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When Bureaucrats Meet Entrepreneurs: The Design of Effective “Public Venture Capital” Programs

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The federal government has played an active role in financing new firms, particularly in high-technology industries, since the Soviet Union’s launch of the Sputnik satellite. In recent years, European and Asian nations and many U.S. states have adopted similar initiatives. While these programs’ precise structures have differed, the efforts have been predicated on two shared assumptions: (i) that the private sector provides insufficient capital to new firms and (ii) that the government either can identify investments which will ultimately yield high social and/or private returns or can encourage financial intermediaries to do so. In contrast to other government interventions designed to boost economic growth, such as privatization programs, these claims have received little scrutiny by economists.

The neglect of these questions is unfortunate. While the sums of money involved are modest relative to public expenditures on defense procurement or retiree benefits, these programs are very substantial when compared to contemporaneous private investments in new firms. Several examples underscore this point:

- The Small Business Investment Company (SBIC) program led to the provision of more than \$3 billion to young firms between 1958 and 1969, more than three times the total private venture capital investment during these years (Noone and Rubel 1970).
- In 1995, the sum of the equity financing provided through and guaranteed by federal and state small business financing programs was \$2.4 billion, more than 60 percent of the amount disbursed by traditional venture funds in that year (Lerner 1999). Perhaps more significantly, the bulk of the public funds went to early-stage firms (e.g., those not yet shipping products), which in the past decade had accounted for only about 30 percent of the disbursements by independent venture capital funds.

- Some of America's most dynamic technology companies received support through the SBIC and Small Business Innovation Research (SBIR) programs while still privately held entities, including Apple Computer, Chiron, Compaq, and Intel (Lerner 1999).
- Public venture capital programs have also had a significant impact overseas: e.g., Germany has created about 800 federal and state government financing programs for new firms over the past two decades, which provide the bulk of the financing for technology-intensive start-ups (Organization for Economic Cooperation and Development 1996).

Table 1 summarizes these programs in more detail. This chapter attempts to address this gap, discussing the major challenges that these programs face.

Government programs in this arena have been divided between those efforts that directly fund entrepreneurial firms and those that encourage or subsidize the development of outside investors. In this chapter, I will focus on "public venture capital" initiatives: programs that make equity or equity-like investments in young firms, or encourage other intermediaries to make such investments. In some such programs, such as the Advanced Technology Program and the Small Business Innovation Research programs discussed below, the funds are provided as a contract or outright grant.

While these efforts have proliferated, a consensus as to how to structure these programs remains elusive. While the design of regulatory agencies has been extensively studied from a theoretical and empirical perspective, little work has been done as to how to structure these programs to ensure their greatest effectiveness and to avoid political distortions. As we discuss below, a number of these programs appear predicated on a premise that is at odds with what we know about the financing process: that technologies in entrepreneurial firms can be evaluated in the absence of the consideration of the business prospects of the firm.¹

This chapter will provide an overview of the motivations for these public efforts, as well as a brief consideration of design questions.

Venture Capitalists and the Financing Challenge

The initial reaction of a financial economist to the argument that the government needs to invest in growth firms is likely to be skepticism. A lengthy literature has highlighted the role of financial intermediaries

in alleviating moral hazard and information asymmetries. Young high-technology firms are often characterized by considerable uncertainty and informational asymmetries, which permit opportunistic behavior by entrepreneurs. Why one would want to encourage public officials instead of specialized financial intermediaries (venture capital organizations) as a source of capital in this setting is not immediately obvious.

The Challenge of Financing Young High-Technology Firms

Before discussing the role of government agencies, it is important to appreciate the challenges that financing young firms pose. I will thus begin by reviewing the types of conflicts that can emerge in these settings.

Jensen and Meckling (1976) demonstrate that agency conflicts between managers and investors can affect the willingness of both debt and equity holders to provide capital. If the firm raises equity from outside investors, the manager has an incentive to engage in wasteful expenditures (e.g., lavish offices) because he does not bear their entire cost. Similarly, if the firm raises debt, the manager may increase risk to undesirable levels. Because providers of capital recognize these problems, outside investors demand a higher rate of return than would be the case if the funds were internally generated.

Even if the manager is motivated to maximize shareholder value, informational asymmetries may make raising external capital more expensive or even preclude it entirely. Myers and Majluf (1984) and Greenwald, Stiglitz, and Weiss (1984) demonstrate that equity offerings of firms may be associated with a "lemons" problem (Akerlof 1970). If the manager is better informed about the investment opportunities of their firms than the investors and acts in the interest of current shareholders, then the manager issues new shares only when the company's stock is overvalued. Indeed, numerous studies have documented that stock prices decline upon the announcement of equity issues, largely because of the negative signal sent to the market.

These information problems have also been shown to exist in debt markets. Stiglitz and Weiss (1981) show that if banks find it difficult to discriminate among companies, raising interest rates can have perverse selection effects. In particular, the high interest rates discourage all but the highest-risk borrowers, so the quality of the loan pool declines markedly. To address this problem, banks may restrict the amount of lending rather than increase interest rates.

