SUPPLY AND DEMAND OF "STEM" OCCUPATIONS IN ARIZONA

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P3 | PRODUCTIVITY AND PROSPERITY PROJECT

ASU W. P. CAREY SCHOOL of BUSINESS
ARIZONA STATE UNIVERSITY

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A Report from the Productivity and Prosperity Project (P3), Supported by the Office of the University Economist

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TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The *demand* for new workers in STEM (science, technology, engineering and mathematics) occupations in Arizona is a function of net job growth in these occupations in the state and the number of workers leaving STEM jobs in Arizona. Employees may leave their position for various reasons, including to retire, to move out of the state, or to change their profession.

The *supply* of new workers in STEM occupations in Arizona is a function of the number of new college graduates in related majors, the number of workers moving to the state who are qualified to fill STEM jobs, and the number of Arizonans who are qualified to fill STEM jobs moving from a non-STEM to STEM occupation.

Serious data limitations prevent the overall estimation of supply and demand of STEM workers in Arizona:

- The change in employment in broad categories of STEM occupations is available, but the figures are estimates based on a survey subject to substantial sampling error. The definitions of the broad categories of STEM occupations do not coincide with the definitions of categories of STEM college graduates.
- Use of employment data on individual STEM occupations would allow a better match to be made to the categories of college graduates, but much of the occupational data are withheld and those occupational data that are available demonstrate unacceptably large amounts of survey error.
- The number of college graduates in STEM-related majors is available, but the number entering the Arizona workforce in STEM occupations is unknown. Some graduates leave Arizona, some continue their education rather than entering the workforce, and some take jobs in other occupations.
- In- and out-migration of workers in broad categories of STEM occupations is available, but the data are old and the figures are estimates based on a survey subject to substantial sampling error.
- The age profile of STEM workers is available with which to estimate the number of retiring workers, but the data are old and the figures are estimates based on a survey subject to substantial sampling error.
- Data on workers who change professions — into or out of STEM occupations — do not exist for Arizona. Similarly, data on those who leave or re-enter the workforce for other reasons, such as maternity leave, also do not exist for STEM occupations in Arizona.

EMPLOYMENT

Annual estimates of employment and wages by occupation by state are produced from surveys of employers conducted by the Occupational Employment Statistics program of the U.S. Department of Labor, Bureau of Labor Statistics (BLS). The standard occupational classification identifies some 800 occupations aggregated into 23 major occupational groups. For states, however, much of the data for individual occupations are not released due to limited sample size. Even when released, sampling error is so large as to make the data for individual occupations unusable. The accuracy of the data for the 23 occupational groups is better, but sampling error still is a concern.

The earliest occupational data are for 1999, with the latest for 2007. Sampling error appears to be substantial in the early years even by occupational group, so data for this analysis have been restricted to the 2002 through 2007 period. This period does not cover an entire economic cycle, with 2002 being a recovery year from the 2001 recession and 2007 being the peak of the cycle. Thus, the annual average change in employment over this period overstates that of an entire economic cycle. The annual average change in employment shown in Table 1 actually is calculated on a 4.5 year period, since the occupational surveying was done in November 2002 and in May 2007.

Most STEM occupations are included in one of four occupational groups: (1) computer and mathematical, (2) **a**rchitecture and engineering, (3) life, physical, and social science, and (4) healthcare practitioners and technical. Because of the educational focus of the STEM Education Center, data for the education, training, and library occupational group also are displayed.

Employment growth has been uneven across these occupational groups. Between 2002 and 2007, the employment gain in the architecture and engineering group was modest, with the group's share of total Arizona employment falling. A modest gain in employment in this occupational group is consistent with the slump in the state's high-technology industries. (For more information on the high-technology industries, see the "High-Technology Activities in Arizona: 2007 Update" report, available from http://economist.asu.edu/p3/knowledge.)

The share of employment in the education occupational group also fell (apparently due mostly to a decline in the share of jobs in the teacher assistants occupation). Unlike most occupations, which experience much faster job growth during economic expansions than during economic slumps, employment gains in education occupations tend to be steadier from year-to-year, meaning that changes in employment share are countercyclical.

In contrast, employment growth in the other STEM occupational groups was relatively rapid between 2002 and 2007. Numeric employment growth was much greater in the health care practitioners group than in the others.

TABLE 1
EMPLOYMENT BY OCCUPATIONAL GROUP IN ARIZONA

	2007		Annual Average Change, 2002-2007	
Occupational Group	**Number**	**Share**	**Number**	**Share**
Computer and Mathematical	56,630	2.1%	2,444	2.7%
Architecture and Engineering	59,680	2.3	878	1.0
Life, Physical, and Social Science	18,520	0.7	1,216	1.4
Healthcare Practitioners and Technical	115,360	4.4	4,902	5.5
Education, Training, and Library	137,700	5.2	1,704	1.9
TOTAL, All Occupations	2,648,000	100.0	89,522	100.0

Note: the subcategories do not sum to the occupational group total because of withheld data.

