

NEW TECHNOLOGY-BASED FIRMS' PURSUIT OF SBIR FUNDS

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ABSTRACT

This paper presents the results of a study that investigated the relationship between characteristics of firms and their experience with applying for Small Business Innovation Research (SBIR) funding. The basic issues investigated are (1) the relationship between firm characteristics and the decision to apply for SBIR funding, and (2) the relationship between firm characteristics and whether the SBIR application was successful. The results of the study demonstrate that local efforts to promote the SBIR program by encouraging firms to apply and by increasing the visibility of workshops can lead to a greater number of firms to apply for SBIR funding. Efforts directed at firms in small communities may be even more effective than efforts directed towards firms in large communities. The results also suggest that organizations that provide SBIR assistance may consider screening potential clients according to the business goals of firm's owners. Owners of "life-style" firms may need extra encouragement and, perhaps, assistance to apply for SBIR funding. Finally, the results also imply that firms that are smaller (as compared to larger firms), have more limited experience raising capital, and serve a smaller market may need greater assistance in pursuing SBIR funding.

INTRODUCTION

The financial theory of capital structure, which assumes that firms will seek a financing structure that minimizes their total cost of capital, may not be applicable to early-stage technology-based firms due to their limited access to the capital markets (Ang, 1992). Capital acquisition, for example, is often jointly determined by owner's personal goals and market conditions (Ang, 1991). New technology-based firms face unique obstacles in raising capital due to issues such as high risk, long product development time, unproven markets, motivation of owners, limited asset base, intellectual property rights, and limited experience with raising capital (Sohl, 1999; Timmons, 1999). One funding opportunity that may be accessed by early-stage technology-based firms is the federal Small Business Innovation Research (SBIR) program. The SBIR program is highly competitive research and development (R&D) source that encourages small firms to explore and commercialize potential new technologies. The

program can be an important source of financing and has been the impetus for the startup of many technology-based companies.

Previous studies found that SBIR funding tends to crowd-out firm financed R&D funding (Wallsten, 2000; Irwin & Klenow, 1996). Receipt of SBIR funding replaces a firm's R&D funding rather than increase total amount of R&D expenditures. This substitution has several potential implications in a firm's capital structure. First, the substitution may reduce the firm's cost of capital by replacing a high cost of capital (i.e. equity and debt) with a lower cost of capital. Second, the firm's risk exposure may be reduced since SBIR funds rather than internal funds are used for the potential commercialization of new products. Third, receipt of SBIR funding may provide a signal to investors concerning quality of the firm and potential of the new technology. This is consistent with findings by Lerner (1999), who found that firms receiving SBIR awards were more likely to subsequently receive venture capital funding than firms not receiving SBIR awards.

This paper presents the results of a study that investigated the relationship between characteristics of firms and their experience with applying for SBIR funding. The basic issues investigated are (1) the relationship between firm characteristics and the decision to apply for SBIR funding, and (2) the relationship between firm characteristics and whether the SBIR application was successful.

An estimated \$60 billion is needed each year to fund the capital requirements of rapidly growing firms. The most common sources of growth capital for early-stage technology-based firms are individual investors (i.e. angels) and venture capital. Despite these capital needs, only approximately \$40 billion is available each year for rapidly growing firms (Sohl, 1999). In addition, investment preferences among individual and venture capital investors have moved toward later stage and less risky firms whose products have demonstrated market potential. This shortage of growth capital, commonly referred to as the "capital gap," acts as a constraint to innovation and the commercialization of new technology.

SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Overview of SBIR Program

Congress established the federal SBIR program in 1982, to increase federal research and development (R&D) funding opportunities for small businesses while meeting the R&D needs of the federal government. The program was created in recognition that small businesses employ about one-half of the country's workforce and, on a per employee basis, generate two and a half times as many innovations as larger businesses. A primary objective of the program is to commercialize SBIR-funded research and development and to generate a positive return on the commercialization of new technology. In October 1992, Congress extended the act to the year 2000, with increased emphasis on commercial products. Each year, roughly \$1 billion is allocated to SBIR from the ten participating agencies for early-stage R&D projects at small technology-based companies (Department of Agriculture, Department of Commerce, Department of Defense, Department of Education, Department of Energy, Department of Transportation, Environmental Protection Agency, Health and Human Services, National Aeronautics and Space Administration, and National Science Foundation).

