Standing on the Shoulders of Midgets: The U.S. Small Business Innovation Research Program (SBIR)

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ABSTRACT. The Small Business Innovation Research (SBIR) program in the United States is one of the most important public policy programs, with a goal of generating innovative hi-technology firms and promoting competitiveness and growth. The purpose of this paper is to describe the SBIR, explain why it has emerged as an important policy instrument, and provide an evaluation of the impact of the SBIR. The findings of this paper suggest that the SBIR has generally accomplished its mission by contributing to the creation of high-technology small firms and enhancing U.S. competitiveness.

1. Introduction

As recently as a decade ago, there were serious concerns about the ability of the United States to withstand competition in the global economy, create jobs and continue to develop. Lester Thurow bemoaned that the United States was "losing the economic race,"[1] because, "Today it's very hard to find an industrial corporation in America that isn't in really serious trouble basically because of trade problems. . . . The systematic erosion of our competitiveness comes from having lower rates of growth of manufacturing productivity year after year, as compared with the rest of the world" (Thurow, 1985, p. 23). W.W. Rostow predicted a revolution in economic policy, concluding that,"The United States is entering a new political era, one in which it will be preoccupied by increased economic competition from abroad and will need better cooperation at home to deal with this challenge."[2]

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In the influential study, *Made in America*, directed by the leaders of the MIT Commission on Industrial Productivity, Michael L. Dertouzos, Richard K. Lester, and Robert M. Solow, a team of 23 scholars, spanning a broad range of disciplines and backgrounds, reached the conclusion that for the United States to restore its international competitiveness, it had to adapt the types of policies targeting the leading corporations prevalent in Japan and Germany.

The last decade has seen a reemergence of competitiveness, innovative activity and job generation in the United States. Not only was this economic turnaround largely unanticipated by many scholars and members of the policy community, but what was even more surprising than the resurgence itself was the primary source – small firms. As scholars began the arduous task of documenting the crucial role played by SMEs in the United States as a driving engine of growth, job creation and competitiveness in global markets (Audretsch, 1995), policy makers responded with a bipartisan emphasis on policies to promote SMEs.[3] For example, in his 1993 State of the Union Address to the country, President Bill Clinton proposed, "Because small business has created such a high percentage of all the new jobs in our nation over the last 10 or 15 years, our plan includes the boldest targeted incentives for small business in history. We propose a permanent investment tax creditor the small firms in this country."[4] The Republican response to Clinton was, "We agree with the President that we have to put more people to work, but remember this: 80 to 85 percent of the new jobs in this country are created by small business. So the climate for starting and expanding businesses must be enhanced with tax incentives and deregulation,

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rather than imposing higher taxes and more governmental mandates."[5]

In fact, one of the responses of U.S. policy to the competitiveness crisis of the 1970s and early 1980s was to enact the Small Business Innovation Research Program (SBIR). The mandate of the SBIR was to enhance U.S. competitiveness by promoting innovative and high-technology small firms. The purpose of this paper is to explain the link between international competitiveness and the promotion of small firms as a policy response to globalization, as well as to provide an evaluation of the SBIR.

In the second section of this paper we document how the comparative advantage has shifted away from the traditional factors of production towards knowledge-based economic activity. The implications of knowledge for entrepreneurship is explained in the third section. In the fourth section the role of the SBIR in promoting entrepreneurship in the U.S. is evaluated. Finally, in the fifth section, a summary and conclusions are provided.

2. Globalization and the shifting source of comparative advantage

Globalization has triggered a virtual spatial revolution in terms of the geography of production.[6] The (marginal) cost of transforming information across geographic space has been rendered to virtually nothing. Confronted with lower cost competition in foreign locations, producers in the high-cost countries have three options apart from doing nothing and losing global market share: (1) reduce wages and other production costs sufficiently to compete with the low-cost foreign producers, (2) substitute equipment and technology for labor to increase productivity, and (3) shift production out of the high-cost location and into the low-cost location.

Many of the European and American firms that have successfully restructured resorted to the last two alternatives. Substituting capital and technology for labor, along with shifting production to lower-cost locations has resulted in waves of *Corporate Downsizing* throughout Europe and North America. At the same time, it has generally preserved the viability of many of the large corporations. As record levels of both European and American stock indexes indicate, the companies have not generally suffered. For example, between 1979 and 1995 more than 43 million jobs were lost in the United States as a result of corporate downsizing.[7] This includes 24.8 million blue-collar jobs and 18.7 million white-collar jobs. Similarly, the 500 largest U.S. manufacturing corporations cut 4.7 million jobs between 1980 and 1993, or one quarter of their work force.[8] Perhaps most disconcerting, the rate of corporate downsizing has apparently increased over time in the United States, even as the unemployment rate has fallen. During most of the 1980s, about one in 25 workers lost a job. In the 1990s this has risen to one in 20 workers.