Source: U.S. Department of Labor, Bureau of Labor Statistics.

DEGREES

The number of university graduates was obtained from the Integrated Postsecondary Education Data System (IPEDS), available online from the National Center for Education Statistics (NCES). Completion numbers (the number of graduates) for all campuses of Arizona's three public universities were obtained for academic years 2002-03 through 2006-07, providing five years of data that match the five years of employment data used. Graduates include those with bachelor's, master's and doctoral degrees, as well as first professional degrees in the field of health care. Degrees related to STEM fall into several categories, as seen in Table 2.

The number of degrees in the computer and information sciences and support services category fell from the 2004 peak, but the number of mathematics and statistics degrees rose faster than the overall number of degrees over the five years. The number of degrees in the engineering technologies and technicians category fell substantially, while the number of engineering degrees fluctuated within a narrow range. Engineering as a share of the total degrees slid. Degrees in the biological and biomedical sciences steadily rose, faster than the rise in overall degrees, as did the number in the physical sciences and science technologies and technicians categories. The number of degrees in the health professions and related clinical services also rose considerably. The number of education degrees rose slowly until a large increase in 2007.

MIGRATION

The Census Bureau provides an annual estimate of migration to and from each state, but information on the characteristics of the migrants historically has been limited to the decennial census. The American Community Survey, which is replacing the long form of the decennial census, will provide such information, but the survey error of the limited amount of data available thus far from the ACS is too large to make use of these data. Thus, the migration data are seven years older than the employment and degree data.

TABLE 2
NUMBER OF GRADUATES AT ARIZONA'S PUBLIC UNIVERSITIES BY ACADEMIC YEAR AND PROGRAM

Program	2003	2004	2005	2006	2007	Annual Average
Computer and Information Sciences and Support Services	379	418	360	310	265	346
Mathematics and Statistics	140	165	153	172	200	166
Engineering Technologies and Technicians	213	179	179	163	49	157
Engineering	1,601	1,683	1,582	1,587	1,651	1,621
Biological and Biomedical Sciences	968	997	1,069	1,122	1,252	1,082
Physical Sciences	393	407	453	456	523	446
Science Technologies and Technicians	62	80	110	124	147	105
Health Professions & Clinical Sciences	935	1,085	1,185	1,205	1,224	1,127
Education	4,569	4,966	4,812	4,980	6,223	5,110
TOTAL, All Degrees	23,940	25,074	25,542	25,647	26,103	25,261

Source: National Center for Education Statistics.

To estimate the number of workers who migrated into and out of Arizona in the occupational groups of interest, the 2000 Census Public Use Microdata Sample Files (PUMS) were used. The number of in-migrants to Arizona from other states or countries between 1995 and 2000 was obtained from the 5 percent Arizona state sample. The number of out-migrants was obtained from the 1 percent national sample, by looking at how many people who at the time of the census resided in any state except Arizona and had lived in Arizona in 1995.

The ratio of in-migrants to out-migrants was particularly high in the health care practitioners occupational group (see Table 3). Thus, net in-migration of those employed in this occupation was disproportionately high. The ratio was almost as high in the sciences occupational group, and was above average in the engineering group. In contrast, in the education and computer groups, the ratio was near the overall average. These figures from the late 1990s may be different from the current situation. For example, since the demand for engineers has declined as employment in some of the high-technology industries has fallen, the number of net migrants in this occupational group likely has decreased since the late 1990s.

AGE OF WORKFORCE

As with the migration data, the only source of data about the age of the workforce in Arizona is from the decennial census PUMS. Thus, the age data are several years old and subject to sampling error.

The focus of the age analysis is to provide insight on the number of workers who might be retiring soon from STEM occupations. The age of the Arizona workforce in 2000 is summarized in Table 4. In 2000, the baby-boom generation was aged 36 to 54, accounting for the higher proportion of workers between age 50 and 54 than between 55 and 59. Presumably, most of those 60 or older in 2000 already have retired, and some of those who were 55-to-59 years old likely have retired as well. Those who were between 50 and 54 probably are beginning to retire.

