


# R&D Investments Drive State Economies: A Guide for Arizona

June 2007

The background of the lower half of the page is a close-up, slightly blurred image of the Arizona state flag. The flag features a field of 11 horizontal stripes of equal width, alternating in color from top to bottom: red, yellow, red, yellow, red, yellow, red, yellow, red, yellow, and red. The stripes are slightly wavy, suggesting the flag is draped or blowing in the wind. The lighting is warm, highlighting the texture of the fabric.

Prepared by  
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## Introduction

Arizona faces unique challenges to its long-term economic prosperity. It is among the fastest growing states in the nation, with an historically low unemployment rate, but it also lags the nation in productivity and wages per job. While it has considerable high-tech industry, primarily aerospace/defense and electronics, the state economy is heavily weighted toward relatively low-tech services such as real estate and tourism.<sup>1</sup>

In this context, it is important to recognize the fierce global economic competition among regions for high-wage (usually high-tech) industries capable of rapid productivity growth. Some of this competition revolves around traditional, location-based economic development tools such as tax breaks or direct financial support for relocating companies. However, public investments in regional science and engineering capability – as well as in a cluster of complementary human resource and business assets – have emerged as the dominant form of regional economic competition for high-growth, high-wage industries.

The need for such public investments if Arizona is to be competitive is clear. Arizona ranks 22nd in the recently issued 2007 *State New Economy Index*<sup>2</sup>, dropping in rank by 7 places from the preceding ranking in 2002<sup>3</sup>. On the *State Technology and Science Index*<sup>4</sup> Arizona ranked 17th nationally. According to *State Science & Technology Indicators*<sup>5</sup> Arizona ranks at or below the national average in a number of key measures including:

- Total R&D expenditures per \$1,000 of Gross State Product (GSP) - 25th
- University R&D/\$1,000 GSP - 26th
- National Assessment of Educational Progress (NAEP) Math test scores - 27th
- Intensity of Science and Engineering (S&E) degrees at the undergraduate and graduate level - 36th and 31st respectively

The economic development competition among states, regions, and even nations using investments in science and technology – usually linked closely to institutions of higher education – is nothing less than a global race. The demonstration of the value of these types of investments falls into two categories: a) economic success stories from places such as Silicon Valley, Route 128, North Carolina, Ireland, and Bangalore; and b) the number, size and diversity of investment programs being undertaken not just by states in the US but by almost every nation or region in the developed or developing world. Before turning to a brief survey of state-level activities in tech-based economic development it is important to review the logic, and desired results, of such investments.

<sup>1</sup> "A Strategic Assessment of the Economic Benefits of Investments in Research in Arizona," June 2007, The L. William Seidman Research Institute, W. P. Carey School of Business, Arizona State University and The Economic & Business Research Center, Eller College of Management, The University of Arizona.

<sup>2</sup> *The 2007 New Economy Index: Benchmarking Economic Transformation in the States*, February 2007, Information Technology and Innovation Foundation, Washington, D.C.

<sup>3</sup> *The 2002 New Economy Index: Benchmarking Economic Transformation in the States*, June 2002, Progressive Policy Institute, Washington, D.C.

<sup>4</sup> *State Technology and Science Index: Enduring Lessons for the Intangible Economy*, March 2004, Ross DeVol and Rob Koepp with Junghoon Ki, Milken Institute, Santa Monica, CA.

<sup>5</sup> *The Dynamics of Technology-Based Economic Development: State Science & Technology Indicators: Fourth Edition*, March 2004, Office of Technology Policy, U.S. Department of Commerce.

### **The Economic Logic for State Investments in Research and Development**

The issue of relative competitive advantage for a state is best understood in terms of assets and liabilities. A highly literate and numerate workforce is an asset. High-tech businesses located in the state are an asset. Nationally recognized universities are an asset. A challenging climate, lack of lifestyle amenities that attract skilled professionals, or poor public K-12 education are liabilities.

Based on the experience of locations such as Silicon Valley, Research Triangle, and Route 128, it is generally acknowledged that the following elements are required (necessary but not alone sufficient) for a vibrant, tech-based economy:

- An intellectual infrastructure (i.e. universities or private research labs);
- Formal and informal mechanisms to transfer knowledge from one individual or institution to another;
- Robust physical infrastructure that includes elements such as high-quality telecommunications, affordable high-speed internet access and accessible airports;
- Highly skilled technical workforce;
- Sources of risk capital;
- High quality of life; and
- Entrepreneurial culture<sup>6</sup>.

