INDICATOR INSIGHT

INNOVATION ◄•► AN EXPERT'S INSIGHT ON THE ISSUE IN ARIZONA

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Innovation—introducing something new—in the 21st century mostly derives from technological advances. Innovation drives the modern economy, leading to gains in productivity and prosperity. In order for a community to realize such gains, it must provide a foundation for innovation.

The foundation includes a strong educational system, a base of research and development activities, innovator access to financial resources, and a solid physical infrastructure among other factors. Science and engineering—in the educational system and in the workforce—are of particular importance. Arizona Indicators includes a tab specific to innovation, but other indicators related to innovation are displayed in various other tabs, particularly Education and Economy.

The Innovation tab is divided into three sets of indicators. One addresses human capital; related indicators are displayed in the Education tab. A second set includes indicators related to financial capital. The third set focuses on the high-technology workforce, as defined by industry and by occupation.

The indicators profiled on the Innovation tab almost uniformly present a discouraging picture of the status of innovation in Arizona. Not only is Arizona below the national average on nearly all measures, it has fallen further below average over time on many indicators.

Human Capital

The economic literature on regional economic growth stresses the importance of high-quality human capital in the workforce. Innovation requires the steady input of human capital into institutions of higher learning and into the workforce. Without strong human capital, innovation and gains in productivity and prosperity are not possible regardless of the strengths of the rest of the foundation.

The performance on entrance exams of entering university students is a measure of the quality of students that are being attracted to the state's universities. Thus, the first indicator looks at university entrance exam scores for entering freshman at Arizona universities relative to the national average of all test takers. No trend is seen at any of the universities, with the exam scores for entering freshman generally above the national average of all test takers at each of Arizona's three public universities. However, the scores at Arizona State University and at the University of Arizona are lower than at each of the peer institutions selected by the Arizona Board of Regents for each university.

Graduate education at the state's universities is a source of talented human capital. Science and engineering specialties are of particular importance to innovation. The number of graduate students and postdoctorates in science, engineering and health fields comprise the second indicator. A postdoctorate is an individual who, without joining the faculty, continues to study or performs professional work at a university after earning a doctorate degree. The number of graduate students and postdoctorates are standardized by expressing the figures per capita (per one million residents).

In the mid-1990s, Arizona's three state universities combined had nearly as many graduate students per capita in science, engineering and health fields as the national average. Since then, the national per capita number has trended up while the Arizona figure has trended down. The latest data for 2007 show Arizona's figure to be 21 percent less than the national average.

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Arizona Indicators is an online information resource and analysis tool that centralizes data about the state and its communities. Arizona Indicators presents interactive visualizations, clear data descriptions, and public opinion data in a broad range of content areas.

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Per capita, Arizona has consistently had fewer postdoctorates in science, engineering and health fields than the national average. However, Arizona's per capita number has trended down since 1998 while the national figure has trended up. The latest data for 2007 show Arizona's figure to be less than half of the national average.

Working individuals with advanced degrees in science and engineering are of particular importance to innovation. The third indicator is the per capita number of employed individuals holding a doctorate in science, engineering and health fields. Arizona's figure in 2006 (the most recent data) was 35 percent less than the national average. Since the early 1990s, Arizona's per capita number has barely increased while the national figure has risen more.

