CHAPTER II:

INFORMATION TECHNOLOGY WORKERS IN THE DIGITAL ECONOMY

By Sandra D. Cooke*

The rapid diffusion of information and communications technologies throughout the U.S. economy and globally during the 1990s led to unprecedented demand for information technology (IT) workers. From 1993 to 2000, employment in IT-producing industries grew more than twice as fast as employment in all private industries and added over 1.8 million jobs. But, since 2000, this trend has reversed. During the 2000–2002 period, IT-producing industries lost over 600,000 jobs.

In recent years, the IT workforce has endured a number of events that have negatively affected the demand for IT workers. The recession of 2001 and subsequent slow recovery have depressed demand for workers in IT industries and IT-related occupations. However, foreign outsourcing of IT jobs and labor saving productivity improvements are among other factors that have contributed to a weak job market for IT workers.

This chapter begins with a section that profiles employment in IT-producing industries and then compares trends in employment and wages during the 1993 to 2000 period with the past two years (2001 and 2002) when IT-producing industry employment declined. The next section examines trends in IT occupational employment and wages according to education and training requirements. The remainder of the chapter discusses the factors that have contributed to recent declining demand for IT workers.

IT-Producing Industries

IT workers develop, design, manufacture, operate, repair and maintain the IT infrastructure that supports e-commerce, the Internet or network-related activities, and IT-enabled processes throughout businesses and organizations. IT-producing industries consist of four major

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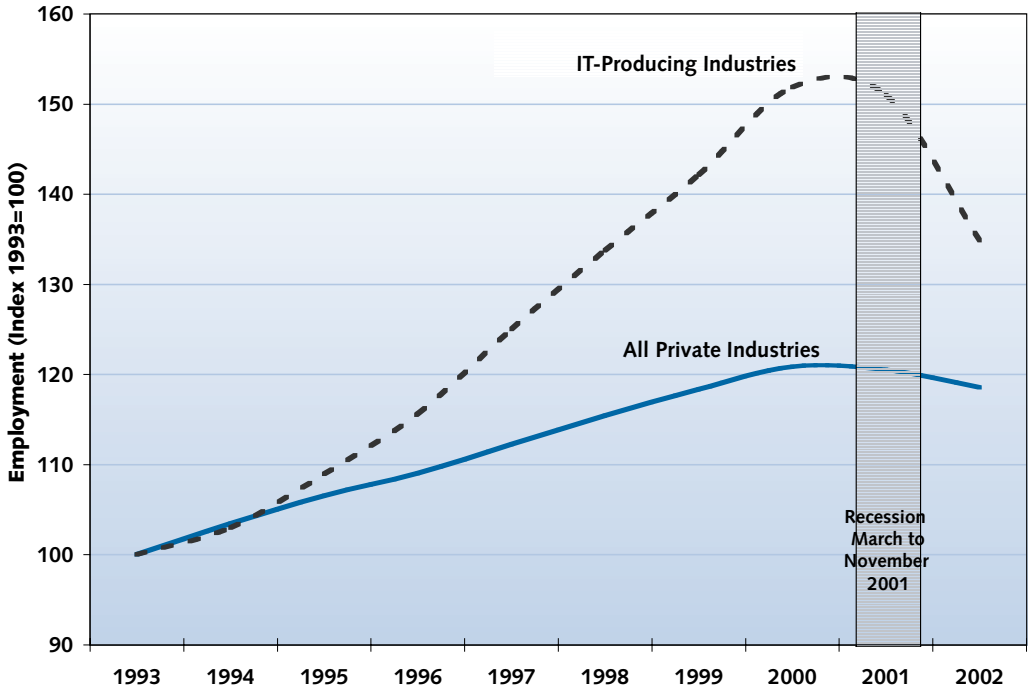
segments: computer hardware, software and computer services, communications equipment, and communications services. (See Box A-2.1 in the appendix to this chapter for a list of IT-producing industries.)[1] Workers in IT-producing industries cover a broad range of occupations (e.g., management, production, and administrative occupations in addition to IT-related occupations).