In the last two decades nations and states have come to recognize that competitively allocated and targeted investments in science and technology are a relatively inexpensive way to create these assets that confer long-lasting competitive economic advantage.

A wide range of analysis and experience points to the types of targeted investments that create the most competitive advantage:

- University-based research that is, if appropriate to the stage of research, collaborative with industry;
- Research that either fills a gap in the core capabilities in the region/state or which substantially extends an existing competence/center of excellence;
- Research activities that are explicitly linked to graduate and, to the extent feasible, undergraduate education; and
- Research activities that are intended to "leverage" additional investments of research from federal and private/foundation sources.

Appropriately targeted (and competitively allocated to ensure quality) investments of this type create assets that confer relative competitive advantage:

1. A critical mass of high-quality, research-active faculty capable of formulating and raising funds from outside the state for value-adding research
2. A large stock and flow of science and technology graduate students and post-doc researchers as

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<sup>6</sup> *A Resource Guide for Technology-based Economic Development: Positioning Universities as Drivers, Fostering Entrepreneurship, Increasing Access to Capital*, August 2006, prepared for the Economic Development Administration, U.S. Department of Commerce by the State Science and Technology Institute (SSTI), Westerville, OH.

- the critical feedstock for the development of new and existing high-tech industries
3. Unique or region-dominant research facilities or centers of excellence that attract industrial collaborators
  4. The soft infrastructure – policies, organizational experience, density of advanced equipment and research personnel – at universities in the state that allow units of those universities (departments, centers, institutes) to compete effectively for federal research funds

The measures of return on investment in state science and technology should be direct or "proxy" measures for items 1-4 above, for example:

1. Changes in the quality and number of research active faculty in the state
2. Changes in the stock, flow, and quality of graduate students and post-doc researchers in the state
3. Changes in industrial participation (funding) of research at state institutions
4. Changes in amount of research funding flowing into the state from federal agencies or other private (philanthropic) sources of research funds
5. Changes in the levels of investment by venture funds in deals originating in the state

#### **Comparison of State R&D Funding Programs**

There is a tremendous variety of programs with very little consistency in the way they are focused, operated or evaluated. Exhibit A provides a summary analysis of selected state-funded R&D programs in California, Massachusetts, Michigan, New York, North Carolina, Ohio, Pennsylvania, and Texas. These states include established leaders in innovation and technology-based economies such as California, Massachusetts and North Carolina; states working to transform their economies to compete in the global knowledge economy, such as Pennsylvania, Ohio and Michigan; and states that, by virtue of their size and resources, have long been engines of efficient economic growth, but now recognize they must develop new strategies, such as New York and Texas.

While it is extremely difficult to draw meaningful lessons across the diversity of programs and differing political situations in these states, we can make three central observations:

1. Many state programs start with on-target goals of allocating research funding to research performers (universities or university-industry collaborations) on the basis of quality and potential contribution to the state economy. There is a tendency for programs to evolve over time into state-business-as-usual, politically-brokered allocation by region and or institution.
2. There is very real and ongoing confusion about how research funding fits in the broader suite of activities that constitute programs for technology-based economic development (TBED). Real research – even applied research that is closely linked to industrial partners – is inherently uncertain, often slow to mature, and can be difficult to evaluate. State government programs – without the technical and scientific “soft” infrastructure of long-established federal science funding agencies – tend to migrate downstream from early-stage, long-term research to shorter-term, easier to evaluate investments such as incubators, research parks, or even investments in

operating high-tech companies. These are important to TBED but they are – in most cases – derivative of a real research enterprise that is co-located.

3. It is often the case that states conceptualize themselves as a company that invests in R&D and controls/maximizes the return on its R&D. They often ignore the fact, or are not aware of the economic logic, of R&D investment; i.e., that most corporate returns from R&D investment accrue to the company through downstream – and usually geographically dispersed – activities such as licensing, manufacturing, marketing, and product-line extension. Too few evaluation processes recognize that the corporate-style economic returns to scientific and technological advancements do not respect national or state borders. Therefore, state investment in science and technology is all about developing a competitive economic advantage (relative to other locations) for new business development, attraction and retention of high-value-added per employee economic activity.