Table 1

U.S. public venture capital initiatives, 1958–2000. The table summarizes programs sponsored by state and federal organizations in which equity investments or equity-like grants were made into privately held companies, or into funds that made such investments. If a program had multiple names, we report the name as of 2000. If a program was terminated before 2000, we record its name at the time of termination. If an organization sponsoring a program changed its name, or if responsibility for the program was transferred between organizations, we record the name of the sponsoring organization as of 2000. If the program was terminated before 2000, we record the sponsoring organization at the time of termination.

Sponsoring organization	Program name	Brief description	Span
Small Business Administration	Small Business Investment Company Program	Provides capital to federally sponsored funds that make debt and equity investments in growth firms.	1958–2000
Department of Commerce	State Technical Services Program	Supported various government programs to help high-technology companies (especially new firms).	1965–1969
Department of Housing and Urban Development Model Cities Administration At least 30 states	Venture Capital Development Assistance	Demonstration projects in selected cities financed businesses begun by residents of targeted neighborhoods.	1967–1971
Department of State Agency for International Development	At least 43 state venture funds or SBIC programs At least 13 developing country venture funds	Make investments into funds supporting new enterprises, which often focus on high-technology firms. Provided loans to financial intermediaries that made equity and debt investments in new enterprises in over 30 countries.	1970–2000 1971–1993
Small Business Administration	Specialized Small Business Investment Company Program	Provides capital to federally sponsored funds that make debt and equity investments in growth firms owned by disadvantaged individuals.	1972–2000
Department of Commerce National Bureau of Standards National Science Foundation	Experimental Technology Incentives Program Federal Laboratories Validation Assistance Experiment	Catalyzed new public programs across agencies to encourage industrial research and venture capital. Funded assessments by national laboratory personnel of prototype products and processes developed by entrepreneurs.	1972–1979 1972–1975

National Science Foundation and Small Business Administration	Innovation Centers Experiment	1973–1981	Provided assistance to high-tech entrepreneurs through incubation centers, subsidies, and technical assistance.
Department of Energy Office of Energy-Related Inventions	Energy Related Inventions Program	1975–2000	Provides financing to individual inventors and small firms to commercialize energy-conserving discoveries.
Small Business Administration	Small Business Development Centers Program	1976–2000	Funds university-based centers to assist small businesses and encourage technology transfer.
Department of Commerce	Corporations for Innovation Development Initiative	1979–1981	Designed to fund state and regional corporations to provide equity financing to new firms. Only one such corporation was funded.
Department of Commerce Minority Business Development Agency	Technology Commercialization Program	1979–1982	Financed minority technology-oriented entrepreneurs, as well as centers to assist such entrepreneurs.
At least 15 states	At least 107 business incubators	1980–1996	Provide office and manufacturing space, support services, and often financing to start-up businesses.
Eleven federal agencies	Small Business Innovation Research Program	1982–2000	Provides awards to small technology-oriented businesses. (Also predecessor programs at 3 agencies, 1977–1982.)
Department of Energy Office of Energy Research	At least 6 contractor-organized venture funds	1985–2000	Make equity investments in spin-offs from national laboratories. (Funds organized by prime or sub-contractors at laboratories with Department's encouragement.)
At least 30 states	State Small Business Innovation Research Programs	1987–2000	Makes SBIR-like grants, often in conjunction with federal SBIR awards.
Department of Commerce National Institute of Standards and Technology	Advanced Technology Program	1988–2000	Awards grants to develop targeted technologies to firms and consortia. Some emphasis on small businesses.
Department of Defense Defense Advanced Research Projects Agency	Experimental venture capital investment program	1989–1991	Designed to make investments in private high-technology firms in exchange for equity or royalties. Program only made one investment.

Table 1
(continued)

Sponsoring organization	Program name	Brief description	Span
Department of State Agency for International Development	Enterprise Fund Program	Oversees 12 federally funded venture funds investing in Eastern Europe, the former Soviet Union, and Africa.	1990–2000
Overseas Private Investment Corporation	Venture capital fund guarantees	Guarantees full or partial return of capital to investors in at least 16 private venture funds in developing countries.	1990–2000
Department of Housing and Urban Development	Tenant Opportunity Program	Funds new businesses and other initiatives by public housing residents (other aspects of program had begun in 1987).	1993–2000
Community Relations & Involvement Office			
Department of Energy Office of the Undersecretary	Defense Programs Small Business Initiative	Provides funding, technological assistance, and national laboratory access to small high-technology businesses.	1993–2000
Eleven federal agencies	Small Business Technology Transfer Program	Finances cooperative research projects between small high-technology firms and nonprofit research institutions.	1994–2000
Department of Defense Cooperative Threat Reduction Program	Defense Enterprise Fund	Finances an independent venture fund investing in defense conversion projects in the former Soviet Union.	1994–2000
Department of the Treasury	Community Development Financial Institutions Fund	Invests in and provides assistance to community development venture capital and loan funds.	1995–2000
Department of Defense	“Fast Track” Program	Provides 4:1 matching funds for private financing raised by SBIR awardees.	1995–2000
Department of Agriculture Rural Business and Cooperative Development Service	Intermediary Relending Program (as amended)	Permits program managers to guarantee returns of investors in rural venture funds.	1997–2000
Central Intelligence Agency	In-Q-It	Invests in information technology-related companies whose products may have national security applications.	1999–2000

These problems in the debt and equity markets are a consequence of the information gaps between the entrepreneurs and investors. If the information asymmetries could be eliminated, financing constraints would disappear. Financial economists argue that specialized financial intermediaries can address these problems. By intensively scrutinizing firms before providing capital and then monitoring them afterwards, they can alleviate some of the information gaps and reduce capital constraints.