TABLE 3
ARIZONA MIGRATION BETWEEN 1995 AND 2000, BY OCCUPATIONAL GROUP

Occupational Group	Annual Average In-Migrants	Annual Average Out-Migrants	Net Migrants	Ratio of In- to Out-Migration
Computer and Mathematical	2,788	1,757	1,031	1.59
Architecture and Engineering	2,535	1,304	1,231	1.95
Life, Physical, and Social Science	863	386	478	2.24
Healthcare Practitioners and Technical	4,045	1,662	2,383	2.43
Education, Training, and Library	3,917	2,323	1,594	1.69
TOTAL, All Employed Migrants	80,920	48,382	32,538	1.67

Source: U.S. Department of Commerce, Census Bureau, 2000 Census Public Use Microdata Sample.

TABLE 4
AGE OF ARIZONA WORKFORCE IN 2000, BY OCCUPATIONAL GROUP

	Percentage of Workers by Age		
Occupational Group	**50 to 54**	**55 to 59**	**60 or Older**
Computer and Mathematical	8.2%	4.2%	2.9%
Architecture and Engineering	9.0	6.2	5.5
Life, Physical, and Social Science	12.6	5.4	5.3
Healthcare Practitioners and Technical	12.5	6.6	6.3
Education, Training, and Library	13.8	8.1	6.6
TOTAL, All Occupations	9.5	6.5	6.8

Source: U.S. Department of Commerce, Census Bureau, 2000 Census Public Use Microdata Sample.

Relative to the entire workforce, those working in the computer and mathematical occupations are relatively young. Architects and engineers also have a slightly younger than average age profile. In contrast, those working in the education occupations are older than average. In addition, a greater than average share of scientists and health care practitioners were 50-to-54 years old in 2000.

ESTIMATING SUPPLY AND DEMAND

Job growth creates a need for new workers. Those entering the workforce after completing their education make up one source of new workers. A comparison of these two components of supply and demand is presented in Table 5. Those moving to Arizona from other states and nations comprise another source of new workers. These data also are displayed in the table, but are seven years older than the employment and degree data. Data on other types of movement into and out of the workforce are lacking.

The data that are displayed in the table indicate that conditions vary substantially by occupational group. In the education occupations, the number of new degrees is triple the employment change, and net migration also is larger than employment change. These much larger numbers of degrees and net in-migrants than employment change suggest that a substantial number of workers are leaving the education profession, as noted in other studies.

In the healthcare occupations, the number of new degrees in Arizona is far less than the change in the number of jobs. With the annual employment change accelerating since 2000, the net migration of workers in this occupational group likely is currently higher than shown in the table. Still, the figures suggest that employers of health care workers may have a difficult time finding workers, at least in some occupations. As the baby-boom generation reaches retirement age (the oldest members of that group currently are 62 years old), the low production of new health care degrees in Arizona may result in a substantial supply-demand imbalance.

In the science occupational group, the number of degrees exceeds the employment change, and a modest number of migrants also boosts the supply. In reality, the number of new degrees is understated relative to the occupational group employment, since the occupational group includes social sciences, while social science degrees are not counted in the degree totals. It may

be that many individuals obtaining a life or physical science degree go on for additional education instead of entering the workforce, or that many move out of Arizona, or that many take jobs in other occupations.

In the architecture and engineering occupational group, the number of degrees greatly exceeds the employment change. Net migration currently probably is less than during the 1995-to-2000 period since job growth in this occupation has slowed since then.

