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May 12, 1998

The Honorable John D. Dingell
Ranking Minority Member
Committee on Commerce
House of Representatives

The Honorable George E. Brown, Jr.
Ranking Minority Member
Committee on Science
House of Representatives

Subject: Information Technology Workers: Employment and Starting Salaries

Industry reports and various newspaper and magazine articles predict that severe shortages of information technology (IT) workers could have a crippling effect on the growth of the economy. In conjunction with cosponsoring a convocation on the supply of IT workers, the U.S. Department of Commerce prepared a report intended to bring attention to the issue and to encourage stakeholders to examine the potential for shortages and to take the necessary steps to ensure an adequate supply of IT workers. That report, issued September 29, 1997, is titled America's New Deficit: The Shortage of Information Technology Workers.[1] Our evaluation of the report found that, although the title implied that the Department of Commerce found a shortage of IT workers, data and analysis contained in the report did not support that conclusion.[2] In fact, the report concludes, and we agree, that more information and data are needed to characterize the IT labor market.

To better understand IT labor market conditions, you asked that we provide you with information on recent trends in IT employment and starting salaries for IT jobs. Specifically, you asked us to determine (1) the unemployment rates for workers in IT occupations, (2) the number of workers employed in IT industries and occupations, (3) the number of degrees awarded in IT fields of study, and (4) the starting salaries offered bachelor's degree candidates in IT jobs.

[1]Washington, D.C.: Department of Commerce, Office of Technology Policy.

[2]Information Technology: Assessment of the Department of Commerce's Report on Workforce Demand and Supply (GAO/HEHS-98-106R, Mar. 20, 1998).

To answer these questions, we gathered information from three sources. Information on unemployment rates for IT workers and numbers of workers employed in IT occupations came from the Current Population Survey (CPS) of the Bureau of Labor Statistics (BLS). The number of workers employed by IT companies comes from the Current Employment Statistics (CES) Survey and is compiled by BLS from payroll records reported monthly. Information on the number and types of IT degrees conferred came from the Integrated Postsecondary Education Data System (IPEDS) of the National Center for Education Statistics (NCES). Information on the salaries offered to bachelor's degree candidates was provided by the National Association of Colleges and Employers (NACE). Although we did not independently verify the data, data from these sources are widely used and represent the best data available. Our data sources are described in more detail in enclosure I. We performed our work in April 1998 in accordance with generally accepted government auditing standards.

In summary, unemployment rates for workers in IT occupations are well below those for all workers. At 1.3 percent in 1997, the rate was less than one-third the rate for all workers. Employment in IT industries has grown steadily, as has employment of workers in IT occupations, which has nearly doubled in the last decade to about 1.9 million in 1997. Despite employment increases averaging 90,000 jobs a year in IT occupations, the number of degrees awarded in IT fields of study has remained fairly constant throughout the 1990s at about 48,000 annually—of which about 27,000 were bachelor's degrees. Salary offers for bachelor's degree candidates in IT fields averaged about $37,500 in 1997—slightly higher than the salaries offered in 1989, after adjusting for inflation, and above the salaries offered in the early 1990s, when starting salaries dipped to under $35,000.

Background

Public attention became focused on issues relating to the IT labor market with the publication of a report by the Information Technology Association of America (ITAA) entitled Help Wanted: The IT Workforce Gap at the Dawn of a New Century in February 1997.[3] Responding to this report, the National Economic Council and the Departments of Commerce, Education, and Labor began to discuss the workforce requirements of the IT sector. The Department of Commerce's Office of Technology Policy was assigned the lead federal role in exploring the IT worker issue. The mission of the Office of Technology Policy is to work in

[3]Arlington, Va.: ITAA.

partnership with the private sector to develop and advocate national policies that maximize technology's contribution to U.S. economic growth, the creation of high-wage jobs, and improvements in our quality of life. The Department of Commerce's report, America's New Deficit: The Shortage of Information Technology Workers, examined the potential for shortages of IT workers.

BLS estimates, on the basis of surveys conducted for the Occupational Employment Statistics program and the CPS, that between 1996 and 2006 the United States will require about 1.3 million additional IT workers as a result of job growth and the replacement of workers who leave the field. Although there is no single, universally accepted definition of the occupations that should be designated as IT occupations, we used the occupations for which BLS collects data—computer programmers, systems analysts, computer scientists, and computer engineers[4]—and the widely used IT industry definition—Standard Industry Classification (SIC) 737, computer and data processing services.[5]

Unemployment Rates for IT Workers

Unemployment rates for IT workers are well below the national average for all workers,[6] but changes in these rates closely followed the movements of annual average unemployment rates for all workers from 1987 through 1997.[7] The unemployment rate for IT workers generally increased in the late 1980s, peaking at 3 percent in 1991 and falling to 1.3 percent in 1997. Unemployment for all workers was 2 to 3 times greater than for IT workers, reaching 7.2 percent in 1992 and falling to 4.7 percent in 1997. (See fig. 1.)