Much of the policy debate responding to the twin forces of the telecommunications revolution and increased globalisation has revolved around a trade-off between maintaining higher wages but suffering greater unemployment versus higher levels of employment but at the cost of lower wage rates. There is, however, an alternative. It does not require sacrificing wages to create new jobs, nor does it require fewer jobs to maintain wage levels and the social safety net. This alternative involves shifting economic activity out of the traditional industries where the high-cost countries of Europe and North America have lost the comparative advantage and into those industries where the comparative advantage is compatible with both high wages and high levels of employment – knowledge based economic activity.

Globalisation has rendered the comparative advantage in traditional moderate technology industries incompatible with high wage levels. At the same time, the emerging comparative advantage that is compatible with high wage levels is based on innovative activity. For example, employment has increased by 15 percent in Silicon Valley between 1992 and 1996, even though the mean income is 50 percent greater than in the rest of the country.[9]

The global demand for innovative products in knowledge-based industries is high and growing rapidly; yet the number of workers who can contribute to producing and commercializing new knowledge is limited to just a few areas in the world. Economic activity based on new knowledge generates higher wages and greater employment opportunities reflecting the exploding demand for new and improved products and services. There

are many indicators reflecting the shift in the comparative advantage of the high-wage countries towards an increased importance of innovative activity. For example, Kortum and Lerner (1997, p. 1) document an unprecedented jump in patenting in the United States, as evidenced by the explosion in applications for United States patents by American inventors since 1985. Throughout this century, patent applications fluctuated within a band between 40,000–80,000 per year. By contrast, in 1995 there were over 120,000 patent applications. Similarly, Berman et al. (1997) have shown that the demand for less skilled workers has decreased dramatically throughout the OECD, while at the same time, the demand for skilled workers has exploded.

3. Entrepreneurship in a knowledge economy

That SMEs would emerge as becoming more important seems to be contrary to many of the conventional theories of innovation. The starting point for most theories of innovation is the firm. In such theories the firms are exogenous and their performance in generating technological change is endogenous (Arrow, 1962). For example, in the most prevalent model found in the literature of technological change, the model of the knowledge production function, formalised by Zvi Griliches (1979), firms exist exogenously and then engage in the pursuit of new economic knowledge as an input into the process of generating innovative activity. The most decisive input in the knowledge production function is new economic knowledge. Knowledge as an input in a production function is inherently different than the more traditional inputs of labour, capital and land. While the economic value of the traditional inputs is relatively certain, knowledge is intrinsically uncertain and its potential value is asymmetric across economic agents.[10] The most important, although not the only source of new knowledge is considered to be research and development (R&D). Other key factors generating new economic knowledge include a high degree of human capital, a skilled labour force, and a high presence of scientists and engineers.

There is considerable empirical evidence supporting the model of the knowledge production function. This empirical link between knowledge inputs and innovative output apparently becomes stronger as the unit of observation becomes increasingly aggregated. For example, at the unit of observation of countries, the relationship between R&D and patents is very strong. The most innovative countries, such as the united States, Japan and Germany, also tend to undertake high investments in R&D. By contrast, little patent activity is associated with developing countries, which have very low R&D expenditures. Similarly, the link between R&D and innovative output, measured in terms of either patents or new product innovations is also very strong when the unit of observation is the industry. The most innovative industries, such as computers, instruments and pharmaceuticals also tend to be the most R&D intensive. Audretsch (1995) finds a simple correlation coefficient of 0.74 between R&D inputs and innovative output at the level of four-digit standard industrial classification (SIC) industries. However, when the knowledge production function is tested for the unit of observation of the firm, the link between knowledge inputs and innovative output becomes either tenuous and weakly positive in some studies and even non-existent or negative in others. The model of the knowledge production function becomes particularly weak when small firms are included in the sample. This is not surprising, since formal R&D is concentrated among the largest corporations, but a series of studies has clearly documented that small firms account for a disproportional share of new product innovations given their low R&D expenditures.