SBIR provides funding for technology development at an earlier stage than the private sector is typically willing to fund and provides up to \$850,000 in pre-prototype R&D funding. A major benefit is that companies retain the patent and commercialization rights to any inventions developed under the program. The Small Business Administration sets overall guidelines for the entire SBIR program. However, each federal agency establishes its own

priorities, award funding limits, and solicitation schedules. Awards are based on a competitive peer review process. To qualify for SBIR funding, the business must (1) be American-owned and independently operated, (2) be for-profit, (3) have the principle researcher employed by the business, and (4) employ fewer than 500 people (Small Business Administration, 2000).

SBIR Program Phases

SBIR is a three-phase program. Phases I and II are supported from the funds allocated through the SBIR program. In Phase I, federal agencies periodically publish solicitations containing topics for which companies are invited to submit proposals. Phase I proposals are funded for a maximum of \$100,000 for six months of research and development that is intended to establish the scientific, technical, and commercial merit and feasibility of a proposed new technology. An average of 10-15% of Phase I proposals are funded.

Companies which successfully complete Phase I are eligible for Phase II funding. Phase II awards are given for a maximum of \$750,000 for two-year projects that are expected to result in a prototype and testing of a new product or service. On average, about one out of every two or three Phase II proposals are funded.

Phase III is the commercialization phase for products and processes developed during Phases I and II. Phase III is not funded through the SBIR program, but can include government procurement contracts, corporate contracts, strategic alliances, manufacturing contracts, economic development agency or venture capital funding.

Potential Benefits of SBIR

SBIR funding offers many potential benefits for qualified small businesses. (1) The funds do not have to be repaid. (2) The funds received do not add to the debt of or claim any equity in the company. (3) The project can be used to develop new products and technologies. (4) The project can be used to begin a small business (through the initial R&D), but should not be the only source of start-up funds. (5) The funds allow a company to conduct R&D that has greater risk than would be funded by traditional sources of financing. (6) Participation in the SBIR process enables a company to become involved in the federal procurement process. (7) Participation provides external verification that the company's technology has potential commercial value.

RESEARCH ISSUES

1. *What is the relationship between local efforts to promote the SBIR program and the firm's decision to apply for SBIR funding?* Outside assistance has been shown to be an important source of assistance for entrepreneurs and be important in increasing the propensity of entrepreneurs to pursue business opportunities (Chrisman, 1999). SBIR-related assistance from local organizations can be limited to providing information to firms that inquire about the program. Alternatively, local organizations can contact firms directly, encourage them to apply, and provide a mentoring service through the process. The difference in approach may depend on the mission and workload of the organization responsible for facilitating SBIR-related efforts. Local efforts to promote and encourage firms to apply for SBIR funding would be expected to result in a larger number of firms applying for SBIR funding. Local efforts to encourage attendance at SBIR workshops and provide assistance with applications would be expected to create an environment where firms are more aware of and less intimidated by the application process. Thus, the greater (lesser) the local SBIR-related efforts, the greater (lesser) the number of firms that

apply for SBIR funding. The issue examined is not the differential impact of promotional methods, but the relationship between efforts to promote the SBIR program and the firm's decision to apply for SBIR funding?

