement among experts that small, high tech companies play an important role in innovation and economic growth. One issue is whether or not the SBIR program, as presently constituted, contributes to the creation of an environment conducive to the formation and advancement of high value added entrepreneurial firms. As discussed previously, these types of businesses flourish in areas that have certain characteristics including a knowledge source, access to capital, skilled labor, and a critical mass of similar firms that both cooperate and compete. Federal initiatives to facilitate technology transfer, collaborative R&D, and technical assistance, as well as to provide matched government funding, can be seen as supportive of technology development. Promoting this environment, the Small Business Innovation Research program offers financial support while the associated Small Business Technology Transfer program encourages joint R&D activities with government laboratories or universities. Within the context of on-going federal efforts, is this sufficient to achieve the program's goals? If not, are there changes that can and should be made to build upon other government activities and further strengthen the impact of the SBIR program on technological advancement?

Several studies indicate that the ability of small firms to be innovative varies by industry and is dependent on the relationship between small and large firms in each industrial sector. Thus, a question may be raised as to whether or not the SBIR activity, as it now operates, promotes the development of productive interactions between companies of different sizes. Is the structure of the agency-wide SBIR effort reflective of the current knowledge on the interaction between small and large firms in the development of new products and processes and their commercialization and marketing? Might alterations be made to the current SBIR program to augment opportunities for increased innovation? If this is considered desirable, how might it best be achieved recognizing that each agency operates an SBIR program consistent with its operating procedures and mission requirements?

Legislation promoting innovation often includes a statement of preferential consideration for small companies; however, these laws, for the most part, also apply to large firms. Thus, concerns have been expressed as to whether or not these initiatives provide the small business community with extra assistance or in effect increase competitive pressures with respect to larger domestic firms. If large companies are also encouraged to undertake research, development, and commercialization of the results, questions may be raised as to the role and position of small firms; will they be hampered in R&D activities due to their size and resource constraints?

In evaluating the possible reauthorization of the SBIR program, an understanding of the role of small firms in economic growth can provide information on which to decide whether or not continued special consideration of these companies

is warranted. However, it remains difficult to determine how current legislative initiatives affect the competitiveness of small firms both in terms of comparisons to larger companies and in international activities. Limited measures of innovation and competitiveness impede assessment of such efforts. Research and development are often but two activities in a generally long and costly process of bringing a product, process, or service to the marketplace. Recent efforts to increase R&D in small firms will not necessarily show commercial results, if any, for many years. In many cases, a lag time of 5 to 15 years between idea and marketable good is commonplace, although this is beginning to decrease and, in some cases, particularly biotechnology, tends to be less. While the majority of federal programs to facilitate increased private sector investments in R&D leading to economic growth were not in existence when the SBIR activity was initiated, some analysts believe that an assessment of the total environment within which small, high tech firms operate might be the most effective means to insure that congressional action achieves its intended objectives.