The breakdown of the knowledge production function at the level of the firm raises the question, *Where do innovative firms with little or no R&D get the knowledge inputs?* This question becomes particularly relevant for small and new firms that undertake little R&D themselves, yet contribute considerable innovative activity in newly emerging industries such as biotechnology and computer software (Audretsch, 1995). One answer that has recently emerged in the economics literature is from other, third-party firms or research institutions, such as universities. Economic knowledge may spill over from the firm conducting the R&D or the research laboratory of a university.

Why should knowledge spill over from the source of origin? At least two major channels or mechanisms for knowledge spillovers have been

identified in the literature. Both of these spillover mechanisms revolve around the issue of appropriability of new knowledge. Cohen and Levinthal (1989) suggest that firms develop the capacity to adapt new technology and ideas developed in other firms and are therefore able to appropriate some of the returns accruing to investments in new knowledge made externally.

By contrast, Audretsch (1995) proposes shifting the unit of observation away from exogenously assumed firms to individuals, such as scientists, engineers or other knowledge workers – agents with endowments of new economic knowledge. When the lens is shifted away from the firm to the individual as the relevant unit of observation, the appropriability issue remains, but the question becomes, *How can economic agents with a given endowment of new knowledge best appropriate the returns from that knowledge?* If the scientist or engineer can pursue the new idea within the organisational structure of the firm developing the knowledge and appropriate roughly the expected value of that knowledge, he has no reason to leave the firm. On the other hand, if he places a greater value on his ideas than do the decision-making bureaucracy of the incumbent firm, he may choose to start a new firm to appropriate the value of his knowledge. In the metaphor provided by Albert O. Hirschman (1970), if voice proves to be ineffective within incumbent organisations, and loyalty is sufficiently weak, a knowledge worker may resort to exit the firm or university where the knowledge was created in order to form a new company. In this spillover channel the knowledge production function is actually reversed. The knowledge is exogenous and embodied in a worker. The firm is created endogenously in the worker's effort to appropriate the value of his knowledge through innovative activity.

4. The public policy response

Public policy towards business has gradually shifted from viewing the role of SMEs through the static lens towards the dynamic framework. For example, the United States Congress enacted the Small Business Innovation Research (SBIR) program in the early 1980s as a response to the loss of American competitiveness in global markets. Congress mandated each federal agency with allocating around four percent of its annual budget to funding innovative small firms as a mechanism for restoring American international competitiveness. The SBIR provides a mandate to the major R&D agencies in the United States to allocate a share of the research budget to innovative small firms. Last year the SBIR program amounted to around $1.2 billion. The SBIR consists of three phases. Phase I is oriented towards determining the scientific and technical merit along with the feasibility of a proposed research idea. A Phase I award provides an opportunity for a small business to establish the feasibility and technical merit of a proposed innovation. The duration of the award is six months and can not exceed $70,000. Phase II extends the technological idea and emphasizes commercialization. A Phase II Award is granted to only the most promising of the Phase I projects based on scientific/technical merit, the expected value to the funding agency, company capability and commercial potential. The duration of the award is a maximum of 24 months and generally does not exceed $600,000. Approximately 40 percent of the Phase I Awards continue on to Phase II. Phase III involves additional private funding for the commercial application of a technology. A Phase III Award is for the infusion and use of a product into the commercial market. Private sector investment, in various forms, is typically present in Phase III.

Under the Small Business Research and Development Enhancement Act of 1992, funding in Phase I was increased to $100,000, and in Phase II to $750,000.

The SBIR was an offshoot of the Small Business Investment Company (SBIC) program, which provided more than $3 billion to young firms between 1958 and 1969. During this period this amounted to more than three times the total amount of private venture capital.

The SBIR represents about 60 percent of all public SME finance programs. Taken together, the public SME finance is about two-thirds as large as private venture capital. In 1995, the sum of equity financing provided through and guaranteed by public programs financing SMEs was $2.4 billion, which amounted to more than 60 percent of the total funding disbursed by traditional venture funds in that year. Equally as important, the

emphasis on SBIR and most public funds is on early stage finance, which is generally ignored by private venture capital. Some of the most innovative American companies received early stage finance from SBIR, including Apple Computer, Chiron, Compaq and Intel.

Through the Small Business Innovation Research (SBIR) program, the National Institutes of Health (NIH) awarded $266 million in grants to small firms for medical and biopharmaceutical research. It is expected that the SBIR program at NIH will exceed $300 million in 1999.

