Policies Promoting Innovation in Small Firms: Evidence from the U.S. and U.K.

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ABSTRACT. We provide background information on U.S. and U.K. policies promoting innovation in small firms and also summarize the papers that appear in this special issue. These studies were presented at a recent workshop that was jointly organized by the University of Nottingham Institute for Enterprise and Innovation (UNIEI) and the Board on Science, Technology, and Economic Policy (STEP) of the U.S. National Academy of Sciences. Based on a synthesis of these papers and other evidence that was presented during the workshop, we conclude that: (1) program evaluation is much more prevalent in the U.S. than in the U.K.; (2) the U.S. Advanced Technology Program (ATP) and Small Business Innovation Research (SBIR) program have been successful; and (3) shared costs between government and industry and frequent assessment are the keys to ensuring that such programs are successful.

1. Introduction

This special issue evolved from our shared interest in the antecedents and consequences of U.S. and U.K. policies designed to promote innovation in new-technology based firms (NTBFs). Although NTBFs constitute only a small percentage of the population of small companies, they are increasingly being viewed as an engine of economic growth and job creation. Thus, an analysis of the effectiveness of these programs is a salient public policy issue, since successful attempts to address innovation market failures through such policy instruments can potentially significantly enhance entrepreneurial activity and economic development.

In both countries, a consensus has emerged that such programs are needed to alleviate critical innovation market failures in such areas as human capital, accommodation, and early stage financing of small NTBFs. That is, policymakers have concluded that a non-negligible percentage of NTBFs could not survive without some form of government assistance during the initial stages of their development.

The purpose of this introductory paper is to present some background information on U.S. and U.K. policies that assist in the development and growth of NTBFs. We also provide a roadmap for the remainder of the papers that appear in this special issue. These papers were presented at a special two-day workshop held at the Nottingham University Business School in September 2000, which was jointly organized by the University of Nottingham Institute for Enterprise and Innovation (UNIEI) and the Board on Science, Technology, and Economic Policy (STEP) of the U.S. National Academy of Sciences. Finally, we also attempt to draw some conclusions from the papers and the discussion that took place during the workshop.

The remainder of this paper is organized as follows. Section 2 describes the NTBF-related policies that have been implemented in the U.S. and U.K., which raise salient issues for academics, policymakers, and practitioners. Section 3 outlines the themes and objectives of the workshop, where evidence was presented on various aspects of these issues. We also provide a parsimonious descrip-

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Small Business Economics **20**: 121–127, 2003.

tion of each paper in the special issue. The final section consists of conclusions drawn from the papers and the workshop and suggestions for additional research.

2. U.S. and U.K. policies promoting NTBFs

Government support for NTBFs can assume various forms, including direct subsidies for projects funded by private firms (e.g., the U.S. Advanced Technology Program (ATP) and the U.K. "Small Firms Merit Award for Research and Technology" (SMART) Program)) or legislative set-asides for innovative small firms (e.g., the Small Business Innovation Research (SBIR) program in the U.S. and Enterprise Zone Initiatives in the U.K.). Another avenue of government assistance is through the establishment of a public-private partnership, which receives some level of support from a public institution.

NTBFs and associated public-private partnerships have gained in prominence in the "new economy", with its greater emphasis on intellectual property, venture capital, entrepreneurial startups and university technology transfer. Indeed, many of these partnerships involve universities and firms, where there is shared use of expertise and laboratory facilities (e.g., a National Science Foundation Industry-University Cooperative Research Center (IUCRC)) or linkages between university scientists and entrepreneurs through incubators, science parks, and university-based startups.

In the U.S., numerous partnerships were formed in the aftermath of legislative initiatives that were designed to promote cooperative R&D and the formation of NTBFs. These policies typically enjoyed widespread bipartisan support, since they were viewed as an important mechanism for stimulating technological spillovers, job creation, and economic growth/development. Several key pieces of legislation were designed specifically to stimulate research joint ventures and the transfer of technology from federal laboratories and universities to small firms. These include the Bayh-Dole Act of 1980, the 1982 Small Business Innovation Development Act (which established the SBIR program), the 1984 National Cooperative Research Act, and the 1992 Small Business Technology Transfer Act (which established the Small Business Technology Transfer Research program).

For instance, the Bayh-Dole Act dramatically changed incentives for small firms and universities to transfer technologies. Bayh-Dole simplified the transfer process by instituting a uniform patent policy across federal agencies, removed many restrictions on licensing, and allowed universities to own the patents that arise from federal research grants. It appears that Bayh-Dole has led to creation of more NTBFs at universities. According to the Association of University Technology Managers (AUTM (1999)), the number of startup firms at U.S. universities rose from 35 in 1980 to 389 in 1998.