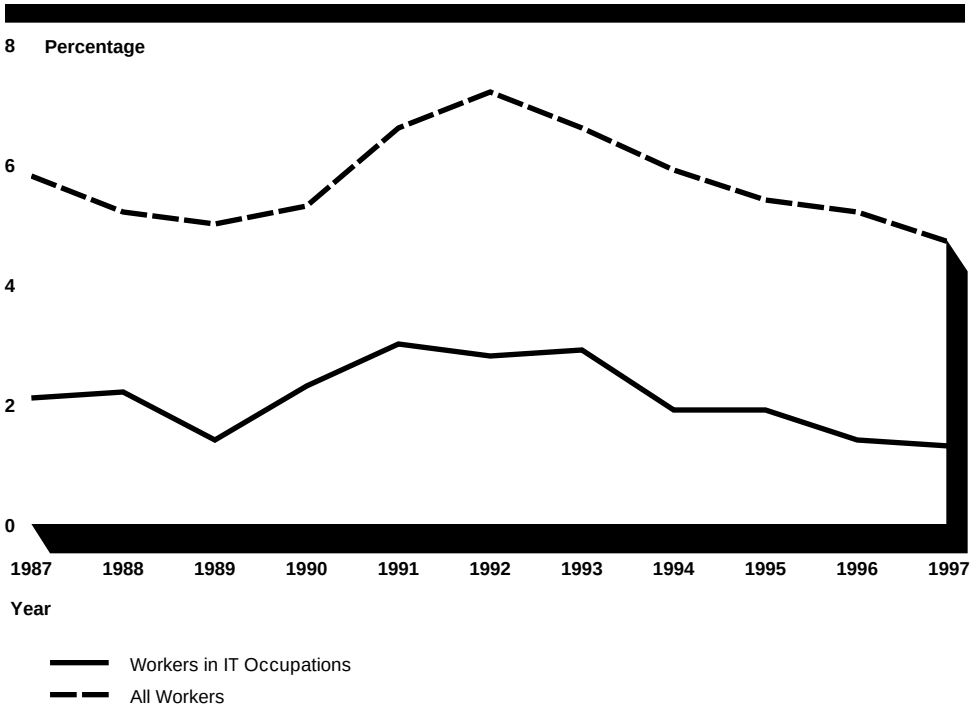
[4]BLS descriptions of these occupations follow: (1) computer programmers write and maintain the detailed instructions, called "programs" or "software," that list in logical order the steps that computers must execute to perform their functions; (2) systems analysts use their knowledge and skills in a problem-solving capacity, implementing the means for computer technology to meet the individual needs of an organization; (3) computer scientists generally design computers and conduct research to improve their design or use and develop and adapt principles for applying computers to new uses; and (4) computer engineers work with the hardware and software aspects of systems design and development.

[5]BLS describes this industry as providing everything related to commercial computer use, from renting and repairing personal computers to designing or installing an entire system; from developing packaged software to writing customized programs; from integrating and reengineering systems to networking and data processing; from managing data bases to operating an entire computer facility.

[6]The unemployment rates for professional specialty occupations are also well below the national average for all workers and follow a pattern similar to those for IT occupations. See encl. II.

[7]Unemployment rates are presented for wage and salary workers. Detailed data tables are presented in encl. II.

Figure 1: Unemployment Rates for Workers in IT and All Occupations, 1987-97

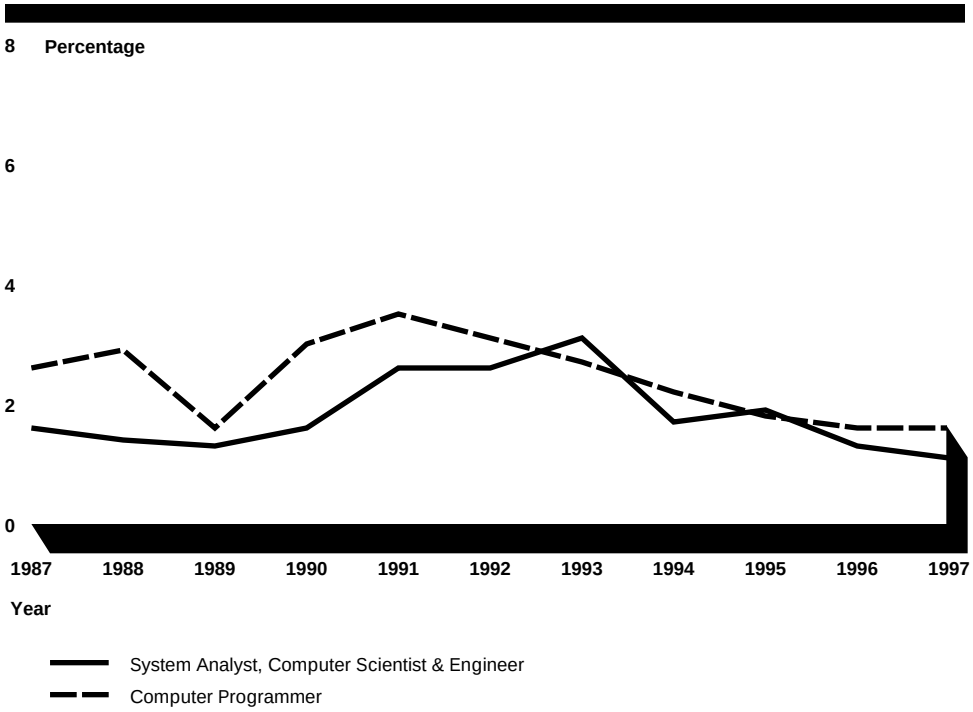


Source: CPS annual average data.

