

State and Local Government Roles in Industrial Innovation

Michael Peltz and Marc A. Weiss

A rapidly increasing number of state and local governments are creating programs to stimulate technological innovation and growth of high-technology industries. Most of these governments have adopted strategies to attract relocating or expanding high-technology firms. Others are trying to encourage local innovation and business development by supporting basic and applied research and the commercial application of innovative products and processes through new business startups and the expansion or modernization of existing firms. Government programs for economic development through technological innovation can be categorized as follows: policy development; education and training; support for research; technical and management assistance; and financial assistance. Many of the programs are new, and their results are difficult to evaluate. Nevertheless, experience to date suggests that successful strategies are likely to be those that (1) integrate various programs under consistent policy objectives; (2) tightly target programs to maintain control over costs and benefits; and (3) adopt as a primary goal the development of an indigenous and economically diverse industry/technology/employment base.

A growing number of America's states and localities are trying to stimulate the growth and development of high-technology industries and enterprises. The Congressional Office of Technology Assessment recently described 150 state economic development initiatives "with at least some features directed toward high-technology development" (1983, 7). Of that total, the OTA identified 38 programs in 22 states specifically designed to create, attract, or retain high-technology firms. Most of those programs have been set up in the past two to three years (National Governors' Association 1983b; OTA 1983 and 1984).

States and localities have not adopted a common definition of "high technology," which makes designating the parameters for the study of high-technology development policies somewhat arbitrary (Glasmeier, Hall, and Markusen 1983; Weiss 1983). To include the variety of policy definitions, we consider high-tech development policies to be those that promote or support

any of the following activities, which correspond roughly to different phases of the product cycle or the innovation development process: (1) research and development of innovative products and processes (i.e., those that have the capacity to improve productivity or the use of resources in various sectors of the economy); (2) commercial application of innovations and the associated creation of new firms; (3) attraction, expansion, or standardization of production among *producers* of innovations; and (4) application of new technologies by established *users* of innovations (OTA 1983).

A few states and cities have begun to assess their needs and economic resources more carefully as they apply to the locational and resource requirements of each phase of industrial innovation development. Those states and cities are beginning to see encouraging innovation for economic development as a long-term process that requires an integrated set of strategies and programs targeted to each phase.

California and Massachusetts have concentrated on retaining and reinforcing their leadership in technology-based industry sectors. They have tried to reinforce their advantages in basic and applied research, education, and venture capital, all of which are key ingredients in new rounds of innovation (Kieschnick 1982a). A number of older industrial states, such as

Peltz is a practicing planner who specializes in state and local economic development policy. He lives in Berkeley, California. Weiss is an assistant professor in the School of Urban Planning and Policy at the University of Illinois at Chicago. He is a former deputy director of the California Commission on Industrial Innovation.

Pennsylvania and Michigan, emphasize high-technology development both to stimulate economic diversification and to make their traditional manufacturing and resource-based sectors more competitive (Pennsylvania Department of Commerce 1982).

Some high-technology development programs promote innovative activity without regard to particular industry sectors (e.g., federal tax credits for research and development), whereas others are targeted at selected industries and firms that embody innovative characteristics (e.g., grants for microelectronics research) or require modernization (e.g., technology extension services to the shoe industry).

State and local high-technology development programs can be grouped into five functional categories: (1) policy development; (2) education and training; (3) basic and applied research; (4) technical and management assistance to innovating firms; and (5) financial assistance to innovating firms (National Governors' Association 1983a and 1983b; OTA 1983 and 1984; State of California 1981 and 1982). The following sections analyze each of the five main types of policies and programs.

Policy development

As a first step in developing a program for technological and industrial innovation, a state's governor or legislature typically appoints a task force or commission to produce an initial consensus about what should be done and to promote ongoing cooperation among government officials, private industry, educational institutions, and organized labor¹ (National Governors' Association 1983b). The governors or legislatures have often justified high-tech initiatives as a response to competition from other states or localities or to failed industrial prospects. For instance, the spate of high-technology legislation introduced in California in 1983 was touted as a necessary response to the state's failure to attract the hotly contested Microelectronics and Computer Technology Corporation.

One of the first state high-technology advisory bodies was the California Commission on Industrial Innovation, which comprised representatives of state government, high-technology firms, financial institutions, universities, and organized labor. Besides its own report (CCII 1982), it commissioned and released detailed, university-based studies on "California's future industries" (Markusen 1983). More recently, state bodies like Rhode Island's Strategic Development Commission and the Massachusetts Commission on the Future of Mature Industries have pursued even more ambitious agendas for economic research and industrial policy development (Rhode Island Strategic Development Commission 1983).

Local government-sponsored task forces on high-technology development are found most often in large,

economically diverse urban areas. Minneapolis's Blue Ribbon Task Force on Research and Technology and the (Chicago) Mayor's Task Force on High-Technology Development are good examples (OTA 1984).

In many localities and in some states, such as Massachusetts, Pennsylvania, Connecticut, and North Carolina, general economic or industrial development offices have played leading roles in policy formulation and program development. They also have initiated specific high-technology development programs to take advantage of certain federal programs.²

Finally, high-technology firms have formed their own policy advocacy and lobbying groups. The Massachusetts High Technology Council, for example, lobbied to reduce the state's capital gains tax and made a substantial contribution to the passage of Proposition 2½, the state's property tax reduction measure. In many localities, chambers of commerce and other private industry associations are working cooperatively with local governments to develop technical education and training programs and industrial recruitment strategies.