Feller (1997) contends that some universities are inclined to use startups as a mechanism for generating financial returns from their intellectual property portfolio when inventions or knowledge cannot be easily patented. Other universities expect to reap a major windfall if the startup eventually goes public.[1] These institutions may also wish to use such NTBFs as a mechanism for stimulating regional economic development. That is, by promoting university-based startups, universities increase the likelihood that they can more effectively localize the economic benefits of technology transfer. In this regard, Feller (1997) also notes that these NTBFs can be viewed as likely tenants for university-based science and technology parks.[2] An emphasis on the use of technology transfer to foster economic development can be extremely useful for public universities, who need to build political support for their institutions in a state legislature.

In the U.K., several bipartisan initiatives to promote small business innovation and public-private partnerships were implemented in the late 1990s, based on ideas advanced in a series of competitiveness "white papers." Although some of these government programs promote innovative activity in firms of all sizes, some are specifically targeted to small NTBFs. Of more direct relevance to NTBFs has been the government's strong emphasis on enhancing the role of higher education in the commercialization of university-based research. Programmes such as University Challenge (UC), Science Enterprise Challenge (SEC), and the Higher Education Innovation Fund (HEIF) form part of a systematic process to create

a third stream of funding for universities, in addition to revenue derived from teaching and research. UC has led to the establishment of zero and early stage equity funds in individual or collaborative groups of universities. SEC has funded the development of a network of Science Enterprise Centres at several U.K. universities, based again at individual or collaborating groups of institutions. These centers are tasked with encouraging the licensing and spinout of university-based research, as well as addressing human capital requirements relating to entrepreneurial skills. HEIF is designed to provide a permanent flow of financial support, of the type developed under UC and SEC, and also through the encouragement of closer integration between universities and industry. The government's growing commitment to programs that stimulate and facilitate innovative activity, especially among small firms, is evident by the recent establishment of an "Innovation Agency" within the Department of Trade and Industry (DTI).

It is interesting to note that the proliferation of programs to support NTBFs also coincides with the trend towards greater scrutiny of public investments in R&D. As described in Link (1996) and Link and Scott (1998), this trend stems, in part, from recent initiatives to hold public technology-based institutions more accountable for documenting the economic impact of the R&D projects they have supported. We predict that universities in both countries will soon encounter similar pressures from legislative bodies that provide funding.[3] Indeed, programs such as UC and SEC in the U.K. are already closely monitored, according to pre-agreed performance targets. Unfortunately, these targets do not constitute valid evaluation criteria. In fact, a key mission of the University of Nottingham Institute for Enterprise and Innovation (UNIEI) is to develop a more sophisticated set of benchmarking metrics and evaluation processes. This will allow researchers to conduct more accurate analyses of the effectiveness of these programs.

The "new economy" policies we have described in this section, which promote innovation and entrepreneurship, have attracted considerable attention on both sides of the Atlantic. More specifically, the implementation of these programs raises the following set of questions:

- What are the institutional features of these policies?
- How do we measure whether these programs are achieving their goals?
- Which programs appear to be the most successful?
- What are the best strategies for universities to employ when they wish to foster an entrepreneurial climate for the creation of NTBFs?
- What are the key areas for future research?

3. The workshop and special issue

To address these questions, we convened a workshop at the Nottingham University Business School in September 2000, consisting of leading academics, senior government officials, corporate executives, and entrepreneurs in the U.S. and U.K. Several academics from continental Europe also attended the workshop, in order to provide a broader European perspective. The University of Nottingham Institute for Enterprise and Innovation (UNIEI) and the Board on Science, Technology, and Economic Policy (STEP) of the U.S. National Academy of Sciences jointly organized this conference. Scholars from MIT, Johns Hopkins, Indiana, Duke, University of North Carolina at Greensboro, Cambridge, University of Warwick, University of London, University of Manchester, Imperial College, University of St. Andrews, University of Edinburgh, University of Bologna, University of Amsterdam, and the Free University of Brussels participated in this conference.

After a paper was presented on a particular theme, a panel of commentators consisting of an academic, a policymaker, and a practitioner (an entrepreneur or corporate executive) led a discussion of the main issues involved. We believe that the design of our workshop had two notable features. First, it included contributors from numerous academic disciplines, such as economics, sociology, finance, accounting, public policy, and management, as well as policymakers, university administrators, and consultants. We believe that this diversity of perspectives is useful, since entrepreneurship is a topic that can be explored from a variety of paradigms. Second, the papers constitute a mix of quantitative and qualitative research, which is entirely appropriate given

the difficulty of measuring and interpreting organizational phenomena.