A similar pattern holds for the unemployment rates of the IT occupations—computer programmers and the occupational group of systems analysts, computer scientists, and computer engineers.[8] The unemployment rates of these occupations follow the general movement of the national average—increasing in the 1980s and then falling to a 1997 rate lower than the corresponding 1987 rate. Unemployment rates for systems analysts, computer scientists, and computer engineers nearly doubled, from 1.6 percent in 1987 to 3.1 percent in 1993, but dropped to 1.1 percent by 1997. Unemployment rates for computer programmers were slightly higher at times, increasing from 2.6 percent in 1987 to 3.5 percent in 1991 and falling to 1.6 percent by 1997. (See fig. 2.)

[8]Unemployment rates and employment levels reported for the occupational categories systems analyst, computer scientist, and computer engineer are collected and reported as a group by BLS, unlike computer programmers, whose unemployment rates and employment levels BLS reports separately.

Figure 2: Unemployment Rates for Workers in IT Occupations, 1987-97



Source: CPS annual average data.

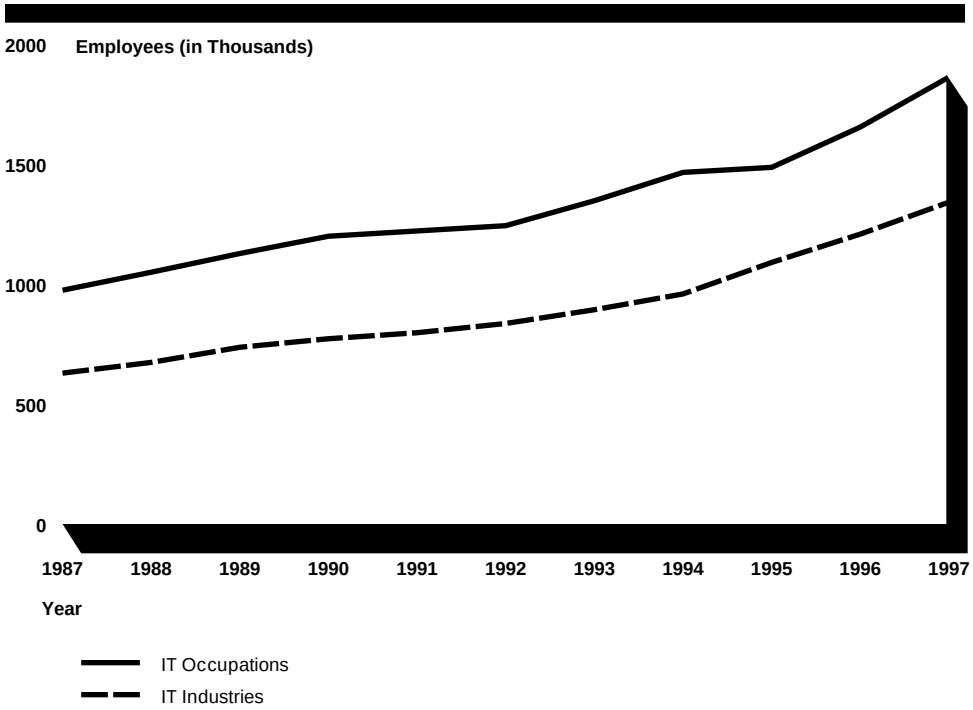
IT Employment

IT-related employment includes workers employed by IT companies (the IT industry) and workers employed in IT occupations. We present information on IT-related employment in two ways. First, we present information on the number of workers employed in the IT industry, whether in IT occupations or in other jobs.[9] Second, we present information on the number of workers employed in IT occupations whether in the IT industry or in other industries.

The number of workers employed in the IT industry grew steadily from 1987 to 1997. Total employment in the IT industry more than doubled from 628,600 in 1987 to 1.34 million in 1997. (See fig. 3.)

[9]We use the IT industry to refer to companies in SIC 737, computer and data processing services, a widely used definition for the IT industry. Industry employment is reported for wage and salary workers.