Education and training

The U.S. education and training system has been attacked severely because of its alleged inability to meet the requirements of a rapidly changing, so-called "information-intensive" economy. At the same time, some claim that the two most important factors in the location decisions of "high-technology" companies are the availability of highly skilled labor and access to high-quality academic institutions (Joint Economic Committee 1982). In that context, states and localities are looking to education and training as concomitant with technological and industrial innovation in stimulating economic development. The following discussion outlines programs state and local governments have initiated to support and improve education and worker training.

Elementary and secondary education

Efforts to improve elementary and secondary education focus on planning and encouraging private-sector participation in programs to increase the number and quality of math and science students, teachers, curricula, and instructional materials and equipment. Improving math, science, and computer education at all grade levels is seen as one of the best ways to produce more and better students for education as scientists, engineers, and technicians, as well as a citizenry with a basic level of technological literacy.

To strengthen math and science teaching, some states issue scholarship loans that are forgiven in exchange for in-state teaching service and support skill development and continuing education programs for teachers. In addition, twenty-two states have raised their standards for admittance to teacher training programs (National Governors' Association 1983b).

To increase the number and quality of students enrolled in math and science courses, states have imposed stricter graduation requirements, set up statewide testing programs, and established special high-technology high schools and residential math and science schools.

Finally, a number of states, including California, Massachusetts, Rhode Island, and Washington, have taken steps to introduce computers and related equipment into elementary and secondary classrooms.

Worker training and retraining

States and localities are the primary administrators of the nation's fragmented employment and training system, including its most recent addition, the Job Training Partnership Act (JTPA). Government training programs that are used by high-technology firms include customized job training, vocational-technical schools and high-technology centers, community college training programs, and programs for retraining.

Thirty-eight states have customized job-training programs (Jones 1983), which are typically used to attract relocating or expanding facilities of established firms. Georgia's "Quick Start" program is one of the most generous. It provides pre-opening training and instruction, and it recruits, tests, and screens potential employees according to company requirements—all at no cost to the firm. Most of these programs are funded by state general fund appropriations and federal aid. In California, the Employment Training Panel uses unemployment insurance funds to pay for job training, upgrading, or retraining.

Vocational-technical schools, community colleges, and skills centers frequently operate training programs tailored to specific high-technology industries. Albuquerque's Technical Vocational Institute, for example, specializes in developing skills in solar power installation and development, computer programming, robotics, and fiber optics.

State and local government support for retraining is usually offered through general job training programs. Unfortunately, public support for retraining, especially under the JTPA, is designed more as an emergency response to worker dislocation and specific labor shortages than as a permanent vehicle for continuing education and training.³

It is important to note that some states are wary of providing training subsidies to firms indiscriminately. Some have legislatively or administratively imposed minimum terms of employment and wage floors in order to avoid subsidizing jobs with high turnover rates and minimum or near-minimum wage rates. In addition, some state programs, such as the Bay State Skills Corporation in Massachusetts, require matching contributions from private industry.

Higher education

Strategies to attract, develop, and retain high-technology enterprises and technical talent may include programs to increase college and university enrollment in science, engineering, and other technical fields; to attract and retain faculty in those fields; and to upgrade educational and research facilities.

Arizona, Florida, Idaho, Minnesota, Missouri, and Washington give special attention to engineering education and research. Arizona State University, for example, is developing a \$32 million Center for Excellence in Engineering, using \$20 million from the state government, \$9 million from private industry, and \$3 million from the federal government. The center is intended to boost engineering faculty and student enrollment, increase teaching salaries, and support education and research in a number of advanced-technology fields. The contributing companies benefit from an increased supply of well-trained engineers and from access to continuing education and training for their older engineers (Lippman 1981).

Other forms of state and local involvement include increased funding for graduate students in engineering and other technical fields; state tax credits for private donations to higher education; university-industry equipment sharing and personnel exchanges; and student internships with private firms. State programs for university-industry research and technology transfer are another way of supporting higher education, but they are discussed here as a separate category of state initiatives for industrial innovation.

Basic and applied research

In order to promote high-technology development, states and localities are strengthening university-based research programs; promoting university-industry links and collaboration in basic and applied research; and encouraging the use of university-generated research by industry. Four methods states and localities are using to stimulate research are discussed here: direct state grants for research in universities and nonprofit research institutions; specialized university research services; research parks; and patent policy.

Direct state grants for research

A few states have used large grants to build research and development capabilities as part of a long-term strategy to develop particular high-technology industry sectors. Some are independent grants; others are matched by private contributions such as programs in Michigan and California.

Michigan has committed more than \$21 million to develop a \$100 million Industrial Technology Institute

in Ann Arbor. The institute will work with private industry to develop advanced research capabilities in robotics, applied research, and retraining programs to integrate robotics into the workplace. The state also has authorized \$6 million for the establishment of the Michigan Biotechnology Institute at Michigan State University in East Lansing. Emphasizing inter-university projects and university-industry collaboration, the biotechnology institute will "select research-based ideas with commercial potential and move them into applied research and industrial development phases as rapidly as possible" (Downs 1983, 1).