2. ***What is the relationship between community size and whether or not a firm has applied for SBIR funding?*** Poor dissemination of information may result in less knowledge of funding opportunities and sophistication among business owners in small communities, especially as related to the SBIR program. Lang, Calantone and Gudmundson (1997) believed that small firms must rely on external expertise to be successful. Firms located in small communities may not have access to the same level of expertise, especially as related to the acquisition of capital, as firms located in large communities. Van Auken (2000) found that owners of small firms in small communities were less familiar with sources of capital than small firms in large communities. As a result of capital market inefficiencies associated with location, owners of small businesses that are located in small communities may be less aware of the SBIR program than owners of small businesses that are located in large communities.
3. ***What is the relationship between the owner's objectives and whether a firm has applied for SBIR funding?*** McMahon and Stanger (1995) stated that the traditionally assumed objective of the firm (wealth maximization) does not accurately reflect the goals of the owner of the small firm. The owner's objective, which may be a combination of profit, long-term value creation, taxation, family issues, life-style vs. high growth preferences, impacts how the firm is financed (Ang, 1992; Petty & Bygrave, 1993). Chaganti, DeCarolus, and Deeds (1995) describe entrepreneurs as being craftsman or managerial. Craftsman entrepreneurs are characterized as being primarily motivated by life-style needs and often prefer a more conservative capital structure (i.e. greater equity as compared to debt in the capital structure). Life style needs refer to issues dealing with maintaining a desired life style rather than pursuing a potentially disruptive high growth strategy. Managerial entrepreneurs are strongly motivated by economic gain and may seek more risky sources of capital to grow the firm. Differences between the objectives of each type of firm impact capital acquisition decisions. Owners of firms having life style objectives may, for example, rely on owner's equity and borrowing from financial institutions. Growth oriented firms utilize a different set of capital to fund needs associated with high expected growth.
4. ***What is the relationship between specific firm characteristics and whether or not a firm has applied for and received SBIR funding?*** The characteristics of a firm, including factors such as age, size, type, and existing capital structure, impact access to alternative sources of capital and ability to successfully raise capital. Greater access to either internal or external capital may result in a firm being less likely to seek SBIR funding (Ang, 1992). Large, mature firms would be expected to have greater internal resources (time, human resources, and capital) available that can be used to fund R&D and technology transfer. New firms, especially technology-based firms, would be expected to have limited internal resources available that can be used to fund R&D and technology transfer.

SAMPLE AND METHODOLOGY

The sample was obtained from a list of companies compiled by the Center for Advanced Technology (CATD) development at Iowa State University. CATD compiled a list of Iowa firms through the Iowa Manufacturing database, CorpTech, and references obtained through CATD contacts. The sample firms for this study were comprised of CATD's database of technology-based firms. This list was supplemented with firms not in CATD's database, but

was located in the research parks at Iowa State University and the University of Iowa. Firms in the sample were checked to insure that they fit the criteria of being technology-based and either involved in the commercialization of new technology or having potential interested in commercializing new technology. The sample included Iowa firms that the CATD identified as currently developing or most likely to develop new technology. The final sample included 165 firms.

A questionnaire was developed and pre-tested during the Fall, 1999. The first and second mailings of the questionnaire occurred during November and December, 1999. A total of 73 useable questionnaires were returned, providing a response rate of 44.2%.

The questionnaire was divided into two sections. The first section collected information on the characteristics of respondent, including year the business was launched, size of community in which firm was located, primary activity of business, form of business organization, market served, total capitalization, and owner's objective. The second section asked questions about the respondent's experience with the SBIR program. Specific questions asked included (1) whether they had ever applied for Phase I SBIR funding (never applied; applied but application was not accepted; received SBIR funding); (2) whether they were aware of SBIR workshops in their area; (3) whether they had ever attended an SBIR workshop and, if so, the quality of the program; and (4) how often they had been contacted and encouraged to apply for SBIR funding.

The results were initially summarized using univariate statistics (means and frequencies) to provide a better understanding of the respondents and characteristics of the data. Subsequently, the data were analyzed using two statistical procedures. Chi-square tests were run to examine the first three research issues. The specific tests examined the relationship between whether or not the firm applied for Phase I SBIR funding and (1) whether the owner was encouraged to apply for SBIR funding, (2) whether the owner was aware of local SBIR workshops, (3) whether the owner had attended an SBIR workshop, (4) size of community in which the firm is located, and (5) owner's objectives for the firm. The first three chi-square tests provide evidence for the first research issue. The fourth and fifth chi-square tests provide evidence for the second and third research issue, respectively.

Logit regression analysis was used to develop evidence for the fourth research issue.