Further, many of the states included in the analysis regularly perform either program evaluations and/or maintain state-level tracking or benchmarking reports focused on the health of the state high-tech economy or, more narrowly, the health and progress of the state's science and technology enterprise. While there are some detailed lessons to be learned from the varying approaches to specific program evaluations, the issue of more general importance is the path that different states have taken to tracking and benchmarking themselves.

### **The Importance of Benchmarking the State's S&T Enterprise**

The purposes of state targeted, competitively allocated investments in research (as opposed to other TBED assets) as well as the measures/evaluation of the value of such investments argue that Arizona should establish a perpetually updated benchmarking process to track performance and adjust investment strategy as necessary.

Massachusetts, for example, has published an annual assessment over the last 10 years<sup>7</sup> that has been an invaluable tool for monitoring key innovation indicators in Massachusetts and other leading technology states (peer states are Virginia, Minnesota, Connecticut, Pennsylvania, Illinois, New Jersey, North Carolina, California, and New York) in six clusters: Computer & Communications Hardware; Defense Manufacturing & Instrumentation; Healthcare Technology; Scientific, Technical, & Management Services; Software & Communications Services; and Postsecondary Education. Washington state has instituted a regular series of benchmark assessments<sup>8</sup> comparing its performance on 40 indicators that fall under three key drivers for innovation (education, research capacity, and entrepreneurial climate) with a set of peer and neighboring states.

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<sup>7</sup> The most recent issue is *2006 Index of the Massachusetts Innovation Economy*, Massachusetts Technology Collaborative and The John Adams Innovation Institute, Westborough, MA.

<sup>8</sup> The most recent report is *Drivers for a Successful Technology-based Economy: Benchmarking Washington's Performance*, July 2006, Williams B. Beyers and Bryan Chee, Technology Alliance, Seattle, WA.

Some of the measures used in these reports and in the nationwide rankings cited in the Introduction, as well as measures of research activity compiled by the National Science Foundation and metrics from other sources, might be useful in tracking and assessing the impact of Science Foundation Arizona's (SFAz) programs.<sup>9</sup>

For example, those SFAz initiatives addressing directly human resources (the K-12 Student & Teacher Discovery Program and Graduate Research Fellowships) might best be assessed using measures such as:

- NAEP math test scores
- average Math SAT Scores
- the number of science and engineering undergraduate and graduate degrees awarded and the number of post-doctorate researchers
- the number of workers with recent undergraduate and graduate S&E degrees
- intensity of various S&E specialty workers
- success in retaining/attracting high-tech workers in Arizona

Over time, the measures related to graduate and post-doctorate S&E degrees and even the intensity of S&E workers in specific fields will also reflect the extent to which these programs are achieving downstream benefits.

The SFAz programs designed to improve success rates in competitions for center and individual PI proposals (Competitive Advantage Awards and Strategic Research Groups) might best be assessed over the short-term using measures such as:

- annual rates of federal R&D expenditures
- annual rates of industrial R&D expenditures
- success rates on center and individual PI proposal submissions

The success of Arizona's research universities in attracting top talent both as faculty and students will also reflect a return on these investments.

At the commercialization end of the TBED spectrum, SFAz's Small Business Catalytic program, designed to spur technology development, company formation and high-tech job creation in Arizona, might be tracked using measures such as:

- patents filed
- patents issued
- licensing income

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<sup>9</sup> The effectiveness of any assessment program relies on a few key caveats. The measures used must be relevant to the objectives of the program(s) being assessed. The process must be transparent and objective. Measures must be taken consistently over time and expectations regarding the time period over which changes can be expected must be reasonable. Interpretation of the results must take into consideration the interaction among programs and recognize that there is a need for critical mass among complementary approaches in achieving measurable impacts as well as limits on the impact that can be expected from a single program component. Finally, metrics must address not only immediate outcomes but longer range expectations and required resources (for example, measuring the number of S&E graduates may show a positive impact, but there is also a need to track the number of graduates remaining in or migrating to the state in order to assess the availability of a skilled workforce).

- firms created in high-technology
- number of Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) awards
- in-state venture funding metrics

These same measures also reflect downstream benefits of the CAA and SRG programs.

### **Conclusion**

Arizona needs to act aggressively. To act passively at this time in history is akin to allowing the state to fall behind in the race for competitive economic advantage based on science and technology.