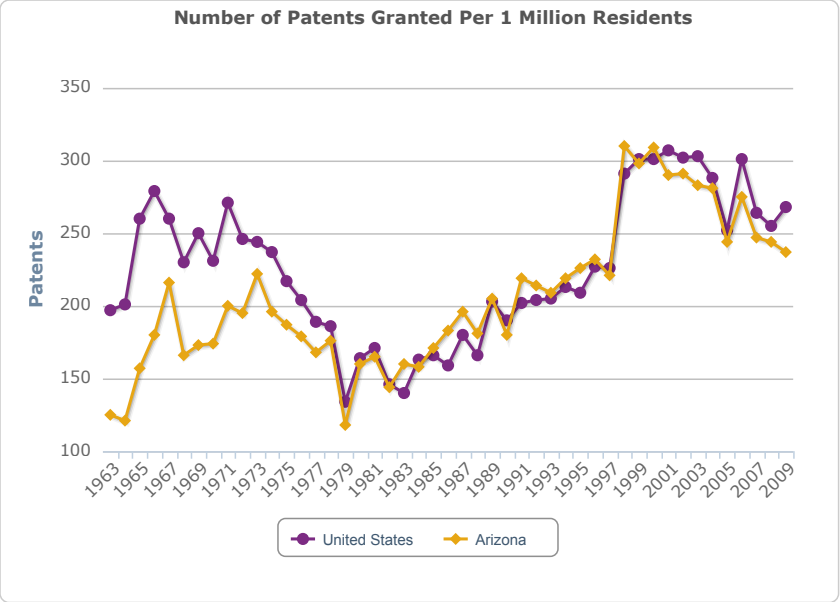

Figure 1 - *Number of Patents Granted Per 1 Million Residents.*

Sources: U.S. Patent and Trademark Office (patents) and U.S. Department of Commerce, Census Bureau (population).

The number of patents granted per capita is another indicator of the innovative talent present in a state. As seen in figure 1, the Arizona number was approximately equal to the national average from the late 1970s through 2000, but the Arizona figure has been lower than average in each of the last nine years, by 12 percent in 2009.

Arizona also is below the national average on related indicators that are displayed in the Education tab, including test scores other than university entrance exams, the percentage of Arizona students graduating from high school, the percentage of all associate and bachelor's degrees that are in science or engineering, and the educational attainment of the working-age population.

Financial Capital

The first financial capital indicator measures the extent to which the state's businesses and universities are engaged in research and development (R&D). The importance of research and development investment is a central theme of the economic literature on economic growth. R&D investment is crucial for attaining increases in labor productivity that ultimately translate into improvements in prosperity and is at the center of an innovation strategy.

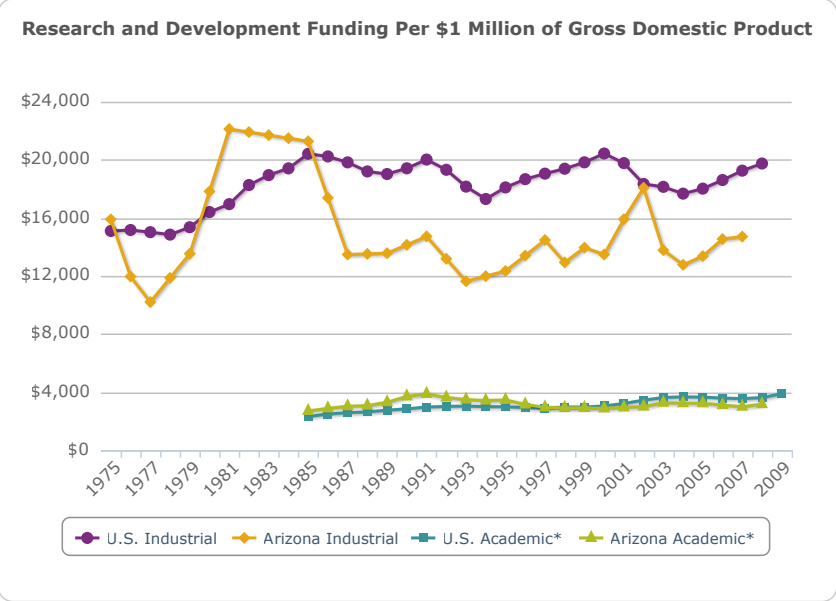

Figure 2 - *Research and Development Funding Per $1 Million of Gross Domestic Product.*

* Academic R&D is reported by fiscal year.

Sources: National Science Foundation (R&D) and U.S. Department of Commerce, Bureau of Economic Analysis (GDP).