California's MICRO program funds faculty proposals from several California campuses for research in microelectronics technology, computer science, and their application. Proposals must be for research that could lead to new industrial products in the future, and they must have a prior commitment from an industrial firm to fund at least half the cost of the project.

Arizona, Missouri, and West Virginia also have substantial state funds to match industry contributions for university-industry collaborative research projects (National Governors' Association 1983b). Not all of these R&D funds, however, are targeted to particular high-technology industry sectors.

University research services

Besides following their own research agendas, universities and university-based institutes regularly offer the specialized services of their faculties and facilities to industry by contract. Some universities also have industrial affiliates—groups of firms that have access to university research services or results, special training programs or courses, and other services, in return for pooled private contributions or fees (National Governors' Association 1983b).

Research parks

Research parks are another way of fostering university-industry research links and technology transfer. They generally are located near a university campus or a large research center and are intended to attract a cluster of private and/or public research facilities. Research parks are risky, long-term investments, however, in that many remain substantially underused for a number of years. Though North Carolina's Research Triangle Park is the largest and best-known, some eighteen states have or are planning research parks (National Governors' Association 1983b). The state of Illinois and the city of Chicago, for example, are establishing a biomedical research park near Chicago's West Side Medical Center and the University of Illinois (City of Chicago 1982). Cities and counties have played important roles in research park development by pro-

viding public services and infrastructure; preparing zoning regulations; selling, leasing, and managing property within the park; and providing subsidized financing to attract new private firms.

Patent policy

Patent policy is a particularly important area of state involvement in university research and technology transfer. Programs to license and promote state-owned or state university-owned patents have been established in a number of states, such as New York, Washington, North Dakota, and Nebraska. State university patent policy, however, also raises at least three controversial issues involving the relationship between public university research and private industry (Langfitt et al. 1983). One is the ownership of intellectual "property" and the appropriate arrangements needed to provide both the public and the private sectors with a fair return while preserving academic values. A second is the effect of commercial application of research findings on the circulation of research results. Some companies have obtained exclusive patent rights from universities and have restricted the publication of research findings. Such restrictions (or those that result when academic researchers withhold information) could undermine the innovation process. Furthermore, if faculty members engage in commercial ventures at the expense of teaching, they could jeopardize the quality of university education. A third issue involves the balance between basic and applied research, and the extent to which the former should remain insulated from commercial priorities.

Some state universities have addressed some of those issues by restricting the size of corporate donations, limiting the amount of consulting faculty members are allowed to do, restricting faculty involvement in the management of commercial ventures, and using innovative university-industry contract language.

Some states also have tried to guarantee that state-funded R&D actually will benefit the citizens of the state. Pennsylvania's patent policy requires any new technology or patents resulting from state-funded applied research (the Ben Franklin Partnership program) to be manufactured in the state, or funds must be fully repaid.

Technical and management assistance

It is often claimed that small firms play a critical role in technological innovation.⁴ Small technology-based companies face substantial barriers to success, however, including technical difficulties, lack of business management expertise, and access to the right kind of financing. States and localities have served a brokering

- 1 Research Triangle Foundation of North Carolina
- 2 Research Triangle Institute
- 3 Forestry Sciences Laboratory of the U.S. Forest Service
- 4 American Association of Textile Chemists and Colorists
- 5 North Carolina Science and Technology Research Center
- 5 Triangle Universities Computation Center
- 6 North Campus
National Institute of Environmental Health Sciences
- 7 Troxler Electronic Laboratories
- 8 International Business Machines Corporation
- 9 Hercules, Incorporated
- 10 National Center for Health Statistics
- 11 National Environmental Research Center
Environmental Protection Agency
- 12 Becton, Dickinson and Company
- 13 Burroughs-Wellcome Co
- 14 University of North Carolina
Research Triangle Park Office
- 15 South Campus
National Institute of Environmental Health Sciences
- 16 Family Health International
- 17 U.S. Army Research Office
- 18 Chemical Industry Institute of Toxicology
- 19 Triangle Universities Center for Advanced Studies Inc
- 20 National Humanities Center
- 21 Airco, Inc
- 22 Northrop Services, Inc
- 23 Data General Corporation
- 24 J.E. Serrine Co
- 25 Instrument Society of America
- 26 Progress Center incl. Radian Corporation
- 27 Digital Switching Division Northern Telecom, Incorporated
- 28 Union Carbide Corporation
- 29 Progress Center incl. Mead Compuchem
- 30 General Electric Microelectronics Center
- 31 Microelectronics Center of North Carolina
- 32 Glaxo, Incorporated
- 33 Sumitomo Electric Research Triangle Inc
- 34 Ciba-Geigy Corporation
- 35 E.I. Dupont de Nemours & Company
- 36 Underwriters Laboratories Inc
- 37 Basf Wyandotte Corporation
- P Park Plaza and Offices