This report and the referenced material constitute a good summary of the extent of information on state programs and the typical flaws in state programs; present a powerful argument for competitive allocated research investments in state-based universities and collaborative research activities; and offer an informed recommendation about how Arizona should start tracking the elements of technology-based economic development (TBED) and how that effort can be tied to the state's research investment.

## **EXHIBIT A**

### **Comparison of State R&D Funding Programs<sup>10</sup>**

This analysis examined a diversity of state-funded R&D programs in California, Massachusetts, Michigan, New York, North Carolina, Ohio, Pennsylvania, and Texas. These states represent established leaders in innovation and technology-based economies such as California, Massachusetts and North Carolina; states struggling to transform their former manufacturing-based economies and position themselves to compete in the global knowledge economy, such as Pennsylvania, Ohio, and Michigan; and states like New York and Texas that by virtue of their size and resources have long been efficient engines of economic activity, but recognize, in the case of New York, the need for continued investment to leverage gains and more widely diffuse economic benefits throughout the state, and for Texas, to move more aggressively into the knowledge economy. The R&D funding programs in each of these states were selected to represent a range of approaches, funding commitments, organizational configurations, and missions, and include programs with relatively long histories as well as more recent initiatives.

It should be noted that in each of these states, the programs studied represent just one component of a broader investment strategy that encompasses other elements such as direct R&D funding to universities; investment in education, including workforce training and math and science education at every level from elementary school through college; research infrastructure funding; technology transfer support; venture capital investments, loans and support programs for entrepreneurs; incubators and technology parks; alliance building and support; tax credits to attract and retain

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<sup>10</sup> The material in this section draws liberally from publicly available sources.

employers; etc. States that have become competitive players in the global economy recognize that there is no one “magic bullet” approach, but the need for sustained investment across the spectrum of activities that characterize the development of an economy based on innovation. This cycle starts with idea generation and progresses through technology transfer and commercialization to company formation/retention.

The history of state investment in academic R&D varies from state to state. What they all share, however, is a recognition that public R&D investments return economic benefits and an understanding that such investments are necessary on a sustained basis if the state is to achieve and retain a competitive position in the knowledge-based economy. Furthermore, most of these programs seek to develop and enhance industry/academic and public/private collaborations, an approach that has proven to be key in translating research activity into economic growth. These programs also share a secondary but important benefit in providing research (and often commercialization exposure) opportunities to faculty and students that help attract scientific talent to the state as well as stem the migration of such talent from the state.

#### **State of California**

California has never had a sustained effort at building academic/industrial R&D collaborations that are funded and operated at the state agency level. Instead, substantially all the state’s R&D funding in support of improving its economic competitiveness takes place within the University of California System. The California Institutes for Science and Innovation (Cal ISIs), four virtual cross-campus research centers designed to support research in fields that were recognized as critical to the economic growth of the state – biomedicine, bioengineering, nanosystems, telecommunications and information technology – continue this tradition. Launched in 2000 as a \$1 billion initiative with a state commitment of \$400 million for capital development of the research buildings, the centers have been successful at meeting a 2:1 funding match requirement, but the state continues to provide operating support to the centers (\$19.8 million in the 2007-2008 budget).

#### **State of Massachusetts**

Massachusetts, which like California has been a successful participant in the knowledge-based economy, is not known for the high level of state appropriations to promote economic development through the growth of technologically innovative companies. Instead, its success was built on its long history of technology innovation buoyed by strong research institutions, vibrant entrepreneurship, a well-educated labor force, a well-developed infrastructure, and a ready supply of risk capital. However, given its low population growth and the absence of significant natural resources, Massachusetts is increasingly dependent on innovation for economic growth. In 2003, an economic stimulus package (Act to Promote Jobs, Economic Stability and Competitiveness in Massachusetts) was passed that included provisions to enable the state to invest in initiatives deemed important to the future of Massachusetts and, for the first time in the Commonwealth, created a formal framework for making substantial investments in technology-based economic development initiatives. This legislation earmarked \$20 million over five years for a new research center matching-fund program administered by the John Adams Innovation Institute.