Industry R&D funding is substantially higher than academic R&D funding, as seen in figure 2. Per $1 million of gross domestic product (GDP), industry R&D funding has not displayed any trend since the mid-1980s. Except during the early 1980s, Arizona's figure has been less than the national average. In 2007 (the latest data), the differential was 24 percent.

Academic R&D funding per $1 million of GDP has trended up nationally but the Arizona figure has dropped since fiscal year 1991. Arizona's figure was greater than the national average through 1997 but by 2008 was 12 percent below average. The federal government is the largest source of academic R&D funding. Per $1 million of GDP, federal

R&D funding has trended up nationally, but the Arizona figure has dropped since 1995. Arizona's figure had been close to the national average through the mid-1990s but was 27 percent below average in 2008. Institutional funding—funding by the university itself—is the second largest source of academic R&D funding. Per $1 million of GDP, institutional R&D funding nationally has trended up, but the Arizona figure has dropped since 1991. Still, Arizona's figure remains considerably above the national average.

The amount of academic R&D funding from state and local governments, industry, and other sources is considerably less than that from the federal government and the institutions. Per $1 million of GDP, funding from industry in Arizona was greater than the national average through 1995 but was 41 percent below average in 2008. Funding from state and local governments was 7 percent below the national average in 2008. Funding from other sources had been near the national average through 1993 but was 32 percent less in 2008.

The second indicator looks at two competitive programs that are administered by the U.S. Small Business Administration (SBA) to distribute federal research and development funds to small, high-technology, innovative businesses. The Small Business Innovation Research (SBIR) program encourages small businesses to explore their technological potential and provides an incentive to profit from commercialization. The ability of the state to attract a significant share of SBIR grants is a reflection of the business climate for innovative activity.

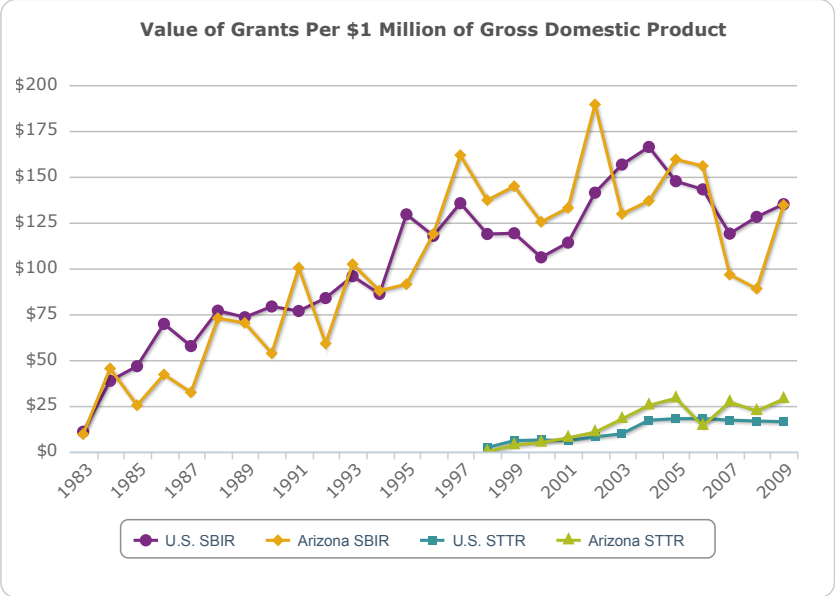

Figure 3 - *Value of Grants Per $1 Million of Gross Domestic Product.*

Source: U.S. Small Business Administration, Office of Technology (grants) and U.S. Department of Commerce, Bureau of Economic Analysis (GDP).

Arizona generally has been below the national average on each of three measures of SBIR grants. In 2009, the per capita number of SBIR grants was 14 percent below average and the per capita value of SBIR grants was 16 percent below average. However, the value of SBIR grants per $1 million of GDP was nearly equal to the U.S. average in 2009 (see figure 3).