Figure 3: Employment in IT Industries and Occupations, 1987-97

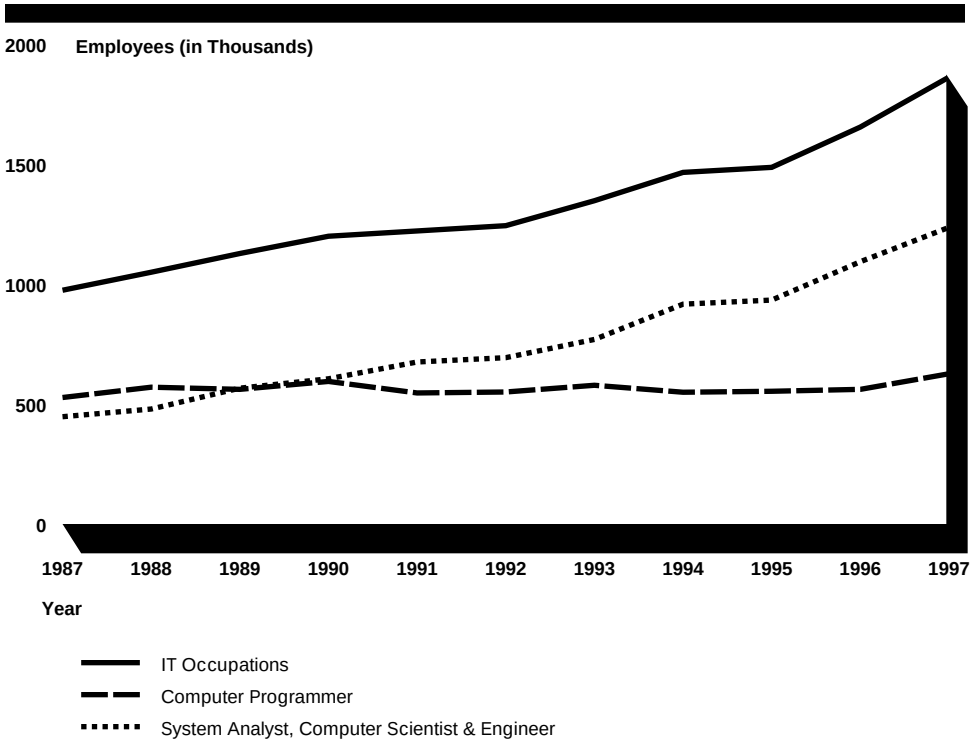


Source: CPS annual average data and CES data.

Similarly, the number of workers employed in IT occupations nearly doubled from 1987 to 1997, when it reached 1.9 million. Employment in IT occupations grew by nearly 90,000 jobs annually from 1987 to 1997.[10] Most of the job growth in IT occupations has been for the occupational categories of systems analyst, computer scientist, and computer engineer. The employment of this group of occupations increased from 447,000 in 1987 to 1.2 million in 1997. The number of computer programmers has changed less drastically, increasing from 527,000 in 1987 to 626,000 in 1997. Although fewer workers were employed as systems analysts, computer scientists, and computer engineers than as computer programmers in 1987, these occupations outnumbered computer programmers by a ratio of 2 to 1 in 1997. (See fig. 4.)

[10]BLS forecasts continued growth in IT occupations, projecting an annual average of 113,000 new jobs in IT occupations between 1996 and 2006.

Figure 4: Employment in IT Occupations, 1987-97

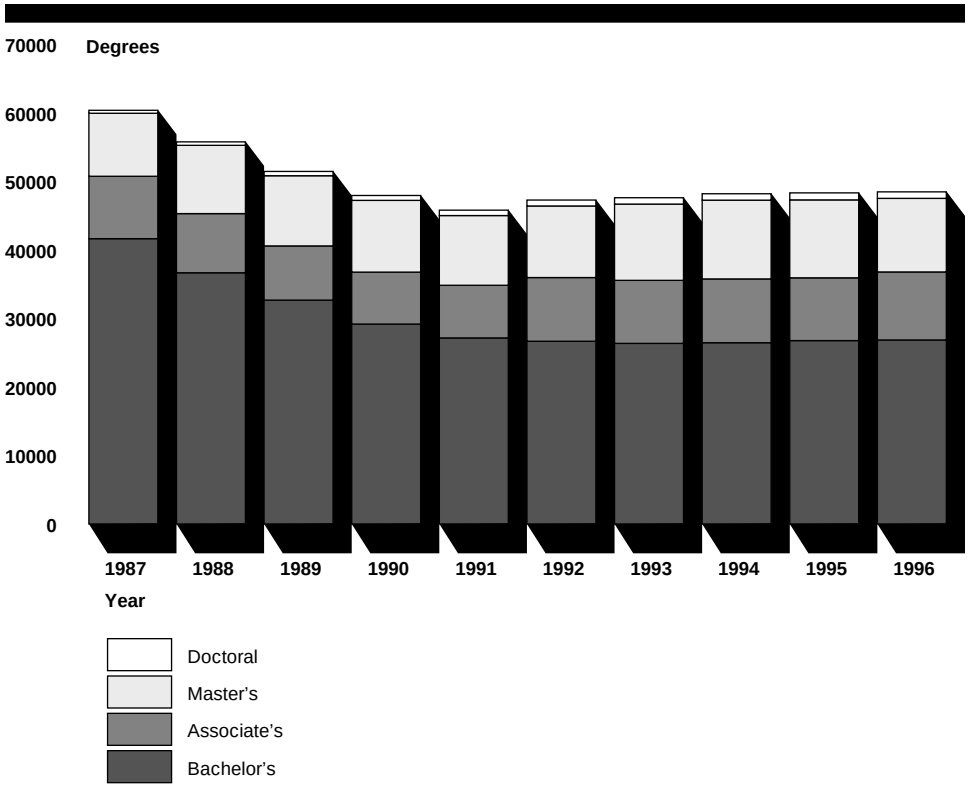


Source: CPS annual average data.