### **State of Michigan**

Michigan, in response to a proposal made by its four largest research institutions, made the first and largest use of tobacco settlement funds for cutting-edge research and technology-based economic development when it established the Michigan Life Sciences Corridor (MLSC) in 1999. The legislation allocated \$1 billion over the course of 20 years to support collaborative life sciences research, development and commercialization. The MLSC program is administered by the Michigan Economic Development Corporation (MEDC), created in the same year as the MLSC and the successor to the Michigan Jobs Commission, the state's economic development department. In 2002, the MLSC program was incorporated into the Michigan Technology Tri-Corridor initiative, adding funding priorities for homeland security and alternative fuel research. In November 2005, the MLSC became the life sciences component of the Competitive-Edge Commercialization Program in the governor's 21st Century Jobs Fund, a \$2 billion, 10-year initiative administered by the MEDC to accelerate the diversification of Michigan's economy in four competitive-edge technologies: life sciences, alternative energy, advanced automotive, manufacturing, and materials and homeland security/defense.

### **State of New York**

New York has a long history in funding university research as part of a technology-based economic development strategy, beginning with the establishment of the New York State Science and Technology Foundation in the early 1960s. The strategic focus, organizational structure and emphasis on funding of academic R&D has fluctuated over time, but since 2000, grant funding has been consolidated in the New York State Office of Science, Technology, and Academic Research (NYSTAR), with the goals of increasing the federal and private funding of R&D at N.Y. academic and research institutions and supporting the commercialization of such research. (In 2006, NYSTAR became a public benefit foundation.) Among the programs administered by NYSTAR are the Centers for Advanced Technology (CAT), initiated in 1983; the College Applied Research and Technology Center program (CART), and the Matching Grants Leverage program.

### **State of North Carolina**

North Carolina initiated one of the earliest efforts to attract technologically innovative industries to the state, and the success of its Research Triangle Park (RTP), created 50 years ago, has established the state as a leader in biotechnology. Today, North Carolina sees as its challenge the fact that the success and prosperity of the Research Triangle region is not shared across the state. Elsewhere in the state there are regional economies characterized by low-wage, low-skill, and undereducated workers. Indeed, many of North Carolina's current efforts are targeted at improving the skills of the workforce through initiatives such as increased support to community colleges and the establishment of regional training initiatives focusing on biomedical and other high-tech fields. Increased support to the universities has generally come from direct appropriations through the budget process to establish and expand programs on campuses throughout the state, attract talented faculty, cover indirect costs, etc., rather than a coordinated competitive R&D funding process, which has to date not been a key component of the state's innovative economic strategy. The primary source of competitive university R&D funding is the North Carolina Biotechnology

Center (NCBC), a private, nonprofit corporation funded mainly by the North Carolina General Assembly, which administers a set of relatively small competitive R&D funding programs (as well as other university grants for activities such as faculty recruitment and research equipment purchases).

### **State of Ohio**

Ohio has not yet been able to build a firm foundation in the innovation-based economy and has struggled to transition from an economy based on natural resources, semi-skilled labor and mass production to one powered by technology and high-tech talent. Recognizing the ground it needs to make up, Ohio made the strategic decision to direct \$493 million from its tobacco settlement funds to fund biomedical research over a 10-year period. Originally designated the Biomedical Research and Technology Transfer program when inaugurated in 2001, the program was renamed the Biomedical Research and Technology Transfer Partnership Award Program when it became part of Ohio's broader Third Frontier project. In 2006, the name of the program was changed to reflect the priority placed on commercializing technologies, and is now known as the Biomedical Research and Commercialization Program (BRCP). BRCP provides grants in the areas of human genetics and genomics, structural biology, biomedical engineering, computational biology, plant biology and environmental biology.

### **State of Pennsylvania**

Pennsylvania's approach to technology-based economic development differs from those of the other states in this analysis in two key respects. Since 1982, when it first developed its strategy, Pennsylvania has focused much more heavily on providing funding for later stages of the innovation cycle, such as seed-stage funding, loans, equity-type investments, and related industry-focused efforts such as incubator development, workforce training, and technical support, rather than university-based R&D funding. Secondly, although there is a statewide TBED strategy, operational management of the programs occurs at the regional, and not at the state level. Over time, both the emphasis on R&D funding and the regional vs. centralized nature of award decisions has shifted. The current university research grant program, initially funded in the 1999-2000 budget cycle, replaced an earlier program managed at the regional level with one managed more centrally.