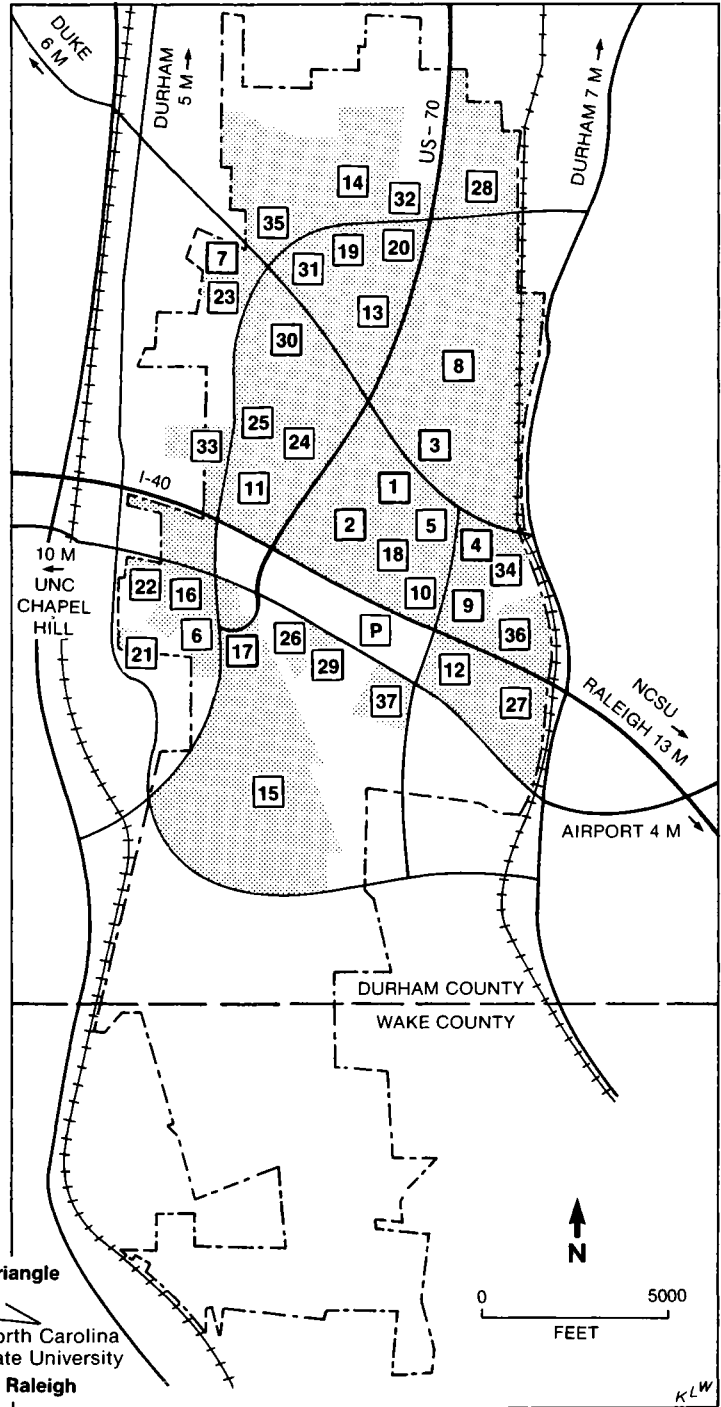
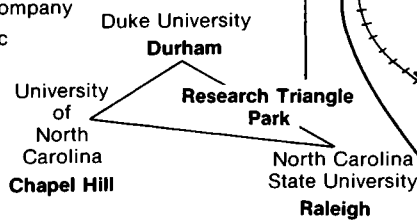


Figure 1. Research Triangle Park, North Carolina. Dotted line is park boundary; shaded area is developed land. (Drafted from material provided by the Research Triangle Foundation)

and evaluative function for people with product ideas who need assistance assessing technical feasibility and market potential, developing or testing prototypes, filing patents and licenses, and developing business plans and management capabilities. By providing those services to firms, states and localities try to speed the evaluation of research for market potential and accelerate the commercial application of new concepts and ideas

(Kieschnick 1982b). This stage culminates when the small firm obtains start-up capital from the private capital markets or, if necessary and available, from public sources of venture capital. (This is discussed in the next section.)

State and local governments offer technical and management assistance through their traditional small business assistance offices and programs; through their

involvement with federal programs and independent, nonprofit development organizations; and by supporting services provided from colleges, universities, and R&D incubator facilities.

Most state economic or business development offices provide small business services of one kind or another (U.S. Small Business Administration 1982). Services offered frequently include assistance with public permits, regulations, procurement, and financing. These programs generally are not targeted to technology-based enterprises; some do provide services, however, that are appropriate to small high-technology firms. For example, the Nebraska Department of Economic Development, in cooperation with the University of Nebraska's College of Engineering, evaluates product ideas and provides other advice to firms and individuals. In Oklahoma, the Industrial Research and Development Center (a nonprofit organization with federal funding) screens, tests, and helps develop inventions of economic benefit to the rural parts of the state (National Governors' Association 1983a).

The federal Small Business Administration offers certain small business management and technical services directly through its field offices or through Small Business Development Centers. The centers are state-operated and funded jointly by SBA and state governments. In 1982 there were twenty-two in existence, one in each of twenty-one states and the District of Columbia (U.S. SBA 1982).

The Pennsylvania Technical Assistance Program is sponsored jointly by the state's Department of Commerce and Pennsylvania State University. This program is an example of how state and federal funds can be used to match advanced-technology firms that are trying to solve particular problems with technical specialists who may be able to help.