Degrees in IT Fields of Study

The number of degrees awarded in the IT fields of study fell during the late 1980s and remained level or increased slowly in the 1990s. Most of the decline in IT degrees awarded can be attributed to the decline in bachelor's degrees from 41,610 in 1987 to 27,136 in 1991, remaining at roughly that level throughout the 1990s. The number of associate's, master's, and doctoral degrees awarded in IT fields increased slowly over the last 10 years, from a combined total of 18,722 degrees awarded in 1987 to a total of 21,601 degrees awarded in 1996. (See fig. 5.)

Figure 5: Degrees Awarded in IT Fields of Study, 1987-96



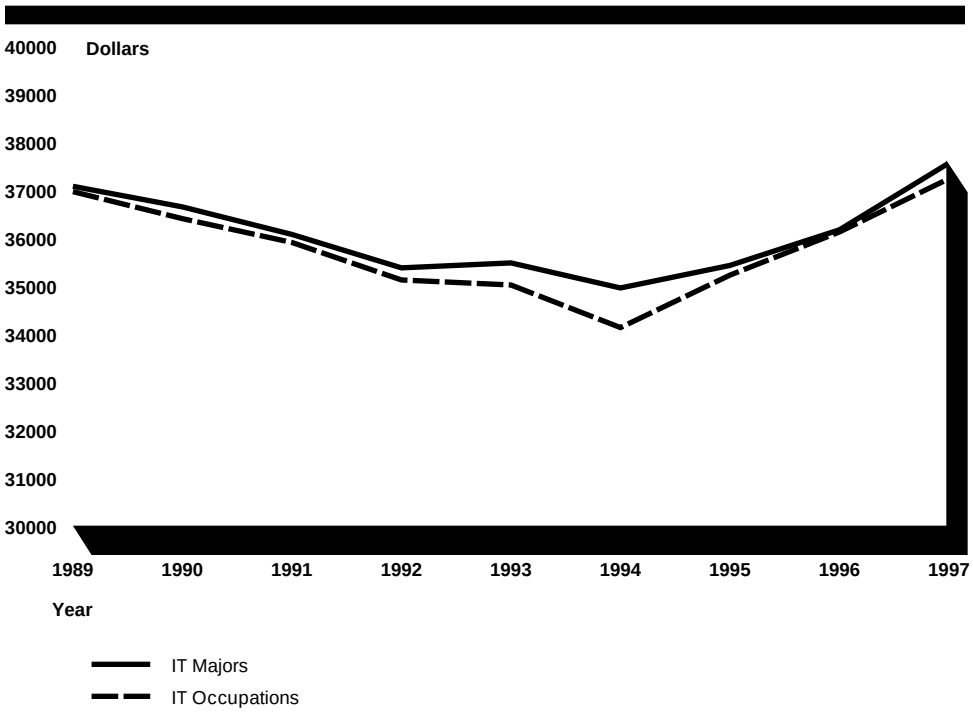
Source: IPEDS data.

Salary Offers in IT Fields

We present information on starting salaries for bachelor's degree candidates in two ways. First, we present information on salaries offered to degree candidates majoring in IT fields of study. This includes bachelor's degrees in computer science, computer programming, information sciences, systems analysis, and computer engineering. Not all starting salaries offered to degree candidates majoring in IT fields are for employment in IT occupations. Second, we present information on salaries offered to degree candidates for employment in IT occupations. These occupations include computer programming, information systems, systems analysis and design, software design and development engineering, and hardware design and development engineering. Not all starting salaries offered to degree candidates for employment in IT occupations are for degree candidates majoring in IT fields.

Generally, salaries offered to degree candidates majoring in IT fields of study decreased in real terms (constant 1997 dollars) from 1989 to 1994 and then increased by 1997 to a level slightly above the 1989 average (see fig. 6). Salary offers to IT majors decreased from $37,000 in 1989 to $35,000 in 1994 and increased to $37,500 by 1997.[11]

Figure 6: Salary Offers to Bachelor's Degree Candidates in IT-Related Fields, 1989-97



Note: Salaries are expressed in constant 1997 dollars.

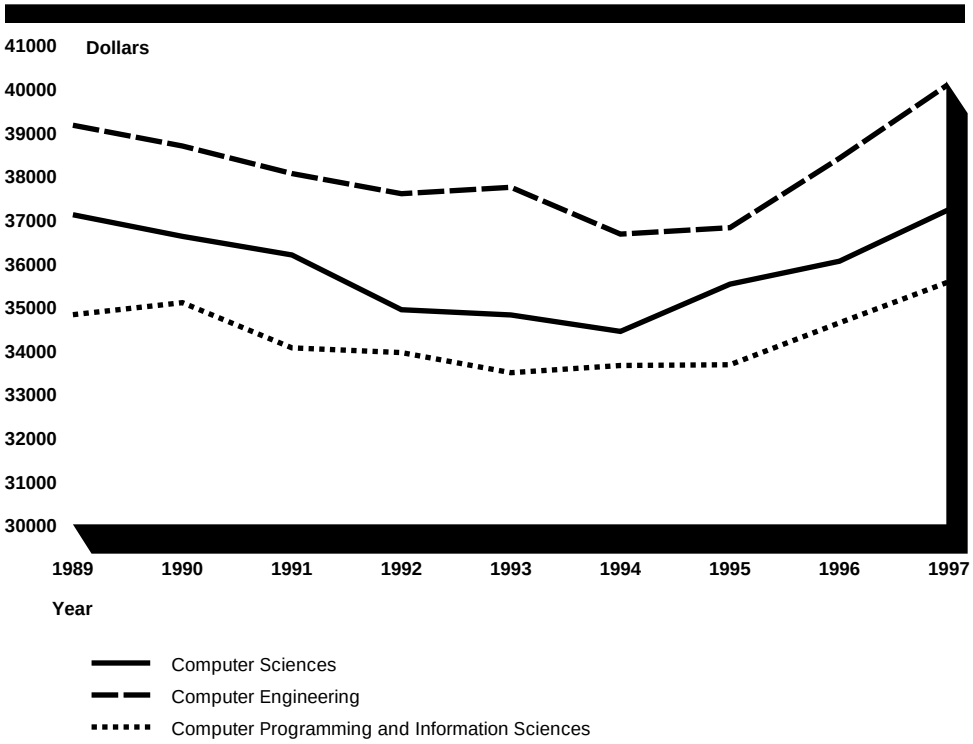
Source: NACE data.