Responses by Venture Capitalists

The financial intermediary that specializes in funding young high-technology firms is the venture capital organization. The first modern venture capital firm, American Research and Development (ARD), was formed in 1946 by MIT president Karl Taylor Compton, Harvard Business School professor Georges F. Doriot, and local business leaders. A small group of venture capitalists made high-risk investments in emerging companies that were formed to commercialize technology developed for World War II. The success of the investments ranged widely: almost half of ARD's profits during its 26-year existence as an independent entity came from its \$70,000 investment in Digital Equipment Company (DEC) in 1957, which grew in value to \$355 million. Because institutional investors were reluctant to invest, ARD was structured as a publicly traded closed-end fund and marketed mostly to individuals (Liles 1977). The few other venture organizations begun in the decade after ARD's formation were also structured as closed-end funds.

The first venture capital limited partnership, Draper, Gaither, and Anderson, was formed in 1958. Imitators soon followed, but limited partnerships accounted for a minority of the venture pool during the 1960s and the 1970s. Most venture organizations raised money either through closed-end funds or small business investment companies (SBICs), federally guaranteed risk capital pools that proliferated during the 1960s. While investor demand for SBICs in the late 1960s and the early 1970s was strong, incentive problems ultimately led to the collapse of the sector.² The annual flow of money into venture capital during its first three decades never exceeded a few hundred million dollars and usually was substantially less.

The activity in the venture industry increased dramatically in the late 1970s and the early 1980s. Industry observers attributed much of the

shift to the U.S. Department of Labor's clarification of ERISA's "prudent man" rule in 1979. Before that year, the Employee Retirement Income Security Act (ERISA) limited pension funds from investing substantial amounts of money in venture capital or other high-risk asset classes. These years also saw the emergence of the limited partnership as the dominant organizational form for venture funds. Financial economists argue that these structures can alleviate the incentive and valuation problems often encountered in publicly traded funds. (See, e.g., Gompers and Lerner 1999b.)

The subsequent years saw both very good and trying times for venture capitalists. On the one hand, during the 1980s and the 1990s venture capitalists backed many of the most successful high-technology companies, including Apple Computer, Cisco Systems, Genentech, Netscape, and Sun Microsystems. A substantial number of service firms (including Staples, Starbucks, and TCBY) also received venture financing. At the same time, commitments to the venture capital industry were very uneven. The annual flow of money into venture funds increased by a factor of ten during the early 1980s, peaking at just under 6 billion 1996 dollars. From 1987 through 1991, however, fund raising declined steadily, reflecting the low returns from overinvestment in certain sectors.³ Over the past decade, the pattern has been reversed. In 2000, a record year for fund raising, nearly \$70 billion was raised by venture capitalists. This process of rapid growth and decline has created a great deal of instability in the industry. (These data are from Gompers and Lerner 2001.)

To address the information problems that preclude other investors in small high-technology firms, the partners at venture capital organizations employ a variety of mechanisms. Business plans are intensively scrutinized: of those firms that submit business plans to venture capital organizations, historically only 1 percent have been funded (Fenn, Liang, and Prowse 1995).

In evaluating a high-technology company, the venture capitalists employ several criteria. To be sure, the promise of the firm's technology is important. But this evaluation is inexorably linked with the evaluation of the firm's management. Venture capitalists are well aware that many promising technologies do not ultimately fill market needs. As a result, most place the greatest emphasis on the experience and flexibility of the management team and the size of the potential market. Even if the market does not evolve as predicted, with a sophisticated team the firm may be able to find an attractive opportu-

nity. The decision to invest is frequently made conditional on the identification of a syndication partner who agrees that this is an attractive investment (Lerner 1994). In exchange for their capital, the venture capital investors demand preferred stock with numerous restrictive covenants and representation on the board of directors.

Once the decision to invest is made, the venture capitalists frequently disburse funds in stages. Managers of these venture-backed firms often only raise a small fraction of the funds initially and are forced to return repeatedly to their financiers for additional capital in order to ensure that the money is not squandered on unprofitable projects. In addition, venture capitalists intensively monitor managers, often contacting firms on a daily basis and holding monthly board meetings during which extensive reviews of every aspect of the firm are conducted. (Various aspects of the oversight role played by venture capitalists are documented in Gompers and Lerner 1999b.)