The papers presented at the workshop dealt with four major themes: the design and implementation of programs to support NTBFs, evaluation and assessment, science parks, and university-industry technology transfer. Below, we consider each of these issues in turn and also provide a brief summary of each paper:

Design and implementation of programs

David Audretsch provides a broad, historical perspective on the SBIR program, which is generally regarded to be one of America's most important initiatives to stimulate innovative activity in small firms. He conjectures that the SBIR was a policy response to concerns regarding globalization and international competitiveness. This is clearly an argument that resonates with policymakers and helps us understand why this initiative continues to draw widespread, bipartisan political support. Professor Audretsch also reviews some of the research on evaluation of this program.

Ron Cooper's study nicely complements the paper by David Audretsch. Dr. Cooper provides us with a detailed review of the goals, objectives, and outcomes of the SBIR program. He also discusses some challenges and then presents some suggestions for modifications in the program that will further enhance performance. His paper should be extremely useful to lawmakers in other nations who wish to emulate such policies. It may also be helpful to academics who wish to examine the impact of these policies on firms and industries. That is, we have observed that some scholars who conduct research on specific programs are not actually familiar with the design of the programs or how the policies are actually implemented. Dr. Cooper's paper helps to fill this gap.

Evaluation and assessment of programs

The substantial resources devoted to programs to promote NTBFs underscore the importance of evaluating their effectiveness. However, program evaluation can be highly complex, because of difficulties in measuring spillover effects. Maryann Feldman and Maryellen Kelley provide important new evidence on research spillovers resulting from the Advanced Technology Program (ATP) in the U.S. Although this program does not explicitly target small companies, it does provide financial support for many research joint ventures that involve small firms. The authors exploit an extremely rich longitudinal database on firms that received ATP awards and firms that applied for such awards, but did not receive one.[4] This allows them to examine an interesting counterfactual; namely whether non-award winners proceed with a research project after rejection. The authors report that, more often than not, the overwhelming majority of non-award winners either abandoned these projects or undertook them on a much smaller scale.

Their findings with respect to award winners are also compelling. Feldman and Kelley report that ATP firms can leverage their awards in several ways. First, it appears that venture capital firms and other providers of financial capital view the award as an important signal of the viability of the project and the company. Thus, there is a "halo effect" associated with the prestige winning of an ATP award, which has helped award winners raise additional funds for R&D. Second, ATP firms often build on the knowledge they have developed by forming new R&D partnerships. Many of these partnerships are in technical areas that are different from the original project. Taken together, these results imply that program recipients constitute a significant source of R&D spillovers. However, more research on the private and social returns to these programs is needed.

Science parks

Science parks are a particular type of property-based incubator initiative that has been strongly supported in the U.S. and the U.K. The advantage of science parks to NTBFs is that they can provide access to critical human and physical capital, as well as an environment that fosters technology transfer and much-needed business skills.

The paper by Al Link and John Scott is a quantitative and qualitative analysis of one of the world's most successful science parks: Research Triangle Park (RTP) in North Carolina. The authors begin with an illuminating discussion of the history of RTP. Next, they attempt to draw

lessons from this experience by outlining a diffusion (hazard) model, which describes the movement of firms onto the park. This model provides an excellent fit to actual data on patterns of firm growth. They extrapolate from this result to formulate a general hypothesis regarding a key determinant of the success of science parks: the existence of a strong entrepreneurial leader. In the case of RTP, this individual, Archibald Davis, guided this project for over two decades. According to the authors, his vision and leadership were especially important in the early days of the endeavor, when it was very difficult to convince companies to move to RTP.

Link and Scott acknowledge that it is difficult to attribute causality to this factor. That is, one could easily point to the existence of three major research universities (University of North Carolina at Chapel Hill, North Carolina State, and Duke University) in the local vicinity as a major determinant of the success of RTP. Still, the authors conclude that policymakers who wish to replicate the success of RTP should be mindful of the importance of continuity of entrepreneurial leadership.