Among students majoring in IT fields of study there were clear distinctions as to which majors received higher starting salary offers. Computer engineering students received the highest salary offers—over $40,000 in 1997. The lowest average salaries among IT majors were offered to students majoring in computer programming and information

[11]The salaries offered to IT majors in fig. 6 represent an average of the salary offers for bachelor's degree candidates in computer science, computer programming, information sciences, systems analysis, and computer engineering. The salary offers for each IT field of study are presented in encl. II.

sciences—roughly $35,600 in 1997.[12] Computer sciences majors received salary offers consistently between those of computer engineers and programmers—about $37,200 in 1997. (See fig. 7.)

Figure 7: Salary Offers to Bachelor's Degree Candidates for Selected IT Fields of Study, 1989-97



Note: Salaries are expressed in constant 1997 dollars.

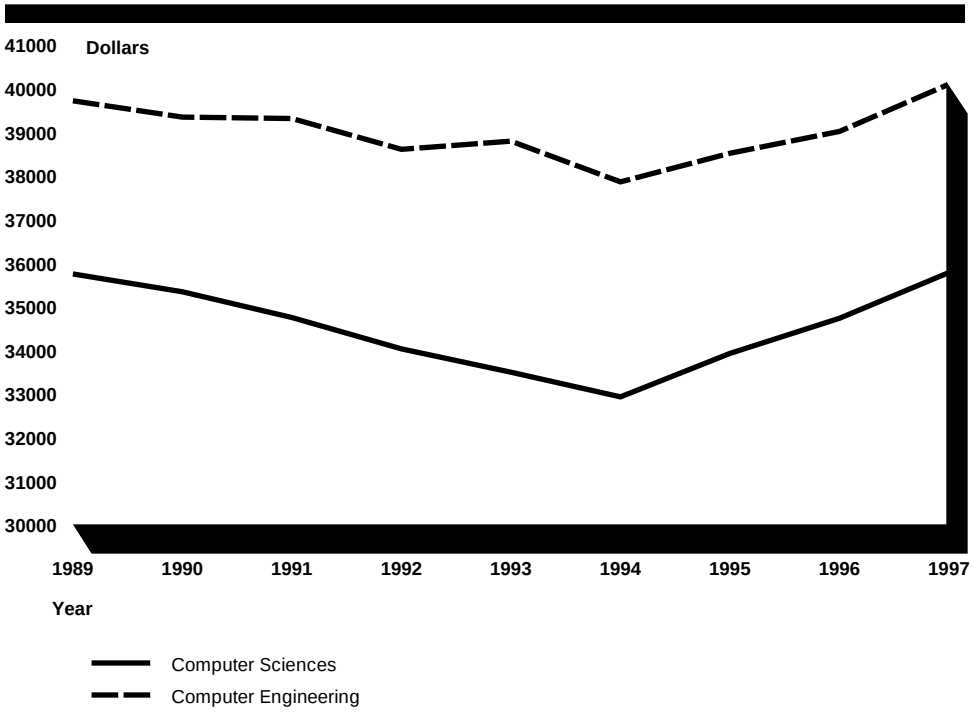
Source: NACE data.

Salaries offered to bachelor's degree candidates for employment in IT occupations, regardless of major, decreased in real terms (constant 1997 dollars) from 1989 to 1994, increasing in 1997 to a level slightly above the 1989 average. Offers for IT jobs to recent graduates, regardless of their field of study, decreased from $37,000 in 1989 to $34,100 in 1994 and

[12]The salary offers reported for computer programming and information sciences represent an average of the salaries offered to each major. The separate salary offers are reported in encl. II.

increased to $37,200 by 1997.[13] Regardless of major, graduates with computer engineering job offers received the highest IT salary offers—over $40,000 in 1997. (See fig. 8.)

Figure 8: Salary Offers to Bachelor's Degree Candidates for Selected IT Occupations, 1989-97



Notes: "Computer sciences" combines salary offers for jobs in computer programming, information systems, and systems analysis and design. "Computer engineering" combines salary offers for jobs in design and development for both hardware and software.

Salaries are expressed in constant 1997 dollars.