SBIR = a + Total Capital + Market + Age

Where SBIR = 1 if never applied for Phase I SBIR funding
= 2 if application for Phase I SBIR funding was rejected
= 3 if application for Phase I SBIR funding was accepted

Total Capital = 1 if total capital acquired < \$100,000
= 2 if total capital acquired \$100,001 - \$500,000
= 3 if total capital acquired \$500,001 - \$1,000,000
= 4 if total capital acquired \$1,000,000 - \$5,000,000
= 5 if total capital acquired > \$5,000,000

Market = 1 if firm served local market
= 2 if firm served regional market
= 3 if firm served national market
= 4 if firm served international market

Age = Age of business

RESULTS

Respondent Characteristics

Table I shows that the primary business activity of most firms (60.6%) was services. The remaining firms fell into either systems integration (26.0%) or other (13.7%) categories. Slightly more than one-half of the firms (54.8%) were organized as C-corporations, approximately 26.0% as S-corporations, and 19.2% were organized in other categories (sole proprietorships, partnerships, cooperatives, and limited liability companies). Almost 58% of the firms had been in operation for 10 years or less (34.2% less than 6 years and 23.1% 6-10 years). Almost 75% of the firms were located in communities of less than 100,000 people. Approximately 34% had raised less than \$100,000 and approximately 38% had raised more than \$1,000,000. The remaining 26% of the firms raised between \$100,000 - \$1,000,000.

Table I
Sample Characteristics
 (n=73)

Firm Characteristic	Percent of Sample
Primary Business Activity	
Services	60.6
Products	26.0
Other	13.4
Organizational Form	
C-Corporation	54.8
S-Corporation	26.0
Other	19.2
Company Age	
<6 years	34.1
6-10 years	23.1
> 10 years	42.8
Community Size	
<25,000	37.0
25,000 - 100,000	37.0
>100,000	24.7
Total Capital Acquired	
< \$100,000	19.2
\$100,001 - \$500,000	15.1
\$500,001 - \$1,000,000	26.0
\$1,000,001 - \$5,000,000	19.2
> \$5,000,000	19.2

SBIR Funding Applications

One objective of the study was to identify differences between firms that applied for Phase I SBIR funding and those that did not apply for Phase I SBIR funding. Approximately 46.5% of the respondents had applied for the SBIR funding. Table II shows the results of Chi-squared analysis that evaluated whether the firm had applied for Phase I SBIR funding and (1) whether they were contacted and encouraged to apply (1=never contacted or contacted one time and 2 = contacted more than one time); (2) whether they were aware of workshops to assist in understanding and applying for SBIR funding (1=yes and 2=no); (3) whether they had attended an SBIR workshop (1=yes and 2=no); (4) owner's objectives for the firm (1-5 ranking; 1 or 2 = life style and 4 or 5 = high growth); and (5) size of community in which the firm is located (1 = less than or equal to 25,000 and 2 = greater than 25,000 population).

Table II
SBIR Grant Application Relative to Variables Affecting Decision to
Apply for SBIR Grant: Chi-Square Analysis
 (n=73)

Variables Affecting Application Decision	Applied for SBIR (%)	Did Not Apply for SBIR (%)	χ^2
Encouraged to Apply	32.8	24.3	4.903 *
Not Encouraged to Apply	13.7	29.7	
Aware of SBIR workshop	38.4	30.2	5.217 *
Not aware of SBIR workshop	8.1	23.8	
Attended SBIR Workshop	24.1	26.4	0.395
Did Not Attend SBIR Workshop	22.4	33.3	
Community Size \leq 25,000	12.5	27.0	4.270 *
Community Size > 25,000	34.0	27.0	
Life Style Preference	18.5	37.0	4.562 *
High Growth Preference	28.0	16.7	

* Significant at 5%

The first research issue examined the relationship between local efforts in promoting the SBIR and whether or not the firm has applied for SBIR funding. The results in Table II show that (1) a higher percentage of firms that were encouraged more than one time applied for SBIR funding as compared to those firms that were either not contacted or contacted only one time (significant at 5%) and (2) a higher percentage of firms that were aware of local SBIR workshops applied for funding as compared to those firms that were unaware of local SBIR workshops (significant at 5%). Interestingly, the results provided no evidence of a statistically significant relationship between attendance at an SBIR workshop and application for SBIR funding.