It is important to note that, even with these many mechanisms, the most likely primary outcome of a venture-backed investment is failure, or at best modest success. Gompers (1995) documents that out of a sample of 794 venture capital investments made over three decades, only 22.5 percent ultimately succeeded in going public, the avenue through which venture capitalists typically exit their successful investments.⁴ Similar results emerge from Huntsman and Hoban's (1980) analysis of the returns from 110 investments by three venture capital organizations. About one in six investments was a complete loss, while 45 percent were either losses or simply broke even. The elimination of the top-performing 9 percent of the investments was sufficient to turn a 19 percent gross rate of return into a negative return.

In short, the environment in which venture organizations operate is extremely difficult. Difficult conditions that have frequently deterred or defeated traditional investors such as banks can be addressed by the mechanisms that are bundled with the venture capitalists' funds. These tools have led to venture capital organizations emerging as the dominant form of equity financing for privately held technology-intensive businesses.⁵

Rationales for Public Programs

At the same time, there are reasons to believe that, despite the presence of venture capital funds, there still might be a role for public venture capital programs. In this section, I assess these claims. I highlight two

arguments: that public venture capital programs may play an important role by certifying firms to outside investors, and that these programs may encourage technological spillovers.

The Certification Hypothesis

A growing body of empirical research suggests that new firms, especially technology-intensive ones, may receive insufficient capital to fund all positive net present value projects due to the information problems discussed in the previous section.⁶ If public venture capital awards could certify that firms are of high quality, these information problems could be overcome and investors could confidently invest in these firms.

As discussed above, venture capitalists specialize in financing these types of firms. They address these information problems through a variety of mechanisms. Many of the studies that document capital-raising problems examine firms during the 1970s and the early 1980s, when the venture capital pool was relatively modest in size. Since the pool of venture capital funds has grown dramatically in recent years (Gompers and Lerner 1998), even if small high-technology firms had numerous value-creating projects that they could not finance in the past, one might argue that it is not clear this problem remains today. While there may have once been a role for government certification, it may not still be there today.

A response to this argument emphasizes the limitations of the venture capital industry. Venture capitalists back only a tiny fraction of the technology-oriented businesses begun each year. In 2000, a record year for venture disbursements, just over 2,200 U.S. companies received venture financing for the first time.⁷ Yet the Small Business Administration estimates that in recent years about 1 million new businesses have started up annually.⁸ Furthermore, private venture funds have concentrated on a few industries: for instance, in 2000, fully 46 percent of the funding went to Internet-related companies. More generally, 92 percent of the funding went to firms specializing in information technology and health care. Thus, many promising firms in other industries are *not* attracting venture capitalists' notice, perhaps reflecting "herding" by venture capitalists into particular areas, a problem that finance theory suggests affects institutional investors (Devenow and Welch 1996). If government programs can identify and support technological areas that are neglected by venture capitalists, they might

provide the “stamp of approval” these high-potential, underfunded firms need to succeed.

But if government officials are going to address these problems, they will need to be able to overcome the many information asymmetries and identify the most promising firms. Otherwise, as de Meza (2002) argues, these efforts are likely to be counter-productive. Is it reasonable to assume that government officials can overcome these problems while private sector financiers cannot? Certainly, this possibility is not implausible. For instance, specialists at the National Institutes of Health or the Department of Defense may have considerable insight into which biotechnology or advanced materials companies are the most promising, while the traditional financial statement analysis undertaken by bankers would be of little value. In general, the certification hypothesis suggests that these signals provided by government awards are likely to be particularly valuable in technology-intensive industries where traditional financial measures are of little use.⁹

The Presence of R&D Spillovers

A second rationale emerges from the literature on R&D spillovers. Public finance theory emphasizes that subsidies are an appropriate response in the case of activities that generate positive externalities. Such investments as R&D expenditures and pollution control equipment purchases may have positive spillovers that help other firms or society as a whole. Because the firms making the investments are unlikely to capture all the benefits, public subsidies may be appropriate.

An extensive literature (reviewed in Griliches 1992 and Jaffe 1996) has documented the presence of R&D spillovers. These spillovers take several forms. For instance, the rents associated with innovations may accrue to competitors who rapidly introduce imitations, developers of complementary products, or to the consumers of these products. Whatever the mechanism of the spillover, however, the consequence is the same: the firm invests below the social optimum in R&D.

After reviewing a wide variety of studies, Griliches estimates that the gap between the private and social rate of return is substantial: the gap is probably equal to between 50 percent and 100 percent of the private rate of return. While few studies have examined how these gaps vary with firm characteristics, a number of case-based analyses (Jewkes et al. 1958; Mansfield et al. 1977) suggest that spillover problems are particularly severe among small firms. These organizations

may be particularly unlikely to effectively defend their intellectual property positions or to extract most of the rents in the product market.

Limitations of "Public Venture Capital" Programs

Even if spillover problems are substantial or government officials can successfully identify promising small firms, these efforts may not solve these financing problems. An extensive political economy and public finance literature has emphasized the distortions that may result from government subsidies as particular interest groups or politicians seek to direct subsidies in a manner that benefits themselves. As articulated by Olson (1965) and Stigler (1971), and as formally modeled by Peltzman (1976) and Becker (1983), the theory of regulatory capture suggests that direct and indirect subsidies will be captured by parties whose joint political activity, such as lobbying, is not too difficult to arrange (i.e., when "free riding" by coalition members is not too large a problem).