Source: NACE data.

[13]The salaries offered to degree candidates for employment in IT occupations reported in fig. 6 represent an average of the salaries offered to degree candidates for employment in computer programming, information systems, systems analysis and design, software design and development engineering, and hardware design and development engineering. Salaries for the separate fields are presented in encl. II.

As agreed with your offices, unless you publicly announce its contents earlier, we plan no further distribution of this correspondence until 7 days from its issue date. At that time, we will send copies to the Chairmen, House Committees on Commerce and Science. Copies will also be made available to others upon request.

If you have any questions about this correspondence, please contact me at (202) 512-7014. Staff who made major contributions to this work include Sigurd R. Nilsen, Assistant Director, and Gene Kuehneman, Senior Economist.

Carlotta C. Joyner
Director, Education and
Employment Issues

Enclosures - 2

Data Sources

We used data from three sources in this correspondence. Information on unemployment rates and numbers of workers employed came from the Bureau of Labor Statistics (BLS). Information on the number and types of degrees conferred came from the Integrated Postsecondary Education Data System (IPEDS) of the National Center for Education Statistics (NCES). Information on the salaries offered to bachelor's degree candidates was provided by the National Association of Colleges and Employers (NACE). Although we did not independently verify the data, data from these sources are widely used and represent the best data available. We discuss the data quality for each source separately below.

BLS Employment Data

Data on unemployment rates and employment by occupation were obtained from BLS annual average tables for the Current Population Survey (CPS), a program of personal interviews conducted monthly by the Bureau of the Census for BLS. The CPS is a nationally representative survey used officially for the purpose of computing unemployment rates. The sample consists of about 50,000 households selected to represent the U.S. population 16 years of age and older. Employment numbers and unemployment rates for computer occupations are calculated by BLS using the annual averages of monthly CPS.

Current Employment Statistics (CES) Survey data on employment for information technologies (IT) industries come from payroll records and are reported monthly to BLS and its cooperating state agencies by nearly 400,000 establishments representing all industries except agriculture. Self-employed people and others not on a regular civilian payroll are not included. IT industries used throughout this report are those in Standard Industrial Classification (SIC) 737, computer and data processing services.

IPEDS Degree Data

NCES has established IPEDS as its core postsecondary data collection program. IPEDS is a single comprehensive system that encompasses all identified postsecondary educational institutions. IPEDS is designed to produce national-, state-, and institution-level data for most postsecondary institutions. NCES collects information on degrees conferred through the IPEDS "Completions" survey. Data are collected from approximately 11,000 postsecondary institutions on the numbers of associate's, bachelor's, master's, and other formal degrees awarded by field of study. In our report, IT fields of study include computer engineering; computer and information sciences, general; computer programming; data processing

technology/technician; information science and systems; computer systems analysis; and other computer and information sciences.

NACE Salary Data

NACE is a national clearinghouse and publisher of information on the career planning and employment of the college-educated workforce. NACE members include human resources/staffing practitioners who hire college graduates and career services practitioners at colleges and universities nationwide. NACE reports salary offers for bachelor's degree candidates separately by field of study and by occupation of job offered. The salary information is compiled using reports from the career planning and placement offices of colleges and universities across the country.[14] NACE does not conduct a survey; placement offices report information on salary offers to NACE on a purely voluntary basis. The offers reported by NACE are described as "a representative sample of actual job offers made to new college graduates during the recruiting year and do not imply all job offers made to all college graduates." Salaries reported do not include any bonuses, fringe benefits, or overtime rates. The most widely used source of such information, NACE is used by colleges, employers, and government agencies.

For school years 1988-89 through 1996-97, NACE collected and reported on salary offers to degree candidates studying computer engineering, computer science, computer programming, information sciences and systems, and systems analysis. For the same period, NACE also collected and reported salary offers for the occupations software design and development engineer, hardware design and development engineer, computer programmer, information systems worker, and systems analyst and designer. We report the salary information for offers made during school years 1988-89 through 1996-97.

[14]The number of participating placement offices varies from year to year and ranged from 343 to 450 from 1989 to 1997.

Data for Figures in This Correspondence

Table II.1: Unemployment Rates for Workers in IT and Other Occupations, 1987-97

Year	Workers in IT occupations	Professional specialty occupations	All workers
1987	2.1%	2.1%	5.8%
1988	2.2	1.8	5.2
1989	1.4	1.8	5.0
1990	2.3	2.0	5.3
1991	3.0	2.5	6.6
1992	2.8	2.7	7.2
1993	2.9	2.7	6.6
1994	1.9	2.5	5.9
1995	1.9	2.5	5.4
1996	1.4	2.3	5.2
1997	1.3	2.1	4.7

Source: CPS annual average data.

Table II.2: Figure 2—Unemployment Rates for Workers in IT Occupations, 1987-97

Year	Systems analysts, computer scientists, and computer engineers	Computer programmers
1987	1.6%	2.6%
1988	1.4	2.9
1989	1.3	1.6
1990	1.6	3.0
1991	2.6	3.5
1992	2.6	3.1
1993	3.1	2.7
1994	1.7	2.2
1995	1.9	1.8
1996	1.3	1.6
1997	1.1	1.6

Source: CPS annual average data.