These results provide evidence that encouragement to apply for SBIR funding and awareness of local workshops on the SBIR program is significantly related to firms applying for funding. The more (less) visible the support programs and the more (less) encouragement that firms receive, the greater (less) likelihood that the firms will apply for SBIR funding. Active local promotional efforts appear to provide a support system that facilitates the application process. The second research issue examined the relationship between the owner's objectives and whether or not a firm had applied for Phase I SBIR funding. The results in Table II show that the owner's objectives for the firm have a direct impact on their likelihood for seeking Phase I SBIR funding. Owners who associated with a growth-oriented firm strategy were significantly more likely to have applied for SBIR funding as compared to owners who associated with a life-style oriented strategy (significant at 5%).

The results in Table II show that a significantly larger number of firms that were located in communities of greater than 25,000 people applied for Phase I SBIR funding as compared to the percentage of firms that were located in communities of less than 25,000 people.

SBIR Application and Approval

The fourth research issue examined the relationship between firm characteristics and whether or not the firm applied for and received SBIR funding. Table III shows the Pearson correlation coefficients for the independent variables in the logit regression model. The table values indicate no statistically significant correlations between the variables.

Table III
Pearson Correlations Between Total Capital Acquired,
Size of Market Served, and Age of Business
(p-values in parentheses)

Variable	Total Capital Acquired	Market Served	Age of Business
Total Capital Acquired	1.00	0.1670 (0.170)	-0.136 (0.264)
Size of Market	****	1.00	0-.152 (0.213)
Age of Business	****	****	****

The results of the logit regression analysis are shown in Table IV. The results indicate that all of the independent variables are statistically significant at 1%. The negative coefficients for total capital acquired (-0.586), market served (-1.258), and age of business (-0.072) indicate that firms which had acquired less (more) capital, served smaller (larger) markets, and were younger (older) were more (less) likely to have applied for and received SBIR funding. These findings are consistent with the expectation that larger (smaller) firms have greater (lesser) financial resources and internal expertise to fund basic research, product development, and technology transfer. Because of their greater access to financial resources, these larger (smaller) firms have less (greater) need for funds provided through the SBIR program. Younger and smaller firms, which commonly experience significant shortages of capital, would be much more likely to view the SBIR program as a more important potential source of capital than older and larger firms.

Table IV
Logit Regression Results
SBIR Success Relative to Total Capital Acquired, Market Served,
and Age of Firm (<10 Years vs. >10 Years)
 (n=69)

Dependent Variable	Independent Variables	Regression Coefficient
SBIR Application	Total Capital Acquired	-0.586 **
($\chi^2 = 19.92$ **)	Market Served	-1.258 **
	Age of Business	-0.072 **

** Significant at 1%

DISCUSSION

An important goal of the SBIR program is to provide R&D funding opportunities for small businesses and assist in the commercialization of new technology. By providing early-stage risk capital, the SBIR program helps fill a financing gap that currently exists in the market. A better understanding of the SBIR program from the firm's perspective can be useful for government agencies that develop SBIR assistance programs. Enhancement of the assistance provided by government agencies can increase the number and success rate of applications. An associated benefit can be an improvement in the success of technology commercialization and the economic development environment.

Government sponsored programs commonly have at least two obstacles that affect participation and success. The first obstacle is the dissemination of information about the program to potential constituents. Creating awareness of program of opportunities can be difficult due to the large amount of information received on a daily basis and fast-paced life styles in today's society. New entrepreneurs are often so busy with activities associated with the launch of the new business that little time is available to learning about new opportunities. Second, government-sponsored programs are sometimes perceived as being complicated, time consuming, and restrictive. Many entrepreneurs may believe that their time is better spent growing their business than pursuing government programs. This may be especially true for owners that have significant time demands from the launch of their new business.