University-based or -affiliated innovation centers, such as those at public universities in Louisiana, Missouri, New Mexico, and Washington, draw on college and university faculty members and students to screen projects and offer management and technical assistance to new technology-based firms that have innovative product and service ideas. Some of the innovation centers were started with funds from the National Science Foundation.

A growing number of states and localities are establishing R&D incubator facilities, which offer comprehensive services to help transform new product ideas into viable commercial ventures. R&D incubators may provide low-cost space and equipment and access to technical and managerial expertise, libraries, and computer facilities. Most R&D incubators are affiliated with universities. Some emphasize entrepreneurial development among their own students and faculty members, whereas others attempt to attract entrepreneurs and investors from the general public.

The Advanced Technology Development Center

at Georgia Institute of Technology in Atlanta is one of the best-known research incubators. It offers entrepreneur-inventors facilities for research, testing, and prototype manufacturing, as well as the services of scientists, engineers, and graduate students on the Georgia Tech campus. Potential ventures are selected from a pool of ideas suggested by scientists, engineers, and researchers. The center was started by the state, but receives a large part of its budget from private contributions. Similar facilities are in operation in Troy, New York, at Rensselaer Polytechnic Institute; at four state-initiated advanced technology centers in Pennsylvania; and in a number of other states (Phalon 1983).

In a few cases, technical and management assistance is provided to older, established firms in order to upgrade their technology and increase productivity.⁵ Arkansas and the National Science Foundation jointly support a university-industry experimental center for small manufacturers. Production assessment, evaluation of design and layout efficiency, advice in technical manufacturing, and financing information are among the services it offers. The University of Maryland's Technology Extension Service performs a similar function. The New Enterprise Institute, a private, non-profit group associated with the University of Maine, helped introduce computer-assisted design and manufacturing in the state's shoe and leather industry (OTA 1983).

Financial assistance

The capital requirements of early-stage enterprise development are, for the most part, fulfilled outside the organized capital markets; that is, most business startups are financed by personal savings and funds from family and friends. Instead of offering badly needed equity or near-equity capital, the vast majority of government financing programs provide loans and loan guarantees. For companies in their early years, which generate little if any positive cash flow, additional debt can be a burden rather than a contribution to better future prospects for the firm. To some extent, the private venture capital market is filling that void. Those funds, however, are highly concentrated geographically.⁶ Even in places like Massachusetts, with a developed venture capital market, "market imperfections" cause some ventures to be overlooked even though they could be expected to provide a reasonable rate of return to compensate for risk (Kieschnick 1979; Litvak and Daniels 1979). Since state and local governments should, and often do, consider the expected social returns (in the form of new businesses, products, jobs, tax revenues, and foregone social welfare expenditures) in their risk-return calculus, taking greater risks in supporting new business ventures may be justified.

States and localities have used the following methods to help small, technology-based firms acquire equity and near-equity capital: venture capital information and

referral; research grants to innovative firms; tax changes to increase equity investment; regulatory changes to increase the availability of venture capital; and direct public investment.

Information and referral

Several states and localities identify sources of venture capital for small businesses and help them put proposals together. Venture capital conferences and workshops are another way to bring entrepreneurs and venture capitalists together.

Some state and local governments also are setting up special programs to make small businesses aware of the federal Small Business Innovation Research program (Small Business Innovation Development Act of 1982, U.S. Public Law 97-219). Under this program, federal agencies with R&D budgets of more than \$100 million are required to set aside 1 percent of their funds for the establishment of the SBIR programs. By 1987, an estimated \$400 million will be available to assist small business research.

R&D grants to innovative firms

The following are a few examples of state research grant programs: In Michigan, a State Research Fund of \$490,000 is used to make grants for in-state development of "technology products or processes" that have demonstrated technical feasibility and commercial applications. Eligible applicants are universities and colleges in cooperation with Michigan-based private firms. The Industrial Technology Board of Ohio's Development Financing Commission offers grants to small- and medium-sized innovating firms whose projects will benefit Ohio by creating jobs and new technologies. Both Pennsylvania and Utah are offering supplemental research grants to firms that are awarded funds under the federal Small Business Innovation Research program.

Tax changes

To increase equity investment in new firms, some states have either eliminated or reduced their capital gains taxes or have offered tax credits for equity investments in venture capital companies. California, for example, eliminated state taxation of long-term capital gains arising from investments in small, in-state firms subject to various conditions. The Montana Capital Companies Act of 1983 promotes the availability of in-state venture capital by providing tax credits to individuals of up to 25 percent of their investment in new venture capital companies (subject to a ceiling). The effect of these state tax incentives, however, is diluted because state tax payments are deductible for federal income tax purposes.

Regulatory changes

Loosening state restrictions on the use of public pension funds offers an important way to channel capital into new ventures. Michigan, for example, has decided that a portion of state retirement funds may be invested as equity in Michigan-based high-technology firms without violating the state's fiduciary responsibilities.