### **State of Texas**

Although Texas has struggled to find the appropriate role for the state in fostering economic development in recent years (during the period 2000 through 2003 the lead state organization for economic growth changed three times), it has a solid history of recognizing the importance of university R&D programs in diversifying the state's economy. In 1987, Texas established a comprehensive grants program for individual academic researchers at a level of \$60 million per two-year budget cycle. The program had three complementary components that address the creation, development, and commercialization of intellectual property: the Advanced Research Program (ARP) (supporting basic research); the Advanced Technology Program (ATP) (supporting applied research); and the Technology Development and Transfer (TDT) Program (supporting technology transfer). At the time they were established, these programs were unique in several ways. They were modeled after the NSF program of the Federal Government in that grants were awarded to individuals rather than institutions. The proposals were reviewed by ad hoc panels of distinguished scientists recruited

from outside the state. The funds enabled researchers to conduct pilot studies, acquire equipment, and in other ways prepare for larger federal grants. Despite the demonstrated effectiveness of these programs, they appear to face an uncertain future as funding has been eliminated or severely cut in the 2003 and 2005 biennial budgets. At the same time, the new Texas Enterprise Fund (TEF), a deal-closing program available at the governor's discretion to make sure that selected economic development or business projects occur in Texas and not in a competing state, was funded for \$295 million. In the most recent budget, the governor's expansion of the TEF initiative to encompass a new Emerging Technology Fund (ETF) was passed at a biennial cost of \$200 million. The ETF program, administered by the governor's office, includes three major areas of investment: increasing public/private collaborations to develop Regional Centers of Innovation and Commercialization; matching research grants; and recruiting top scientific talent to Texas universities. It is unclear whether the ETF program is considered a replacement for the ATP/TDT program or if it will be as rigorously competitive.

Table 1 summarizes the salient features of each state program. The programs vary in the scale of both total funding available and the size of individual awards. At the high end are Michigan's 20-year commitment of \$1 billion and Ohio's \$493 million commitment over 10 years, both funded from the tobacco settlement agreement, as well as California's \$400+ million investment in collaborative research centers through the University of California System; awards in Texas exceeding \$1 billion over the 10-year period ending in 2006, and New York's \$316 million investment since 2000. North Carolina, Pennsylvania and Massachusetts have much more modest direct R&D investment programs, reflecting in part their strategic emphasis on and long history of fostering strong alliances and collaborations among private sector, higher education and government entities as the key component of technology-based economic development in the state. All are designed to increase competitiveness and address key components such as diversification, collaborations and alliances, and building a skilled workforce.

Table 1. Comparison of State University R&amp;D Funding Programs

State	California	Massachusetts	Michigan	New York	North Carolina	Ohio	Pennsylvania	Texas
<b>2005 GSP per capita/Rank<sup>11</sup></b>	\$44.9K / 13	\$50.9K / 6	\$37.2K / 37	\$49.7K / 7	\$39.9K / 23	\$38.5K / 29	\$39.3 K / 26	\$43.3K / 16
<b>Program</b>	California Institutes for Science and Innovation	Research Center Matching Fund (3 programs)	Michigan Life Sciences Corridor (now part of 21st Century Jobs Fund)	<ul style="list-style-type: none"> <li>Centers for Advanced Technology (CAT)</li> <li>College Applied Research &amp; Technology Center Program (CART)</li> <li>Matching Grants Leverage Program (MG)</li> </ul>	<ul style="list-style-type: none"> <li>Biotechnology Research Grant (new program in 2006)</li> <li>Collaborative Funding (CF)</li> <li>Multi-disciplinary Research (MD)</li> </ul>	Biomedical Research and Commercialization Program (BRCP) component of Third Frontier Project	Ben Franklin University Research Grants	<ul style="list-style-type: none"> <li>Advanced Research Program (ARP)</li> <li>Advanced Technology Program (ATP)</li> <li>Technology Development and Transfer (TDT) Program</li> </ul>
<b>Administered By</b>	University of California System	John Adams Innovation Institute, (economic development division of the Massachusetts Technology Collaborative)	Michigan Economic Development Corporation	New York Foundation for Science, Technology and Innovation (NYSTAR)	North Carolina Biotechnology Center	Ohio Department of Development	Ben Franklin Technology Development Authority (BFTDA)	Texas Higher Education Coordinating Board
<b>Type of Entity</b>	Public	Public	Private Corp	Public Benefit Foundation	Private, nonprofit corporation	Public	Public	Public
<b>Mission Elements</b>	<ul style="list-style-type: none"> <li>Competitiveness</li> <li>Expand university R&amp;D</li> <li>Educate R&amp;D leaders/wkforce</li> </ul>	<ul style="list-style-type: none"> <li>Competitiveness</li> <li>Increase research base</li> <li>Increase TBED</li> </ul>	Diversify economy in competitive technologies	Leverage academic R&D to drive economic development	Economic development; <ul style="list-style-type: none"> <li>Expand university R&amp;D</li> <li>Foster collaborations</li> </ul>	Create jobs thru biotech research	<ul style="list-style-type: none"> <li>Spur economic growth</li> <li>Strategic alliances</li> </ul>	Economic development & diversity
<b>Start Date</b>	2000	2003	2000	CAT-1983 CART-2004 MG-2000	1984	1999 (first grants FY 2001)	1999-2000	ARP/ATP - 1987; TDT - 1993
<b>Focus</b>	Interdisciplinary collaboration in 4 focus areas (bio; ICT, nano, IT research/society)	Matching grants for research centers and centers of excellence	Life sciences	High tech centers and matching grants	biotech	biomed	University / industry collaboration; Applied research only	ARP -Physical & life sciences & eng'g ATP – Ag biotech, biomed, C&E Eng'g, energy, env. sci & eng'g, mfg tech, mat'ls tech, micro- elec. & telecomm