These distortions may manifest themselves in several ways. One possibility (Eisinger 1988) is that firms may seek transfer payments that directly increase their profits. Politicians may acquiesce in such transfers in the case of companies that are politically connected. A more subtle distortion is discussed by Cohen and Noll (1991) and Wallsten (1996): officials may seek to select firms based on their likely success and fund them regardless of whether the government funds are needed. In this case, they can claim credit for the firms' ultimate success even if the marginal contribution of the public funds was very low.

The presence of these distortions is likely to vary with program design. Consider the case of the SBIR program. The Small Business Innovation Development Act, enacted by Congress in July 1982, established the SBIR program. The program mandated that all federal agencies spending more than \$100 million annually on external research set aside 1.25 percent of these funds for awards to small businesses. When the program was reauthorized in 1992, Congress increased the size of the set-aside to 2.5 percent. In 1997, this represented annual funding of about \$1.1 billion.

While the eleven federal agencies participating in the program are responsible for selecting awardees, they must conform to the guidelines stipulated by the act and the U.S. Small Business Administration

(SBA). Awardees must be independently owned, for-profit firms with fewer than 500 employees, at least 51 percent owned by U.S. citizens or permanent residents. Promising proposals are awarded Phase I awards (originally no more than \$50,000, today \$100,000 or smaller), which are intended to allow firms to determine the feasibility of their ideas. (Typically about ten Phase I applications are received for every award made.) Approximately one-half of the Phase I awardees are then selected for the more substantial Phase II grants. Phase II awards of at most \$750,000 (originally, \$500,000) are transferred to the small firm as a contract or grant. The government receives no equity in the firm and does not own the intellectual property that the firm develops with these funds.

In particular, one of the reasons that has been suggested for why the SBIR program is relatively effective (as documented in Lerner 1999) is that the decision makers are highly dispersed. In particular, the federal program managers are scattered across many sub-agencies and are responsible for many other tasks as well. Thus, the costs of identifying and influencing these decision makers are high. In programs where a central group makes highly visible awards, the dangers of political distortions are likely to be higher.

The Challenge of Program Design

An immense literature in regulatory economics and industrial organization has considered the structure of regulatory bodies. The different ways in which regulators can monitor and shape industry behavior—and Congress can in turn monitor the regulators—has been explored in detail. (For an overview, see Laffont and Tirole 1993.)

Other areas of interactions between government officials and firms, however, have been much less well scrutinized. Not only is the theoretical foundation much less well developed, but the empirical literature is at a much earlier stage. (For an overview of the current state of empirical research, see Klette, Moen, and Griliches 2000.) Thus, our observations must be necessarily tentative in nature.

The design of efforts to assist high-technology entrepreneurs in one program, the Advanced Technology Program (ATP) run by the Department of Commerce, was examined in Gompers and Lerner 1999a. The object of this program is to fund generic pre-commercial technology, whether developed by single firms or joint ventures. The

awards are made in the form of contracts, typically for sums between a few hundred thousand and several million dollars. Between its inception in 1990 and 1997, the program awarded nearly a billion dollars in research and development funding to approximately 300 technology-based projects conducted by American companies and industry-led joint ventures.

While the ATP program is not mandated to fund firms of any particular size, it has become a major funder of small businesses. From 1990 to 1997, 36 percent of ATP funding went to small businesses. An additional 10 percent went to joint ventures led by small businesses.

In particular, we asked how the public sector could interact with the venture community and other providers of capital to entrepreneurial firms in order to most effectively advance the innovation process. Reflecting the early state of knowledge and lack of a theoretical foundation, we did not analyze these challenging questions through a large-sample analysis. Rather, we relied on seven case studies of ATP firms, complemented by a review of the secondary literature.

As part of this analysis, we highlighted four key recommendations, which are likely to be more generally applicable to public venture capital programs. In this section, we will review each of these recommendations. I particularly highlight our final recommendation, which challenges the premise that technologies in entrepreneurial firms can be evaluated in the absence of the consideration of the business prospects of the firm.

First, there is a strong need for public officials to invest in building relationships with and an understanding of the U.S. venture capital industry. Financing small entrepreneurial firms is exceedingly challenging. The venture capital industry employs a variety of important mechanisms to address these challenges, which empirical evidence suggests are quite effective. Because of the magnitude and success of venture capital financing, it is important that administrators view their actions in the context of this financial institution.

A corollary to the first point is that public venture capital investments should be made with an eye to the narrow technological focus and uneven levels of independent investments. As noted above, venture investments tend to be very focused on a few areas of technology that are perceived to have great potential. Increases in venture fund raising—which are driven by factors such as shifts in capital gains tax rates—appear more likely to lead to more intense price competition for transactions within an existing set of technologies than to greater

diversity in the types of companies funded. (For a discussion of these patterns, see Gompers and Lerner 2000.) Administrators may wish to respond to these industries' conditions by (i) focusing on technologies which are not currently popular among venture investors and (ii) providing follow-on capital to firms already funded by venture capitalists during periods when venture inflows are falling.