Direct public investment

A growing number of states are establishing quasi-public or private corporations to make equity, near-equity, and other investments in small technology-based businesses. Connecticut, Massachusetts, New York, and Indiana have initiated venture capital corporations. The Connecticut Product Development Corporation, for example, underwrites up to 60 percent of the cost of developing specific products or processes by established, in-state firms. In return, CPDC receives a small percentage (generally 4 percent to 5 percent) of sales, but cannot receive more than five times the amount of its original contribution. Initial funding of \$7 million was provided through the sale of general obligation bonds, but now the CPDC receives a substantial amount of royalty revenue. Since its establishment in 1973, the CPDC has helped develop more than 50 products, twenty-two of which are on the market, and a large number of Connecticut-based jobs. The other venture capital corporations can use a variety of financial instruments, including stock, to invest in new and small, in-state innovative companies.

Some cities, such as Buffalo, have used Community Development Block Grant funds to purchase stock in small technology-based firms. Cincinnati is one of the only cities that is contributing funds to capitalize what will become a private venture capital firm. The city invested grant funds, and a private foundation made additional funds available. The business communities in a number of other cities, such as Philadelphia and Minneapolis, are very active in promoting the formation of state and local private venture capital funds.

Some considerations in program evaluation

Very few high-technology development initiatives at the state and local level have undergone objective and thorough evaluation, which makes it difficult to say anything about their effectiveness. Even if there was an inclination to do so, however, evaluating these programs in terms of their economic development goals presents many difficulties. First, perspective varies from one jurisdiction to another, and so, therefore, do evaluations of program goals. Those goals range from employment growth, increased incomes, and business development and retention to economic diversification, increased industrial productivity, and creating or re-

taining competitive advantages in certain industry sectors. How a federal or national evaluation would interpret those goals might be different from the way a regional or local evaluation would interpret them. For example, new jobs and businesses in one place may have been old jobs and businesses in another. That may not concern states and localities. Boosting the competitive advantage of one group of firms in one part of the country may simply contribute to a redistribution of market share and profits among national firms (although a general increase in competition in certain industries may be desirable from a national perspective).

In addition, there are a number of technical difficulties involved in evaluating the ways these programs affect development. As in most economic development programs, it is difficult to differentiate among activity (e.g., firm behavior) that is induced by state or local policy, activity that is induced by national policy, and activity that is actually determined by the market. Lack of comparability between different places also hinders attempts at evaluation; that is, places define high-technology differently, direct their policies toward different ends, embody interrelationships among several programs, and start with different sets of local economic conditions.

Perhaps the best thing states and localities can do to get around the difficulty in evaluating program performance elsewhere is to design their programs with some built-in assurances that desirable outcomes will be achieved or undesirable outcomes compensated. That may involve developing new or improved monitoring techniques and organizations as well as incorporating legally enforceable performance requirements or quid-pro-quo for private firms that benefit from a state or local development policy or program. The example of the Ben Franklin Partnership program in Pennsylvania was mentioned earlier. That concept also is embodied in the comprehensive economic policy package proposed by Rhode Island's Strategic Development Commission, which includes low-interest business loans that revert to a higher interest rate unless the jobs generated by the recipient of the loan prove to be permanent. Undesirable outcomes also are legally mitigated in Vacaville, California—located in a region experiencing rapid high-tech industrial growth—by a city ordinance that requires firms to provide at least three months' advance notice of closures or major layoffs and to meet other requirements if they have received any publicly subsidized financing from the city (Chapter 18.50 of the Vacaville Municipal Code).

Conclusion

Since there is no way to make sound, objective judgments of these high-technology development initiatives, we offer only impressions of some of their accomplishments and shortcomings.

First, although states and localities are at different stages in implementing high-technology economic strategies, those that are farthest along are integrating key components—R&D, business/entrepreneurship, labor, education, and finance—into the economic development strategy, policy, and planning process. More and more states and localities are recognizing the importance of in-depth studies of the industries and resources upon which an economic development strategy can be built to suit their needs.

Second, the increasing emphasis on using research and educational institutions in long-term economic development strategies is a positive trend. Used along with other measures, these institutions have great potential not only to create new opportunities for economic growth, but also to create new products and techniques that help communities to overcome development barriers and technological constraints and to meet particular (including regionally based) public needs. Full exploration of those possibilities will require more participation from research and educational communities in formulating economic development strategies; it also will require more participation from labor, small business, and other community organizations in setting research and educational priorities.

Third, the growing use of targeted instruments for public intervention in the state and local economy is also an important positive trend. The public sector, including state and local government, has become overly reliant on the tax code to achieve particular economic development objectives. Direct public investment is generally a more effective way to target limited public funds for the support of particular areas of education and research, industry sectors, desirable economic activities, and particular geographic areas. Furthermore, if the public investment program is properly designed, it can be more effective than tax policy in stimulating private investment.

There are some profound shortcomings to state and local high-technology initiatives, only a few of which we explore here. One is that by focusing their new education initiatives in science, engineering, and math (which are indeed critical in the innovation process), state and local governments are adopting a somewhat short-sighted approach to education and training. To cope properly with the accelerating rate of technological and economic change, which is laying waste our projections of occupational and skill demand, the public sector must strike a balance between providing technical and job skill-related education, on the one hand, and a basic well-rounded education (English, writing, communications, and analytic reasoning), on the other.⁷ Unfortunately, fiscal and political pressures are leading state and local policymakers to give priority to the former.