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<sup>11</sup> Arizona 2005 Gross State Product (GSP) \$36.5; rank 40.

**Table 1. Comparison of State University R&D Funding Programs Continued**

State	California	Massachusetts	Michigan	New York	North Carolina	Ohio	Pennsylvania	Texas
<b>Scale</b>	\$1.2B total; \$400M+ from CA operating funds and Garamendi bonds <sup>12</sup>	\$20M over 5 yrs AWARDS: \$11.3M thru 12/05 SOURCE OF FUNDS: Economic Stimulus Trust Fund	\$1B commitment over 20 years AWARDS: \$275.9M thru 2006; SOURCE OF FUNDS: tobacco settlement	\$316M invested since 2000 in all NYSTAR Programs CAT- \$111M 2000-2005 MG - \$46M CART-?	2006: Collaborative Funding Assistance \$480K; Multi-disciplinary Research Grants \$860K	\$493M commitment over 10 yrs AWARDS: \$105.5M through 2006 SOURCE OF FUNDS: Tobacco settlement	\$18.2 M in 1st year; unknown for succeeding years	\$508M 1987-2006; \$169M ARP \$339M ATP/TDT
<b>Competitive Awards?</b>	YES	YES	YES	CAT & CART - YES	YES	YES	YES	YES
<b>Minimum Match</b>	2:1	4:1 –Centers 1:1-Center Dev. 1:1 – 1:2 COE	YES (unspecified ratio)	CAT-1:1 Yr 1-5 & escalating Yrs. 6-10 MG-3:1 cash + 1:1 in-kind	YES – varies by program from 10% up	1:1	NONE	1:1 for TDT only
<b>Collaboration Required?</b>	YES	PREFERRED	For applied research awards only	NO	Biotech: NO CF: YES MD: YES	YES	PREFERRED	NO
<b>Eligible Organizations</b>	2 or more UC campuses	Universities; non-profit research institutions	Grants: universities, non-profit research insts; non-profits corps	CAT/CART: university; univ-affiliated research institution (non-profit) MG: university and non-profit research insts	Univs., non-profit insts (collaborators can be fr. Industry)	Univs, public/private research orgs/non-profit firms	Univs & private sector entities with univ collaborator	Academic researchers
<b>Award Size/Term</b>	\$100M over 4 years	Centers-\$2M max; 5 yrs max Center Dev-\$150K max COE- \$3-5M	No limit on \$; up to 3 yrs	CAT-up to \$1M/yr for 10 yrs CART-up to \$.5M/yr for 5 yrs MG-\$100K/yr minimum	Biotech: up to \$75K/up to 18 mos. CF: \$40-50K/yr up to 3 yrs MD-\$250K total/2yr max	\$5M-\$8M up to 3 yrs	Unknown	Unknown

<sup>12</sup> UC revenue bonds backed by anticipated increase in overhead recovery from incremental federal grants made possible by the existence of the Institute.





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