IT-PRODUCING INDUSTRIES EXPERIENCE MAJOR JOB LOSSES

After several years of unprecedented job creation, employment in IT-producing industries has fallen sharply. From 1993 to 2000, employment in IT-producing industries grew more than twice as fast as employment in all private industries (annually 6.2 percent and 3.2 percent respectively). (Figure 2.1A) Over the period, IT-producing industries added over 1.8 million jobs. (Figure 2.1B) But, since 2000, employment in IT-producing industries has fallen more than six times faster than all private industries. Between 2000 and 2002, IT-producing industries lost over 600,000 jobs, about one-fourth of the total private industry jobs lost over the same period. (Table 2.1)

Figure 2.1.A. Index of Changes in Industry Employment: IT-Producing Industries and All Private Industries

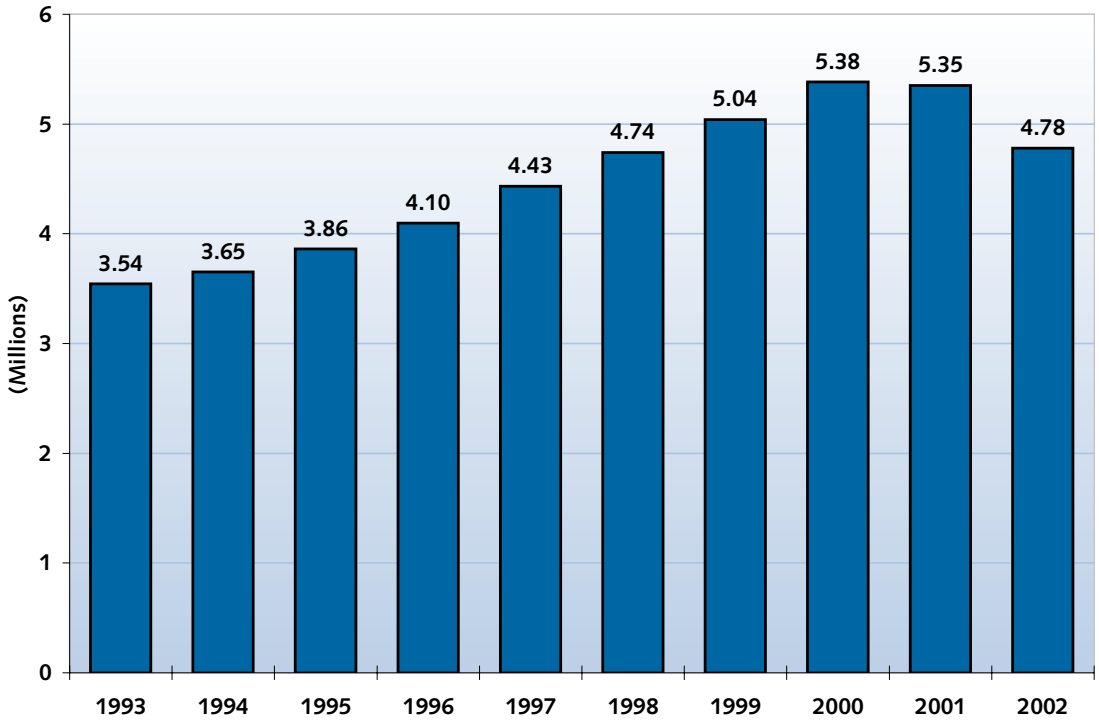


Source: Estimates derived from BLS data.

[1] IT-producing industries referenced in this Chapter do not exactly match those in Chapter 1. Chapter 1 uses Census Bureau data based on the 1997 North American Industrial Classification System (NAICS) and this chapter uses Bureau of Labor Statistics (BLS) data based on the 2002 NAICS. See the Appendix at the end of this chapter for additional information.