A third point is that federal officials must appreciate the need for flexibility that is central to the venture capital investment process. Venture capitalists make investments in young firms in settings with tremendous technological, product market, and management uncertainties. Rather than undertaking the (often impossible) task of addressing all the uncertainties in advance, they remain actively involved after the investment, using their contractually specified control rights to guide the firm. These changes—which often involve shifts in product market strategy and the management team—are an integral part of the investment process. In our case studies, it appeared that ATP administrators too often view these shifts as troubling indications that awardees are deviating from their plan, rather than as a natural part of their evolution.¹⁰

Fourth, just as the venture capital community carefully analyzes the track record of entrepreneurs they are considering funding, government officials should examine the track record of the firms receiving public venture awards. As it is now, public venture capital programs are often characterized by a considerable number of underachieving firms.¹¹ In particular, certain company characteristics—attributes that may not be adequately considered in the selection process of these programs—appear to be highly correlated with a company's ability to achieve its research and commercialization goals. These include the experience of the management team, the presence of a clear product market strategy, and a strong desire to seek private financing. By devising new methods to search for such factors, government officials would be better able to distinguish between high-performing and underachieving firms.

Our research indicates that a prevalent characteristic among underachieving companies is the existence of research grants from numerous government sources, with few, if any, tangible results to show from previous R&D awards. Because a lack of results can easily be attributed to the high-risk nature of technology development, many of these companies can avoid accountability indefinitely. These government grant-oriented research organizations are able to drift from one federal

contract to the next. For such companies, it appeared that public venture capital funds were treated in exactly the same manner as other government research grants: it did not appear that ATP funding showed any notable returns or that the unique program goals were well served.

Adding to the problem is the fact that companies with substantial government grant experience appear to have several advantages over other firms when applying for future public awards. Past grants, regardless of project outcomes, help a company gain legitimacy in a particular area of research, as well as acquire the equipment and personnel needed to do future work. There is also a tendency for some government programs to try to “piggyback” on other government programs, hoping to leverage their grant dollars. In addition, firms gain considerable insight into the grant application process with each proposal they submit. These firms consequentially often have a greater chance of being awarded future government grants than other firms. The end result can be a stream of government funding being awarded to companies that consistently underachieve.

To level the playing field, our research suggests that public venture capital should more closely scrutinize the amount of funding a company has received from prior government sources. A greater number of underachieving firms could be weeded out if government officials conducted a more comprehensive evaluation of a company’s past performance and examined the tangible progress attributable to each government grant the firm has received. Moreover, large inflows of prior government funding without significant product development may indicate that a particular company is unlikely to generate significant commercialization of new technologies.

Another telltale characteristic of underachieving firms was the existence of factors outside the scope of the publicly funded projects that undermined their ability to successfully complete and later commercialize government-funded technology. Legal troubles, for instance, can divert substantial amounts of human and financial resources away from a company’s R&D projects and even cause dramatic changes in the size and structure of the company. And when a firm is ready to commercialize its technology, the liability concerns associated with pending legal battles will often drastically impair the company’s ability to attract venture capital investment dollars.

For early-stage companies, additional limiting factors frequently involve managers who lack experience in running small companies.

Although some of these managers may have accumulated business experience as consultants or as members of large organizations, the successful operation of early-stage companies can demand very different management skills. It thus comes as no surprise that when venture capitalists sink substantial funds in a company, they will often place their own hand-picked manager in charge—typically an individual who has already been successful in managing an early-stage company in a similar industry. Because much of the skills needed for managing startup companies comes through experience, the existence of managers who do not have this background can significantly undermine a company's ability to succeed.

In a broader context, each of these performance-undermining factors emphasizes the need for government officials to critically evaluate whether a particular company is a viable vehicle for accomplishing its commercialization goals. This goes far beyond a simple assessment of the feasibility of a business plan. In fact, many of these potentially limiting factors will not even be discussed in a company's written proposal to the government. It is tempting, of course, to attribute the failures resulting from such factors to the high-risk nature of the technology. But to a large extent, companies exhibiting a high potential for underachievement could be more thoroughly weeded out by placing a greater emphasis on these factors during the selection process. The R&D project itself may be high-risk, but the risks of turning the technology into a product should be minimized. Regardless of how innovative or enabling a technology may be, or how well a business plan is constructed, if these undermining factors are present, a company will be hard pressed to succeed. In short, the claim that technological projects can be assessed in entrepreneurial firms without consideration of business issues is profoundly mistaken.

A broader implication is that administrators of public venture capital programs must think carefully about the validity of the concept of "pre-commercial research" in an entrepreneurial setting. An extensive body of entrepreneurship research has highlighted the unpredictability of the entrepreneurial process. Very few entrepreneurs, whether in high- or low-technology settings, commercialize what they initially set to develop in their original time-frame. Rather, successful entrepreneurs gather signals from the marketplace in response to their initial efforts, and adjust their plans accordingly. Once they identify an opportunity, they move very rapidly to take advantage of it before major corporations can respond. Yet many federal agencies, leery of being seen

as “picking winners,” push entrepreneurs to devote Advanced Technology Program funds to purely pre-commercial research. This may lead them to ignore an essential source of information: i.e., feedback from customers. Even more detrimental are those instances where a company—having identified an attractive commercial opportunity—is afraid to rapidly pursue it, lest they jeopardize their public funds (on which they are relying as a key source of financing) on the grounds that they are pursuing commercial research. While well intentioned, such policies may have the perverse effect of punishing success. One potential change would be to allow firms that rapidly commercialize publicly funded projects to use the funds to pursue another project.