The performance of science parks is a multidimensional construct that may incorporate a number of different objectives relating to their influence on local firms and their environment. Despite the potential importance of science parks as a mechanism for generating technological spillovers and employment growth, there has been little systematic analysis of their impact on the performance of NTBFs. Donald Siegel, Paul Westhead, and Mike Wright review and critique recent research on U.K. science parks. After presenting a brief history of science parks in the U.K., they note that there are several types of science parks, which can be classified on the basis of their managerial strategies. The authors then examine recent empirical evidence on the impact of science parks on the performance of NTBFs, which suggests that the returns to being located on a science park (for a given NBTF) are negligible. They conjecture that these results may be spurious, due to imprecise estimates of the returns to being located on a science park. The authors also assert that such findings may be masking important differences in the returns to different *types* of science parks. They conclude by outlining an agenda for additional research on the effects of these institutions on NTBF performance.

University-industry technology transfer

Universities are becoming increasingly motivated by the need for success in commerce, as well as in traditional academic pursuits (Powell and Owen-Smith, 1998). The benefits of commercialization may be captured through a number of different technology transfer mechanisms. The dominant form of commercialization has traditionally been licensing, but there is growing interest in university-based entrepreneurial startups (Siegel et al., 1999).

Lockett, Wright and Franklin examine university-based startups or "spin-out" companies. The authors surveyed technology transfer officers at 57 U.K. universities, in an effort to explore whether there are clear differences in strategies employed by universities in the creation and management of spinout firms. They can also distinguish between those universities that have been most active in this arena and those that have been less active.

The authors find that universities that generate the most startups have clear, well-defined strategies regarding the formation and management of spinouts. These schools tend to use surrogate (external) entrepreneurs, rather than academic entrepreneurs, to manage this process. It also appears as though the more successful universities have greater expertise and vast social networks that help them generate more startups. However, the role of the academic inventor was not found to differ between the more and less successful universities. Finally, equity ownership was found to be more widely distributed among the members of the spinout company in the case of the more successful universities. The authors conclude that the best approach for universities that wish to launch successful technology transfer startups is a combination of academic and surrogate entrepreneurship. This mixture would allow universities to simultaneously exploit the technical benefits of inventor involvement *and* the commercial know-how of surrogate entrepreneurs.

Our final piece is a comment by Loet Leydesdorff, which provides a cautionary note regarding the spread of entrepreneurial activity at

universities. The author warns that any evaluation of "best practices" in university entrepreneurship or technology transfer (e.g. the study by Lockett, Wright, and Franklin) must also carefully assess the broader impacts of such activities on all stakeholders involved in the process of technology transfer (i.e., government, industry, faculty, students, and the local community). He also voices some concern regarding the tensions that arise regarding ownership of intellectual property, given the complexity of relationships between universities, industry, and government.

4. Conclusions

Perhaps the most fruitful discussion came in the final session of the workshop, which was devoted entirely to "lessons learned and future directions." Although it is difficult for such a large group to reach a consensus, there was virtual unanimity on the following points. First, the U.S. is more advanced than the U.K., in terms of evaluation and assessment of programs that support innovative activity (e.g., the ATP). However, it must be noted that efforts are currently being undertaken in the U.K to address this imbalance, by developing more sophisticated benchmarking metrics and evaluation processes. Second, evidence from the U.S. suggests that the ATP and SBIR programs have been successful. Moreover, there are social as well as private returns to the different programs, which need to be accounted for in any comprehensive evaluation of a given program. Third, it appears that the success of these programs (e.g., ATP and SBIR) is due to the assistance they provide to small R&D intensive firms, who typically engage in highly uncertain collaborative research projects. Finally, it appears that shared costs between public and private partners and frequent assessment are the keys to ensuring that these programs are successful.

There was also a consensus regarding the need for more sophisticated and comprehensive analyses of these programs. Although there is some limited evidence on the performance of these programs, systematic efforts are warranted to improve the precision of estimates of the private and social returns to investment in small business innovation programs. In order to achieve this goal, we need better measures of the long-term outcomes of specific projects and programs, including an in-depth, longitudinal analysis of the behavior of firms that apply for funding and do not receive it. Finally, special attention should be devoted to failure, since the incidence of numerous firm failures is an inevitable result of entrepreneurial activity.

Notes

[1] Note that many of the technologies employed by such startups are embryonic.

[2] Siegel et al. (1999) report that universities have recently become more receptive to the idea of accepting an equity position in an entrepreneurial startup, in lieu of up-front licensing revenue.

[3] Of course, for private companies involved in public-private partnerships, *shareholder* accountability is a powerful force, ensuring that corporate managers will closely monitor the financial return on investment in the partnership.

[4] It is interesting to note that ATP is one of the few government programs that tracks non-award winners.

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