IT-producing industry employment increased from 3.5 million workers in 1993 to a peak of 5.4 million in 2000 and then fell to 4.8 million in 2002. Until 2000, IT-producing industry employment was characterized by "churning," meaning that most sub-industries especially in IT services industries gained jobs while many IT manufacturing sub-industries lost jobs. However, during the most recent period, job losses have occurred across the board. Figure 2.2 shows that, from 1993 to 2002, IT services employment outpaced IT manufacturing employment growth, but, since 2000, both IT manufacturing and IT services industries have been rapidly shedding jobs.

Figure 2.1.B. IT-Producing Industry Employment Levels (1993 to 2002)

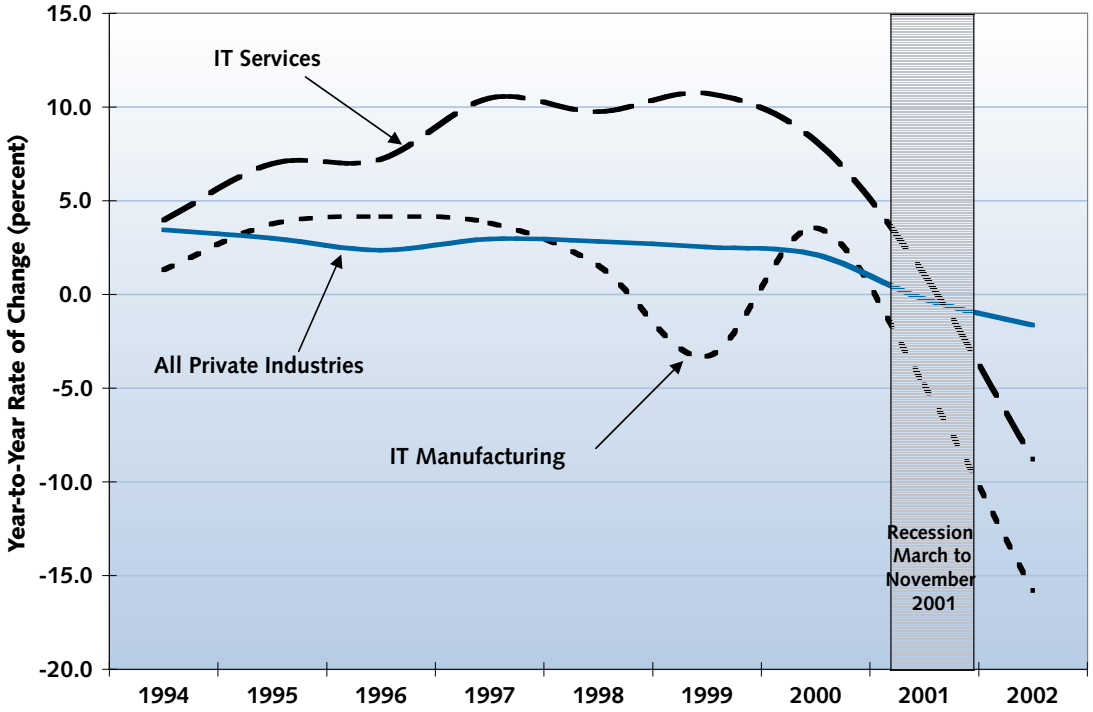


Source: Estimates derived from BLS data.

Employment in IT manufacturing industries declined from 1998 to 1999 because of declining exports to countries affected by the Asian financial crisis, but quickly rebounded in 2000. As recently as mid-2001, while the economy at large had started shedding jobs, many IT services industries were still adding jobs. However, in 2002, almost all IT-producing industries lost jobs.[2] From 2001 to 2002, employment declined 8.8 percent for IT services and 15.8 percent for

[2] See Appendix Table 2.1 in *Digital Economy 2003 Technical Appendices* for a complete list of employment in IT services and IT manufacturing industries. (http://www.esa.doc.gov/reports.cfm)

Figure 2.2. IT-Services and IT-Manufacturing Employment Year-to-Year Rates of Change



Source: Estimates derived from BLS data.