Conclusions

This chapter has examined the design of public venture capital programs. Much is still to be learned about the design of these programs. While the literature on the design of regulatory agencies and the problem of political distortions in subsidy programs has yet to consider public venture capital programs in much depth, one can be optimistic that this will be a topic of increasing interest to researchers. With the help of these theoretical insights—as well as the willingness of program administrators to encourage dispassionate analyses of their strengths and weaknesses—our ability to say more about the design of these programs should grow.

That being said, the many difficulties suggest the need for caution in proceeding with these programs. Indeed, it has been suggested that public policy may be far more effective in encouraging venture capital activity by addressing the demand for such funds—through such steps as encouraging academic R&D and cutting the tax rates that entrepreneurs pay on capital gains—rather than by directly boosting the supply of such funds (Gompers and Lerner 1998). The many hazards that these public programs face, as discussed above, suggest why efforts to address directly the supply of venture financing may be ineffective.

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Notes

1. Several limitations—necessitated by the limited available space—should be acknowledged up front. First, I will focus on the experience of the United States. Second, I will focus on government efforts to directly finance young firms, rather than on those that subsidize venture capital organizations, as has been done in the Israeli Yozma program or the BioRegio effort in Germany.
2. In particular, many SBICs made investments in ineffective or corrupt firms. Observers noted that SBIC managers' incentives to screen or monitor portfolio firms was greatly reduced by the presence of government guarantees that limited their exposures to unsuccessful investments.
3. The measurement of the riskiness of venture investments pose many challenges, as Gompers and Lerner (1997) discuss. As a result, there has not been a satisfactory systematic effort to calculate the risk-adjusted return for private equity over this period.
4. A Venture Economics study (Ross and Isenstein 1988) finds that a \$1 investment in a firm that goes public provides an average cash return to venture capitalists of \$1.95 in excess of the initial investment, with an average holding period of 4.2 years. The next best alternative, a similar investment in an acquired firm, yields a cash return of only 40 cents over a 3.7-year mean holding period.
5. While evidence regarding the financing of these firms is imprecise, Freear and Wetzel's (1990) survey suggests that venture capital accounts for about two-thirds of the external equity financing raised by privately held technology-intensive businesses from private-sector sources.
6. The literature on capital constraints (reviewed in Hubbard 1998) documents that an inability to obtain external financing limits many forms of business investment. Hall (1992), Hao and Jaffe (1993), and Himmelberg and Petersen (1994) show that capital constraints appear to limit research-and-development expenditures, especially in smaller firms, though the limits may be less binding than those on capital expenditures. Holtz-Eakin, Joulfaian, and Rosen (1994a,b) discuss these constraints on the survival of entrepreneurial firms.
7. Statistics on venture capital financing are available at <http://www.nvca.org>.
8. See <http://www.sba.gov>.
9. Another possibility, of course, is that the government could provide certification without funding, e.g., by selecting a small number of firms each year for prizes. Whether these signals would be as credible or whether government officials would approach this assignment with sufficient seriousness remains open to question.
10. Of course, since the goal of the program is to fund companies that are developing socially beneficial technologies, there is a need for program officers to be alert for firms

that radically shift their objectives. For instance, one supercomputer firm devoted considerable resources after receiving an ATP award to developing an e-commerce program, at a time when such technologies were receiving extensive funding from independent venture capitalists.

11. The presence of "SBIR mills" that have won large numbers of awards by cultivating relationships with federal officials is a manifestation of this phenomenon in another federal program (Lerner 1999).

References

Akerlof, G. A. 1970. The market for 'lemons': Quality uncertainty and the market mechanism. *Quarterly Journal of Economics* 84: 488–500.

Becker, G. S. 1983. A theory of competition among pressure groups for political influence. *Quarterly Journal of Economics* 98: 371–400.

Cohen, L. R., and R. G. Noll, eds. 1991. *The Technology Pork Barrel*. Brookings Institution.

de Meza, D. 2000. Overlending. *Economic Journal* 112 (477) (February): F17–F31.

Devenow, A., and I. Welch. 1996. Rational herding in financial economics. *European Economic Review* 40: 603–615.

Eisinger, P. K. 1988. *The Rise of the Entrepreneurial State: State and Local Economic Development Policy in the United States*. University of Wisconsin Press.

Fenn, G. W., N. Liang, and S. Prowse. 1995. *The Economics of the Private Equity Market*. Board of Governors of Federal Reserve System.

Freear, J., and W. E. Wetzel Jr. 1990. Who bankrolls high-tech entrepreneurs? *Journal of Business Venturing* 5: 77–89.

Gompers, P. A. 1995. Optimal investment, monitoring, and the staging of venture capital. *Journal of Finance* 50: 1461–1489.