Table II.3: Figure 3—Employment in IT Industries and Occupations, 1987-97

Year	IT industries	IT occupations
1987	628,600	974,000
1988	673,300	1,049,000
1989	736,300	1,127,000
1990	771,900	1,199,000
1991	797,000	1,221,000
1992	835,500	1,243,000
1993	892,800	1,347,000
1994	958,600	1,465,000
1995	1,089,000	1,486,000
1996	1,207,900	1,654,000
1997	1,341,000[a]	1,862,000

[a]Preliminary data.

Sources: CPS annual average data and CES data.

Table II.4: Figure 4—Employment in IT Occupations, 1987-97

Year	Systems analysts, computer scientists, and computer engineers	Computer programmers	IT occupations
1987	447,000	527,000	974,000
1988	479,000	570,000	1,049,000
1989	566,000	561,000	1,127,000
1990	605,000	594,000	1,199,000
1991	675,000	546,000	1,221,000
1992	693,000	550,000	1,243,000
1993	769,000	578,000	1,347,000
1994	916,000	549,000	1,465,000
1995	933,000	553,000	1,486,000
1996	1,093,000	561,000	1,654,000
1997	1,236,000	626,000	1,862,000

Source: CPS annual average data.

Table II.5: Figure 5—Degrees Awarded in IT Fields of Study, 1987-96

	Degree			
Year	Associate's	Bachelor's	Master's	Doctoral
1987	9,101	41,610	9,190	431
1988	8,628	36,638	9,957	505
1989	7,900	32,652	10,237	625
1990	7,574	29,160	10,460	713
1991	7,677	27,136	10,168	787
1992	9,290	26,650	10,438	863
1993	9,196	26,338	11,118	928
1994	9,301	26,437	11,487	933
1995	9,152	26,749	11,366	1,024
1996	9,922[a]	26,837[a]	10,729[a]	950[a]

[a]Preliminary data.

Source: IPEDS data.

Table II.6: Figure 6—Salary Offers to Bachelor's Degree Candidates in IT-Related Fields, 1989-97

Year	IT majors (any occupation)	IT occupations (any major)
1989	$37,070	$36,959
1990	36,641	36,396
1991	36,067	35,900
1992	35,371	35,119
1993	35,474	35,014
1994	34,952	34,127
1995	35,422	35,220
1996	36,164	36,119
1997	37,556	37,231

Note: Salaries are expressed in constant 1997 dollars.

Source: NACE data.

Table II.7: Figure 7—Salary Offers to Bachelor's Degree Candidates for Selected IT Fields of Study, 1989-97

Year	Computer sciences	Computer engineering	Computer programming and information sciences
1989	$37,095	$39,146	$34,804
1990	36,599	38,670	35,080
1991	36,173	38,039	34,044
1992	34,918	37,577	33,936
1993	34,798	37,724	33,475
1994	34,421	36,651	33,640
1995	35,504	36,798	33,657
1996	36,030	38,390	34,619
1997	37,215	40,093	35,560

Note: Salaries are expressed in constant 1997 dollars.

Source: NACE data.

Table II.8: Figure 8—Salary Offers to Bachelor's Degree Candidates for Selected IT Occupations, 1989-97

Year	Computer sciences	Computer engineering
1989	$35,738	$39,706
1990	35,329	39,332
1991	34,739	39,300
1992	34,021	38,594
1993	33,486	38,781
1994	32,921	37,848
1995	33,917	38,504
1996	34,722	39,004
1997	35,771	40,087

Note: Salaries are expressed in constant 1997 dollars.

Source: NACE data.

Table II.9: Salary Offers to Bachelor's Degree Candidates by IT Field of Study, 1989-97

Year	Computer sciences	Computer programming	Information sciences	Systems analysis	Computer engineering
1989	$37,095	$36,651	$34,207	$37,320	$39,146
1990	36,599	34,658	35,159	37,523	38,670
1991	36,173	31,948	34,431	32,431	38,039
1992	34,918	35,332	33,164	34,220	37,577
1993	34,798	35,098	33,014	35,247	37,724
1994	34,421	33,930	33,546	35,975	36,651
1995	35,504	33,642	33,659	35,070	36,798
1996	36,030	33,293	34,788	35,874	38,390
1997	37,215	35,298	35,572	41,833	40,093

Note: Salaries are expressed in constant 1997 dollars.

Source: NACE data.

Table II.10: Salary Offers to Bachelor's Degree Candidates by IT Occupation, 1989-97

Year	Computer programming	Information systems	Systems analysis	Software design and development	Hardware design and development
1989	$35,671	$34,645	$36,657	$39,526	$39,980
1990	35,107	34,706	36,274	39,053	39,668
1991	33,894	35,046	35,873	38,519	40,223
1992	33,553	33,369	35,386	38,364	39,019
1993	32,813	33,574	34,606	38,016	39,813
1994	32,853	32,102	33,638	37,530	38,495
1995	33,784	33,708	34,352	38,068	39,448
1996	34,372	34,701	35,471	38,372	40,715
1997	35,597	35,196	36,597	39,630	41,081

Note: Salaries are expressed in constant 1997 dollars.

Source: NACE data.

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