IT manufacturing industries, much faster than the 1.6 percent average rate of job loss for all private industries. Some individual industries have seen employment fall by more than 20 percent in one year. These industries include telephone apparatus, electrical capacitors, bare printed circuits, electrical components, and fiber optic cable manufacturing. The only IT-producing industries that added jobs in 2002 were satellite and related telecommunications and office machine rental and leasing, two relatively small industries.

At a more disaggregated level, we find similar trends. Of all IT-producing industries, software and services industry employment grew the fastest over the 1993 to 2000 period, (more than 12 percent per year), adding over 1 million jobs. Since 2000, this IT group has lost 166,000 jobs.[3] (Table 2.1.) Communications services, fueled by growth in Internet, fax, pager, and cell phone use, grew at 4 percent per year from 1993 to 2000. Expectations of future high demand led to rapid investment in fiber optic networks and equipment during the 1990s. By 2002, excess capacity without the expected demand led to increased competition and industry consolidation. As a result, the communications services industry has eliminated almost 60,000 jobs since 2000.[4] Employment of both computer equipment and communications equipment workers grew

[3] See Appendix Table 2.2 in *Digital Economy 2003 Technical Appendices* for a complete list of employment in IT-producing industry groupings. (http://www.esa.doc.gov/reports.cfm)

[4] Terence M. McMenamin, Rachel Krantz, and Thomas J. Krolik, "U.S. Labor Market in 2002: Continued Weakness," *Monthly Labor Review.* February 2003: 6.

over the earlier period, but started to decline before the two IT services groups. In 2002, computer and related exports slowed and the communications equipment industry continued to suffer from excess capacity.

Table 2.1. IT-Producing Industry Employment By Major IT Sector

Major IT Sectors[1]	Employment (000s)				Average Annual Rate of Change (%)		
	1993	2000	2001	2002	93-00	00-01	01-02
Computer Hardware	1,357.2	1,679.6	1,596.4	1,376.4	3.1	–5.0	–13.8
Software and Computer Services	951.9	2,127.5	2,160.8	1,961.0	12.2	1.6	–9.2
Communications Equipment	283.3	322.0	301.5	248.4	1.8	–6.4	–17.6
Communications Services	951.4	1,252.5	1,291.8	1,193.1	4.0	3.1	–7.6
All IT-Producing Industries	3,543.8	5,381.6	5,350.4	4,779.0	6.2	–0.6	–10.7
All Private Industries	91,855.0	110,996.0	110,707.0	108,886.0	2.7	–0.3	–1.6

Note: [1]Based on 2002 NAICS.

Source: Estimates derived from BLS data.

IT-PRODUCING INDUSTRY WAGES DECLINE SLIGHTLY

In 2002, the average annual wage for workers in IT-producing industries was $67,440, down 1.3 percent from the average of $68,330 for 2001. In contrast, the average annual wage for all private workers increased 1 percent to $36,520 in 2002.[5] One explanation for the much higher than average wages in IT-producing industries relative to all private industries is that most IT jobs tend to be high skilled, high wage jobs as explained in the next section.

In 2002, software publishing and software reproducing ranked among the IT-producing industries with the highest annual wages, ($99,440 and $92,260, respectively).[6] Reflecting the dot com shakeout, workers in the Internet service provider and web search portal industry saw annual wages decline by 16.6 percent.

[5] Previous analyses showed that the gap between IT-producing industry wages and the average for private industries has widened over time. See for example, Figure 5.3 on page 43 of *Digital Economy 2002*. (http://www.esa.doc.gov/pdf/DE2002_CH5.pdf) NAICS-based industry wages are only available for 2001 and 2002.

[6] See Appendix Table 2.3 in *Digital Economy 2003 Technical Appendices* for the complete ranking of IT-producing industries. (http://www.esa.doc.gov/reports.cfm)

IT-Related Occupations

Workers in IT-related occupations develop, design, manufacture, operate, maintain, and repair IT products and provide related services across all industries, including IT-producing industries. For example, network administrators work in education, health, legal, engineering and government services industries as well as in IT-producing industries. Our definition is broader than other definitions of IT-related occupations and includes workers in occupations that build, maintain, and repair the IT infrastructure such as telecommunications and computer equipment operators, repairers, and installers as described in Box 2.1.