Gompers, P. A., and J. Lerner. 1997. Risk and reward in private equity investments: The challenge of performance assessment. *Journal of Private Equity* 1, winter: 5–12.

Gompers, P. A., and J. Lerner. 1998. What drives venture capital fund raising? *Brookings Papers on Economic Activity: Microeconomics*: 149–192.

Gompers, P. A., and J. Lerner. 1999a. Capital Formation and Investment in Venture Markets. Report GCR–99–784, Advanced Technology Program, National Institutes of Standards and Technology, U.S. Department of Commerce.

Gompers, P. A., and J. Lerner. 1999b. *The Venture Capital Cycle*. MIT Press.

Gompers, P. A., and J. Lerner. 2000. Money chasing deals? The impact of fund inflows on the valuation of private equity investments. *Journal of Financial Economics* 55: 281–325.

Gompers, P. A., and J. Lerner. 2001. *The Money of Invention*. Harvard Business School Press.

Greenwald, B. C., J. E. Stiglitz, and A. Weiss. 1984. Informational imperfections in the capital market and macroeconomic fluctuations. *American Economic Review* 74 (2, Papers and Proceedings of the Ninety-Sixth Annual Meeting of the American Economic Association) (May): 194–199.

- Griliches, Z. 1992. The search for R&D spillovers. *Scandinavian Journal of Economics* 94 (Supplement): S29–S47.
- Hall, B. H. 1992. Investment and Research and Development at the Firm Level: Does the Source of Financing Matter? Working paper 409b, National Bureau of Economic Research.
- Hao, K. Y., and A. B. Jaffe. 1993. Effect of liquidity on firms' R&D spending. *Economics of Innovation and New Technology* 2: 275–282.
- Himmelberg, C. P., and B. C. Petersen. 1994. R&D and internal finance: A panel study of small firms in high-tech industries. *Review of Economics and Statistics* 76: 38–51.
- Holtz-Eakin, D., D. Joulfaian, and H. S. Rosen. 1994a. Entrepreneurial decisions and liquidity constraints. *RAND Journal of Economics* 23: 334–347.
- Holtz-Eakin, D., D. Joulfaian, and H. S. Rosen. 1994b. Sticking it out: Entrepreneurial survival and liquidity constraints. *Journal of Political Economy* 102: 53–75.
- Hubbard, R. G. 1998. Capital-market imperfections and investment. *Journal of Economic Literature* 36: 193–225.
- Huntsman, B., and J. P. Hoban Jr. 1980. Investment in new enterprise: Some empirical observations on risk, return, and market structure. *Financial Management* 9 (summer) 44–51.
- Jaffe, A. B. 1996. Economic Analysis of Research Spillovers: Implications for the Advanced Technology Program. Report GCR 97-708 Advanced Technology Program, National Institute of Standards and Technology, U.S. Department of Commerce.
- Jensen, M. C., and W. H. Meckling. 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics* 3: 305–360.
- Jewkes, J., D. Sawers, and R. Stillerman. 1958. *The Sources of Invention*. St. Martin's Press.
- Klette, T., J. Moen, and Z. Griliches. 2000. Do subsidies to commercial R&D reduce market failures? Microeconomic evaluation studies. *Research Policy* 29: 471–495.
- Laffont, J.-J., and J. Tirole. 1993. *A Theory of Incentives in Procurement and Regulation*. MIT Press.
- Lerner, J. 1994. The syndication of venture capital investments. *Financial Management* 23, autumn: 16–27.
- Lerner, J. 1998. "Angel" financing and public policy: An overview. *Journal of Banking and Finance* 22: 773–783.
- Lerner, J. 1999. The government as venture capitalist: The long-run impact of the SBIR program. *Journal of Business* 72: 285–318.
- Liles, P. 1977. *Sustaining the Venture Capital Firm*. Management Analysis Center.
- Mansfield, E., J. Rapoport, A. Romeo, S. Wagner, and G. Beardsley. 1977. Social and private rates of return from industrial innovations. *Quarterly Journal of Economics* 91: 221–240.
- Myers, S. C., and N. Majluf. 1984. Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics* 13: 187–221.

Noone, C. M., and S. M. Rubel. 1970. *SBICs: Pioneers in Organized Venture Capital*. Capital.

Olson, M. 1965. *The Logic of Collective Action*. Harvard University Press.

Organization for Economic Cooperation and Development. 1996. Venture capital in OECD countries. *Financial Market Trends* 63.

Peltzman, S. 1976. Towards a more general theory of regulation. *Journal of Law and Economics* 19: 211–240.

Ross, P. W., and S. Isenstein. 1988. *Exiting Venture Capital Investments*. Venture Economics, Inc.

Stigler, G. 1971. The theory of economic regulation. *Bell Journal of Economics* 2: 3–21.

Stiglitz, J. E., and A. Weiss. 1981. Credit rationing in markets with incomplete information. *American Economic Review* 71: 393–410.

Wallsten, S. J. 1996. The Small Business Innovation Research Program: Encouraging Technological Innovation and Commercialization in Small Firms. Unpublished paper, Stanford University.