Organizations that provide SBIR-related assistance are faced with the challenge of overcoming these obstacles. The results in this study suggest that efforts to encourage applications and promote visibility are positively associated with the percentage of firms that apply for SBIR funding. A promotional plan that improves the dissemination of information about the SBIR program can help to overcome the obstacles discussed above. A fundamental task for organizations that offer SBIR-related assistance is to compile a valid mailing list of firms that may be eligible for SBIR funding. Once compiled, firms can be contacted through brochures, telephone calls, or other announcements about workshops and new program developments.

A concern that should be assessed by organizations that provide SBIR-related assistance is the goal of the owner of the firm. Owners who are motivated by growth-oriented strategies rather than life-style objectives could be greater assistance since they are more likely to apply for

SBIR funding. Alternatively, organizations that provide SBIR assistance may decide to devote special efforts devoted to making life-style oriented owners aware of SBIR funding opportunities.

Another concern of organizations that provide SBIR-related assistance is the dissemination of SBIR-related information to firms located in small communities. Efforts could be directed at compiling a list of firms located in small communities that may be disconnected with the flow of information about, but might qualify for, government programs. Keeping these firms informed of SBIR funding opportunities might encourage owners to attend a workshop and apply for funding.

The results also indicated that relatively smaller, younger, and less experienced firms are less likely to apply and be successful with SBIR funding applications. Organizations providing SBIR assistance may consider directing efforts at these smaller, younger, and less experienced firms. The larger, older, and more experienced firms may have sufficient resources to pursue SBIR funding with little outside assistance.

Business owners of all sizes should not overlook SBIR grants as a potential source of funding. The lack of size, experience, or familiarity with the SBIR program, remoteness of location, and perceived business goals should not be viewed as constraints to submitting applications. Established organizations can assist through the process with advice on the application process and content.

CONCLUSIONS

This study examined issues related to entrepreneurs' involvement in the SBIR program. The results of the study demonstrate that local efforts to promote the SBIR program visibility by encouraging firms to apply for SBIR funding and increasing the visibility of workshops, can lead to a higher number of firms that apply for SBIR funding. Efforts directed at firms in small communities may be even more effective than efforts directed towards firms in large communities. The results also suggest that organizations that provide SBIR assistance may consider screening potential clients by the business goals of firm's owners. Owners of "life-style" firms may need extra encouragement and, perhaps, assistance, to apply for SBIR funding. Finally, the results imply that firms that are smaller, have more limited experience raising capital, and serve a smaller market (as compared to larger firms) may also need greater assistance in pursuing SBIR funding.

The interpretation of the results of this study is limited in several respects. The sample is limited to only a single state at a single point in time. Replication of the study in other geographic areas would confirm whether the results are specific to the Midwestern U.S. or are typical of other regions. Such a study could identify differences in SBIR proposal success by region. Another study could examine why eligible firms decided against pursuing SBIR funding. In addition, a longitudinal study could validate the findings relative to the impact of economic trends and government initiatives over time. A longitudinal study could also track the success of technology transfer among firms that received SBIR funding as compared to those that did not receive SBIR funding.

The results of this study can be of benefit to government agencies that work with firms in technology transfer, owners of firms that are engaged in bringing new technology to the market, business consultants, and the academic community. The results indicate that proactive efforts by government agencies that provide SBIR-related assistance to firms may increase the likelihood of firms applying for and receiving SBIR funding. The results can be useful to owners of firms who may be candidates for SBIR funding. Some owners, especially

those with life-style preferences and located in small communities, may benefit by being more proactive in seeking SBIR funding. Owners may also benefit from contacting government assistance organizations to inquire about SBIR workshops. Business consultants and public business service providers can use the results to better understand the importance of encouraging firms to apply for SBIR funding and publicizing SBIR workshops. Working with new small firms that have limited resources may be important. However, the results also suggest that efforts to provide assistance to firms in their pursuit of SBIR funding should not ignore larger firms. The academic community can use the results in curriculum and course development to give students better insight into the SBIR program and information on the success of SBIR applications. This type of material would be especially useful in a discussion of the acquisition of capital by firms involved in technology transfer.

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