Box 2.1. IT-Related Occupations

Skill Level: High

Computer and information systems managers

Engineering managers

Computer and information scientists, research

Computer programmers

Computer software engineers, applications

Computer software engineers, systems software

Computer support specialists

Computer systems analysts

Database administrators

Network and computer systems administrators

Network systems and data communications analysts

Computer hardware engineers

Electrical engineers

Electronics engineers, except computer

Electrical and electronic engineering technicians

Skill Level: Moderate

Data entry keyers

Computer, automated teller, and office machine repairers

Telecommunications equipment installers and repairers, exc. line installers

Electrical and electronics repairers, commercial and industrial equipment

Electrical power-line installers and repairers

Telecommunications line installers and repairers

Electrical and electronic equiptment assemblers

Electromechanical equipment assemblers

Semiconductor processors

Skill Level: Low

Communications equipment operators

Billing and posting clerks and machine operators

Computer operators

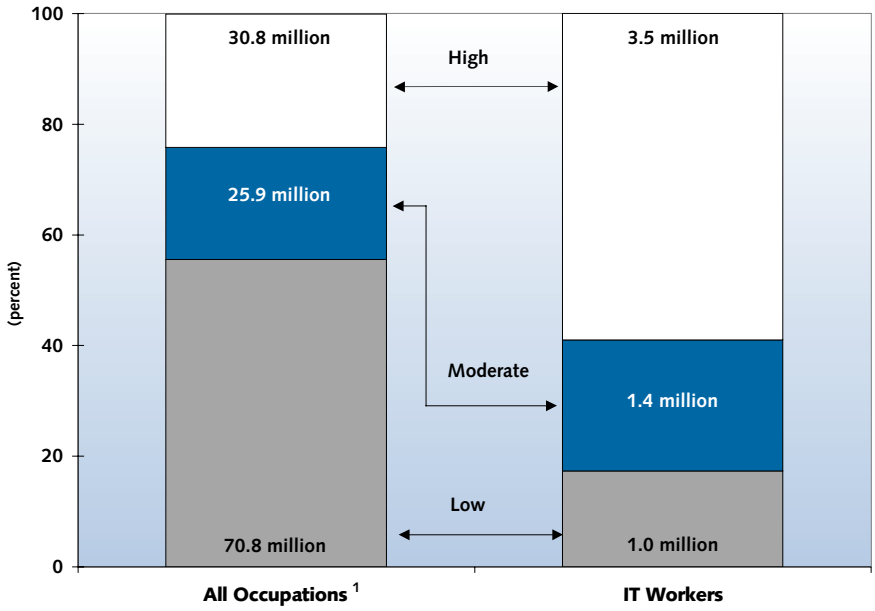
Other office machine operators, exc. computer

IT OCCUPATIONAL EMPLOYMENT IS ALSO DECLINING

As in IT-producing industries, job losses in IT-related occupations began after 2000. In 2002, workers in IT-related occupations totaled 5.9 million, roughly 3.2 percent (197,000) fewer than in 2001. Most IT jobs are highly skilled; i.e., occupations that require formal education and training and/or work experience. For the nation as a whole, the opposite is true. Proportionately more workers fall into the low-skilled category that requires much less formal education and training. (Figure 2.3) Education and training requirements for IT occupations have increased over time, as they have for the workforce at large. In contrast to past years when IT job losses were concentrated in low-skilled categories, since 2000, IT occupations have experienced job losses across all skill levels.