In addition to the NIH, the United States Department of Defense also uses the SBIR program to fund biotechnology firms. Between 1983 and 1997 there was more than $240 million in SBIR awards for biotechnology companies from the Department of Defense. Phase I accounted for $47 million and Phase II accounted for $194 million (Wessner, 2001).

To evaluate the impact of the SBIR on the commercial activities of SMEs, a large, comprehensive survey was undertaken by the U.S.National Academy's division on Science, Technology, and Economic Policy (STEP) (Wessner, 2001). In addition, case studies were undertaken on the basis of detailed interviews with the founders, owners and employees of over fifty firms (Scott, 2001; Link, 2001; Link and Scott; 2001). All of the case study firms had received SBIR assistance. They are dispersed across the United States and span a broad range of technologies, products and industries. While some are new startups, others have a proven track record of success. These case studies examined the impact of the SBIR in a broad context. In particular, the results from evaluating the SBIR suggested that the benefits of the SBIR extends beyond the impact on the individual recipient firm. The social rate of return, which incorporates this external positive impact, exceeds the positive rate of return. There was no evidence of a negative rate of return associated with the SBIR. There is compelling evidence that the SBIR program has had a positive impact on developing the U.S. biotechnology industry. The benefits have been documented as:

- The survival and growth rates of SBIR recipients have exceeded those of firms not receiving SBIR funding (Lerner and Kegler, 2001)
- The SBIR induces scientists involved in research to change their career path. By applying the scientific knowledge to commercialization, these scientists shift their career trajectories away from basic research towards entrepreneurship (Feldman, 2001 and Audretsch et al., 2001).
- The SBIR awards provide a source of funding for scientists to launch start-up firms that otherwise would not have had access to alternative sources of funding.
- SBIR awards have a powerful demonstration effect. Scientists commercializing research results by starting companies induce colleagues to consider applications and the commercial potential of their own research.

5. Conclusions

Globalization is shifting the comparative advantage in the United States away from being based on traditional inputs of production, such as land, labor and capital, towards knowledge. As the comparative advantage has become increasingly based on new knowledge, public policy has responded in two fundamental ways. The first has been to shift the policy focus away from the traditional triad of policy instruments essentially constraining the freedom of firms to contract – regulation, antitrust in the U.S., and public ownership of business. The policy approach of constraint was sensible as long as the major issue was how to restrain large corporations in possession of considerable market power. That this policy is less relevant in a global economy is reflected by the waves of deregulation and privatisation. Instead, a new policy approach is emerging which focuses on enabling the creation and commercialisation of knowledge. Examples of such policies include encouraging R&D, venture capital and new-firm startups. In particular, the new focus of SME policies is to promote the first type of strategy deployed by SMEs to enhance global competitiveness – innovation. Probably the greatest and most salient shift in SME policy over the last fifteen years has been a shift from trying to preserve SMEs that are confronted with a cost disadvantage due to size inherent scale disadvantages, towards promoting the startup and viability of SMEs involved in the commercialization of

knowledge, or knowledge-based SMEs. The SBIR program of the United States is clearly one such policy that has recognized the important role that innovative small firms play in generating competitiveness and growth.

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Notes

[1] Lester Thurow, 'Losing the Economic Race', *New York Review of Books*, September 1984, pp. 29–31.

[2] W. W. Restow, 'Here Comes a New Political Chapter in America', International Herald Tribune, 2 January 1987.

[3] For example, U.S. News and World Report (16 August, 1993) reported, 'What do Bill Clinton, George Bush and Bob Dole have in common? All have uttered one of the most enduring homilies in American political discourse: That small businesses create most of the nation's jobs.'

[4] Cited from Davis et al. (1996, p. 298).

[5] Representative Robert Michel, House Minority Leader, in the Republican Response to the 1993 State of the Union Address, cited from Davis et al. (1996, p. 298).

[6] According to *The Economist*, 'The death of distance as a determinant of the cost of communications will probably be the single most important economic force shaping society in the first half of the next century.' 'The Death of Distance', *The Economist*, 30 September, 1995.

[7] 'The Downsizing of America', *New York Times*, 3 March, 1996, p. 1.

[8] See Audretsch (1995).

[9] 'The Valley of Money's Delights', *The Economist*, 29 March, 1997, special section, p. 1.

[10] Arrow (1962) pointed out this is one of the reasons for inherent market failure.

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