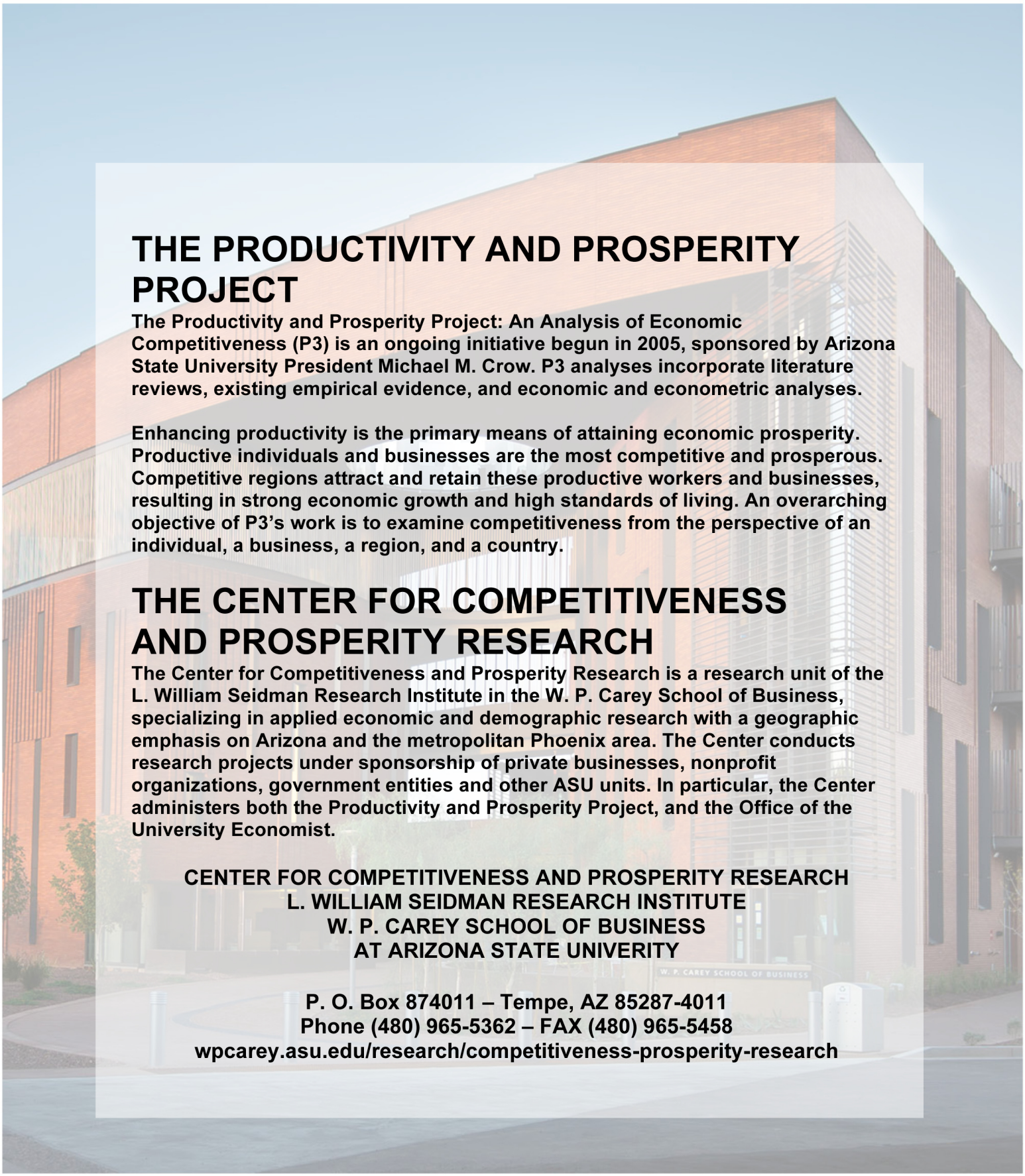
The situation is the opposite in the computer and mathematical group, with the sum of new degrees and net migration well below the employment change. However, many of those working in computer occupations probably have a degree in something other than the NCES category of computer and information sciences and support services; some likely have an engineering degree. Thus, the computer/mathematical and architecture/engineering groups have been combined in the table.

TABLE 5
SUMMARY OF DATA BY OCCUPATIONAL GROUP

Occupational Group	Employment Change	New Degrees	Difference	Net Migration
Combined Computer and Engineering	3,322	2,290	-1,032	2,262
Computer and Mathematical	2,444	512	-1,932	1,031
Architecture and Engineering	878	1,778	900	1,231
Life, Physical, and Social Science	1,216	1,633	417	478
Healthcare Practitioners and Technical	4,902	1,127	-3,775	1,594
Education, Training, and Library	1,704	5,110	3,406	2,383

Notes:
Employment change is the annual average from 2002 through 2007.
New degrees is the annual average of 2003 through 2007.
Net migration is the annual average from 1995 to 2000.

Source: U.S. Department of Labor, Bureau of Labor Statistics; National Center for Education Statistics; U.S. Department of Commerce, Census Bureau, 2000 Census Public Use Microdata Sample.



THE PRODUCTIVITY AND PROSPERITY PROJECT

The Productivity and Prosperity Project: An Analysis of Economic Competitiveness (P3) is an ongoing initiative begun in 2005, sponsored by Arizona State University President Michael M. Crow. P3 analyses incorporate literature reviews, existing empirical evidence, and economic and econometric analyses.

Enhancing productivity is the primary means of attaining economic prosperity. Productive individuals and businesses are the most competitive and prosperous. Competitive regions attract and retain these productive workers and businesses, resulting in strong economic growth and high standards of living. An overarching objective of P3's work is to examine competitiveness from the perspective of an individual, a business, a region, and a country.

THE CENTER FOR COMPETITIVENESS AND PROSPERITY RESEARCH

The Center for Competitiveness and Prosperity Research is a research unit of the L. William Seidman Research Institute in the W. P. Carey School of Business, specializing in applied economic and demographic research with a geographic emphasis on Arizona and the metropolitan Phoenix area. The Center conducts research projects under sponsorship of private businesses, nonprofit organizations, government entities and other ASU units. In particular, the Center administers both the Productivity and Prosperity Project, and the Office of the University Economist.

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