More than half of the jobs in IT-related occupations (3.5 million) require an associate degree or higher.[7] (Table 2.2)[8] Occupations in the high educational and training category include computer engineers, systems analysts, programmers and support specialists. From 1999 to 2000, all high skilled occupations gained jobs except engineering managers and computer and information scientists in research. After 2000, all high skilled occupations lost jobs except

Figure 2.3. IT Occupational Employment, by Education and Training Requirement, 2002



Education and Training Category:

HIGH: Associate degree or higher
MODERATE: Long-term on-the-job training (OJT), related work experience, or post secondary vocational training
LOW: Short- to moderate-term OJT

[1]Estimate based on 2000 employment distribution.

Source: Estimates derived from BLS data.

[7] The grouping of the nine official BLS education and training categories into High, Moderate, and Low reflects the author's interpretation of training intensity of IT-related occupations and therefore, are not official BLS estimates.

[8] Analysis is limited to four years (1999–2002) because of recent changes to the occupational classification system.

network systems and data communications analysts and computer hardware engineers. The high skilled group as a whole accounted for almost half of the 516,000 IT-related jobs lost since 2000.[9]

IT workers that fall into the moderate education and training category generally require long-term on-the-job training, related work experience, or post secondary vocational training. Moderately skilled IT workers totaled 1.4 million in 2002 and included such occupations as telecommunications and electronic equipment installers and repairers. Although this group accounts for only a fourth of all IT workers, from 1999 to 2002, it suffered more than a third of the total IT occupational job losses. Semiconductor processors, data entry keyers and electronic equipment assemblers led the job losses in this group.

Table 2.2. IT Occupational Employment by Education and Training Requirement 1999 to 2002

Education and Training Category[1]	Employment (000s)				Average Annual Rate of Change (%)		
	1999	2000	2001	2002	99-00	00-01	01-02
High	3,434.7	3,763.0	3,595.0	3,512.5	9.6	–4.5	–2.3
Moderate	1,652.0	1,646.7	1,522.2	1,410.7	–0.3	–7.6	–7.3
Low	1,150.8	1,060.1	1,034.0	1,030.3	–7.9	–2.5	–0.4
IT-related occupations	6,237.5	6,469.9	6,151.2	5,953.5	3.7	–4.9	–3.2
All occupations	127,274.0	129,739.0	127,980.4	127,523.7	1.9	–1.4	–0.4

Notes: [1]HIGH: Associate degree or higher;
MODERATE: Long-term on-the-job training (OJT), related work experience or post secondary vocational training
LOW: Short- to moderate-term OJT

Source: Estimates derived from BLS data.

Low skilled IT jobs such as communications equipment operators and billing and posting machine operators, require only short- or moderate-term job training. This group lost the fewest jobs during 2000–2002 mainly because low skilled jobs have been declining over time. IT jobs requiring little training are more apt to be replaced by technology. For example, voice recognition technology and on-line telephone directories likely have reduced the need for telephone operators and directory assistants. Similarly, sophisticated billing and sales tracking software can eliminate some functions performed by billing and posting clerks.

[9] See Appendix Table 2.4 in *Digital Economy 2003 Technical Appendices* for a complete list of IT occupational employment and Appendix Table 2.6 for a description of duties of each IT-related occupation. (http://www.esa.doc.gov/reports.cfm)

Despite high requirements for formal education and training for IT occupations, a recent study by the Commerce Department's Technology Administration found that formal education in an IT field only provides part of what employers seem to be requiring.[10] In addition to formal education, employers are seeking IT workers with specific technical skills, certifications, work experience and soft skills such as interpersonal or business skills. This is evident in an emerging IT occupation called the "IT business technologist or IT business analyst," which requires technical, business, and communication skills. A worker in this occupation would serve as a liaison between non-IT workers who have a business problem and the IT department, which is charged with solving the problem.[11]

OCCUPATIONAL WAGE GROWTH HAS SLOWED

Earnings of IT workers vary based on their skills and educational levels. For specific occupations, we find that in 2002, average earnings ranged from $95,740 for highly skilled engineering managers, who typically have a bachelor's degree plus experience, to $23,220 for communications equipment operators, positions that require little formal training.[12] Although wages continue to increase, the rate of growth slowed starting in 1999 for most IT occupations. Annual wages of both computer and engineering managers increased by almost 8 percent since 2001.