Second, states and localities have not given enough consideration to the environmental and human con-

sequences of high technology. That will inevitably result in high-technology development and policies that do not serve the public interest. The myth of "clean" high-tech firms, for example, has been shattered by those who are suffering from the mishandling of toxic wastes and occupational illness in the electronics industry (Benner 1982; Citizens for a Better Environment 1983). Many state and local governments have responded to citizen pressure by passing "right-to-know" legislation and proposing other important planning initiatives (Skinner 1983).

In addition, little is being done to prevent massive economic dislocation that is accompanying technological change. Given a low level of labor union organization, communities and workers cannot rely solely on innovative labor-management contracts for many basic human protections (Lawrence and Chown, n.d.). The constant threat of displacement demands initiative by the public sector. In part, what is required is a comprehensive system for developing human resources, including a stronger corporate commitment to internal placement of otherwise redundant employees in new openings, to financing recurrent education and training, and to sustaining worker incomes during transition periods (Institute for Research on Educational Finance and Governance 1983). If the private sector cannot counteract the effects of permanent job loss by supplying an adequate number of good employment opportunities, then new forms of public intervention will be needed to create those opportunities.

Finally, there is a great deal of uncertainty as to whether current state and local initiatives for technological and industrial innovation can promote regional development in areas that are relatively isolated from existing high-technology centers. The workings of the market and national spending policies have produced only a few regions where most high-tech products and processes are developed. Most others lack the critical mass of research, technical, entrepreneurial, and financial resources on which to base policies that target the development and capitalization of small technology-based ventures. Their principal locational characteristics with respect to the product cycle are their lower costs (of production and living) and environmental amenities. These communities, therefore, tend—or try—to attract branch plants of large high-technology companies that offer little, if any, highly skilled employment.

It is often claimed that attracting a number of branch plants over time ultimately will create enough skilled labor and supportive infrastructure to meet the requirements of operations with greater technological content (less standardized operations and more skill and scientific research involved in the labor process), and hence initiate self-sustaining growth (Rees and Stafford 1983). There are no guarantees, however, that branch plants of high-technology firms, which often contain little actual technological content and are located

in areas isolated from high-tech centers, will eventually generate salutary spinoffs. Furthermore, since the large manufacturing facilities are drawn increasingly to lower-cost foreign locations, they do threaten abrupt economic dislocation (Shorrock 1983).

A historical analysis of the primary centers of technological innovation and sustained high-tech industrial development reveals that they have been built on a foundation of massive and sustained public (mainly federal) investment (in military research and production, education, and transportation). We should not pretend that most communities can develop that capacity over the long term without similar large-scale public investments. Those who claim that states can play a key role in stimulating economic development through technological innovation are right; but to think that states and localities, without a much greater commitment of *national* resources, can take a leadership position in stimulating technological innovation and economic development to meet human needs is to leave most of the country behind. State initiatives for technological and industrial innovation are said to be the makings of a national policy for industrial competitiveness; but without greater consideration of their human and spatial implications, they could very well turn into a national policy of regional and social abandonment.

Notes

1. In several instances, labor representation is either weak or entirely absent. The lack of labor organization in many high-technology industry sectors is partially responsible. Nevertheless, this does raise important questions about public accountability in high-technology policymaking.
2. For example, the U.S. Small Business Administration's Small Business Development Center program and Small Business Investment Company program, the Economic Development Administration's Corporations for Innovation Development, and the Small Business Innovation Research program all have catalyzed state and/or local initiatives for innovative small business ventures.
3. Experience reveals that the frequently unfulfilled requirements of a retraining program for dislocated workers include providing ample lead time to plan and assess needs and the transferability of skills; starting retraining before the worker actually loses his job; making training class schedules flexible to enable workers to continue looking for jobs; providing adequate financial support for laid-off workers; developing reliable labor-market forecasts; and coordinating closely with prospective employers (California Employment Development Department 1983).
4. The U.S. Department of Commerce and the National Science Foundation report that more than half of all scientific and technical developments since the beginning of the century could be attributed directly to the efforts of small firms and inventors. They also appear to account for a much larger number of innovations per R&D dollar than medium- and large-sized companies. Nevertheless, in 1974, about 90 percent of all R&D in the private sector was performed by only 200 firms. Needless to say, there is substantial disagreement about the relative importance of small business in the innovation process (Congressional Budget Office 1981; Corporation for Enterprise Development 1982).
5. Targeting "mature" industries for productivity enhancement or automation threatens to repeat the mistakes of past agricultural mechanization (assisted by the states) by neglecting to take into account the large-scale dislocation of workers and communities.

At the very least, public assistance to users of innovation should be accompanied by requiring firms to either guarantee new employment for workers (in existing or other divisions in the company), and/or provide adequate retraining and income support to workers whose jobs are threatened or eliminated by the introduction of technology.

6. As of mid-1982, more than four-fifths of the nation's private venture capital was managed in six states. Thirty-six percent of the companies that received venture capital financing in 1982 were located in California, while 15 percent were located in Massachusetts, 6 percent in New York, and 5 percent in Texas. Of course, the lack of venture capital in some areas is, in part, a result of the lack of promising ventures.
7. De-emphasizing liberal arts may be short-sighted even from the standpoint of future labor requirements in high-technology industries. That point is brought out in a study of computer services in California. The study points to the experience of one firm doing research on computer speech synthesis and voice recognition—an area that is likely to grow with the rise of "user-friendly" computer systems. The company's employees are graduate students in linguistics and are "valued not only for their knowledge of the mechanics of speech, but for their general professional commitment to understanding communications, not just computing machinery" (Hall et al. 1983, 114).