The Small Business Technology Transfer (STTR) program is a smaller program designed to facilitate the transfer of technological innovation from nonprofit research institutions to small commercial enterprises. It primarily is a program linking research universities to commercialization efforts. Arizona compares favorably on this program, with the per capita number of STTR grants, the per capita inflation-adjusted value of STTR grants, and the value of STTR grants relative to GDP all considerably above the national average in 2009.

Venture capital is the third financial indicator. Venture capitalists invest in firms that have a high potential for growth but are not ready to do an initial public offering of stock. The investments tend to be both high risk and high return. Venture capital activity can be used to measure the number of potentially high-growth firms being started. These typically are innovative high-technology firms, such as biotechnology enterprises.

On each of three measures—the per capita number of deals, the per capita value of venture capital, and the value of venture capital per $1 million of GDP—Arizona consistently has been far below the national average. Each measure was about 70 percent below average in 2009 (see figure 4).

High-Technology Employment

High-technology activities by definition are innovative activities. As defined by industry, high-technology employment in Arizona historically was a substantially greater share of private-sector employment than the national average. However, for at least two decades, high-tech's share has fallen appreciably in Arizona relative to the national average. High technology's share of the Arizona economy is now barely higher than the national average.

Occupational data are more useful than industrial data in identifying certain types of activity, such as high technology, that are related to innovation. Employment shares that are above average in highly skilled, highly paid occupations indicate that

a workforce is positioned to make innovative advances. Geographic areas with below-market wages in these occupations will have a more difficult time attracting workers or firms.

Three occupational groups—computer and mathematical; architecture and engineering; and life, physical and social sciences—are defined as high-technology. As a share of total employment, the number of workers in these groups has declined slightly in Arizona since 2001 (the earliest data) but has increased nationally. Arizona's high-tech share has fallen from above to marginally below the U.S. average. Arizona has lagged behind the nation in employment growth in the computer and mathematical and architecture and engineering groups.

The median wage in high-tech occupational groups is far higher than the overall median wage. In Arizona, the median wage in each group is less than the national median for the group. The median wage in the computer and science groups has declined in Arizona relative to the national average since 2001.

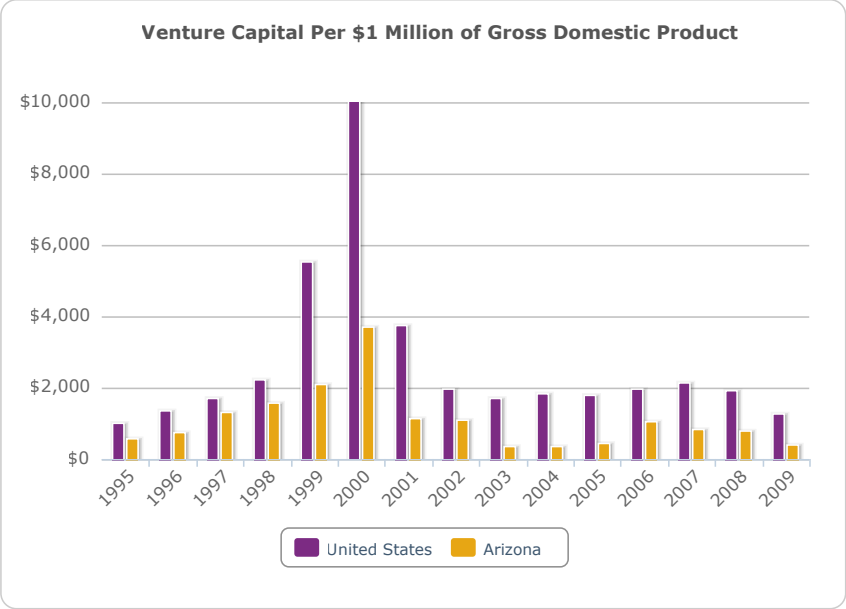

Figure 4 -*Venture Capital Per $1 Million of Gross Domestic Product.*

Sources: MoneyTree Report (venture capital) and U.S. Department of Commerce, Bureau of Economic Analysis (GDP).