References

- Benner, Susan. 1982. Storm clouds over Silicon Valley. *Inc.* (September): 84–94.
- California Commission on Industrial Innovation. 1982. Winning technologies: A new industrial strategy for California and the nation. Report of the commission, September. Sacramento: Office of the Governor.
- California Employment Development Department. 1983. Displaced worker evaluation report. Sacramento: California Employment Development Department.
- Citizens for a Better Environment. 1983. *Toxics in the bay*. San Francisco: Citizens for a Better Environment.
- City of Chicago. 1982. Report of the Mayor's Task Force on High-Technology Development.
- Corporation for Enterprise Development. 1982. The role and nature of small firm technological innovation. *The Entrepreneurial Economy* 1, 6: 4–5.
- Congressional Budget Office, U.S. Congress. 1981. *The productivity problem: Alternatives for action*. Washington: U.S. Government Printing Office.
- Downs, Charles. 1983. Biotechnology Institute—MSU's research strengths help win MBI for Lansing. *MSU Today* 3, 1 (Fall): 1.
- Glasmeyer, Amy K.; Peter Hall; and Ann R. Markusen. 1983. Defining high-technology industries. Working paper No. 407. Berkeley, Calif.: Institute of Urban and Regional Development.
- Hall, Peter; Ann R. Markusen; Richard Osborn; and Barbara Wachsmann. 1982. California's future industries: Computer services. Sacramento: California Commission on Industrial Innovation, Office of the Governor.
- Institute for Research on Educational Finance and Governance. 1983. *IFG Policy Notes* 4, 3: entire issue. Palo Alto, Calif.: Institute for Research on Educational Finance and Governance.
- Joint Economic Committee, U.S. Congress. 1982. *Location of high technology firms and regional economic development*. Washington: U.S. Government Printing Office.
- Jones, David. 1983. Financing job retraining: Beyond the current debate. *Ways and Means* 6, 6: 1, 6. Washington: Conference on Alternative State and Local Policies.
- Kieschnick, Michael. 1979. *Venture capital and urban development*. Washington: Council of State Planning Agencies.
- . 1982a. The incipient California industrial policy. Unpublished manuscript.
- . 1982b. How states can foster R&D. *The Entrepreneurial Economy* 1, 6: 2–3. Washington: The Corporation for Enterprise Development.
- Langfitt, Thomas W.; Sheldon Hackney; Alfred P. Fishman; and Albert V. Glowasky, eds. 1983. *Partners in the research enterprise: University-corporate relations in science and technology*. Philadelphia: University of Philadelphia Press.
- Lawrence, Ann, and Paul Chown. n.d. *Plant closings and technological change: A guide for union negotiators*. Berkeley, Calif.: Center for Labor Research and Education.
- Lippman, Thomas W. 1981. How Arizona attracts high-tech companies. *San Jose Mercury*, San Jose, Calif., 29 December.
- Litvak, Lawrence, and Belden Daniels. 1979. *Innovations in development finance*. Washington: Council of State Planning Agencies.
- Markusen, Ann R. 1983. High-tech jobs, markets and economic development prospects: Evidence from California. *Built Environment* 9, 1: 18–28.
- National Governors Association, Task Force on Technological Innovation. 1983a. *State activities to encourage technological innovation: Preliminary report of survey findings*. Washington: National Governors Association.
- . 1983b. *Technology and growth*. Washington: National Governors Association.
- Office of Technology Assessment, U.S. Congress. 1983. Technology, innovation, and regional economic development: Census of state government initiatives for high-technology industrial development—Background paper no. 1. Washington: U.S. Government Printing Office.
- . 1984. Technology, innovation, and regional economic development: Encouraging high-technology development—Background paper no. 2. Washington: U.S. Government Printing Office.
- Pennsylvania Department of Commerce. 1982. *Advanced technology policies for the commonwealth of Pennsylvania*. Harrisburg: Pennsylvania Department of Commerce.
- Phalon, Richard. 1983. University as venture capitalist. *Forbes* 19 December: 82–93.
- Rees, John, and John Stafford. 1983. A review of regional growth and industrial location theory: Towards understanding the development of high-technology complexes in the U.S. Unpublished manuscript.
- Rhode Island Strategic Development Commission. 1983. *The greenhouse compact—A report to the Rhode Island Strategic Development Commission*. Providence: Rhode Island Strategic Development Commission.
- Shorrock, Tim. 1983. Atari moves to Asia. *Multinational Monitor* 4, 4: 11–13.
- Skinner, Joanne. 1983. States act to protect citizens from toxics. *Ways and Means*, 6, 4: 1, 6. Washington: Conference on Alternative State and Local Policies.
- State of California. 1981. *State activities to encourage technological innovation*. Sacramento: Department of Economic and Business Development.
- . 1982. *State activities to encourage technological innovation: An update*. Sacramento: Department of Economic and Business Development.
- U.S. Small Business Administration. 1982. *A directory of state small business offices and activities*. Washington: U.S. Small Business Administration.
- Weiss, Marc A. 1983. High-technology industries and the future of employment. *Built Environment* 9, 1: 51–60.