A survey by Foote Partners LLC found that, on average, IT earnings are down from previous years and large signing bonuses are much less common. During 2002, base salaries in 85 IT occupations studied, declined by an average of 2.8 percent while bonuses declined by 32 percent. Only a few occupations experienced increased demand, including IT security specialists, whose earnings increased by 5.5 percent.[13]

The National Association of Colleges and Employers reports that average starting salaries for 2003 computer sciences graduates declined 4.1 percent to $47,109 (but computer science remains the highest paid specialty). The average offer to information sciences and systems graduates fell by 7.5 percent to $38,282.[14]

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[10] U.S. Department of Commerce, Technology Administration, Office of Technology Policy, *Education and Training for the Information Technology Workforce*, Report to Congress from the Secretary of Commerce (Washington, DC: U.S. Department of Commerce, June 2003): 57.

[11] Mary Stevens, "Bridging the Gap," *E-Week* April 14, 2003. (http://www.eweek.com/print_article/0,3048,a=40332,00.asp)

[12] See Appendix Table 2.5 in *Digital Economy 2003 Technical Appendices* for a complete list of IT occupational earnings and Appendix Table 2.6 for a description of duties of each IT-related occupation. (http://www.esa.doc.gov/reports.cfm)

[13] David Foote, "IT Job Trends Yield Surprises," *Computerworld*, February 10, 2003. (http://www.computerworld.com/careertopics/careers/story/0,10801,78304,00.html)

[14] NACE's Fall 2003 Salary Survey, National Association of Colleges and Employers (http://www.naceweb.org)

IT Employment Demand and the Recession of 2001

IT-Producing Industries

Overall weakness in the economy has affected workers across all industries and occupations, including IT workers. Since 2001, the U.S. economy has lost 1.8 million private sector jobs and the decline in IT employment has been a part of this overall trend. IT-producing industries have lost over 570,000 jobs since 2001. During the 1991 business cycle, IT-producing industry employment sank lower than other industries and was slower to recover, but grew much faster than average after that. By 1992, the economy on average was adding jobs, but employment growth only turned positive for IT-producing industries in 1993.[15] Since the 2001 recession ended, IT-producing industry employment has continued to decline.

A recent report by the Federal Reserve Bank of New York compares the current "jobless" recovery with the previous one (1991) to determine whether job losses were cyclical or structural.[16] The authors examined industry job flows before and after the past recessions. If employment recovered quickly, they determined the change in employment was cyclical. If the industries lost jobs during the recession and continued to lose jobs afterwards, they concluded that the job losses were structural. Some IT-producing industries ranked among the industries that lost jobs during the recent recession and that continue to lose jobs, indicating a permanent relocation or loss of jobs.

The authors suggest that despite some structural job losses, the similarities between the current and previous recoveries, specifically, a recovery driven by productivity growth, with little initial job creation, could bode well for the future. Thus, if the current recovery eventually follows the pattern of the previous one, once the economy does turn around, we can expect a lengthy period of economic growth.

IT-Related Occupations

IT occupational employment does not show consistent patterns across the last two business cycles. During the 1990–91 recession, the average unemployment rate of all computer related occupations (computer scientists, systems analysts, and engineers and computer programmers) was 2.7 percent.[17] The unemployment rate for these occupations was higher during the 2001 recession (3.7 percent), but has since continued to climb to a historically high rate of 5.2 percent in 2002. From 1993 to 2000, the unemployment rate for computer-related occupations was much lower than the national average and basically tracked the national average in direction and

[15] See Table A-4.1 in U.S. Department of Commerce, Economics and Statistics Administration, *Appendices to the Emerging Digital Economy II* (Washington, DC: U.S. Department of Commerce, June 1999): 26. (http://www.esa.doc.gov/pdf/EDE2appendix.pdf)

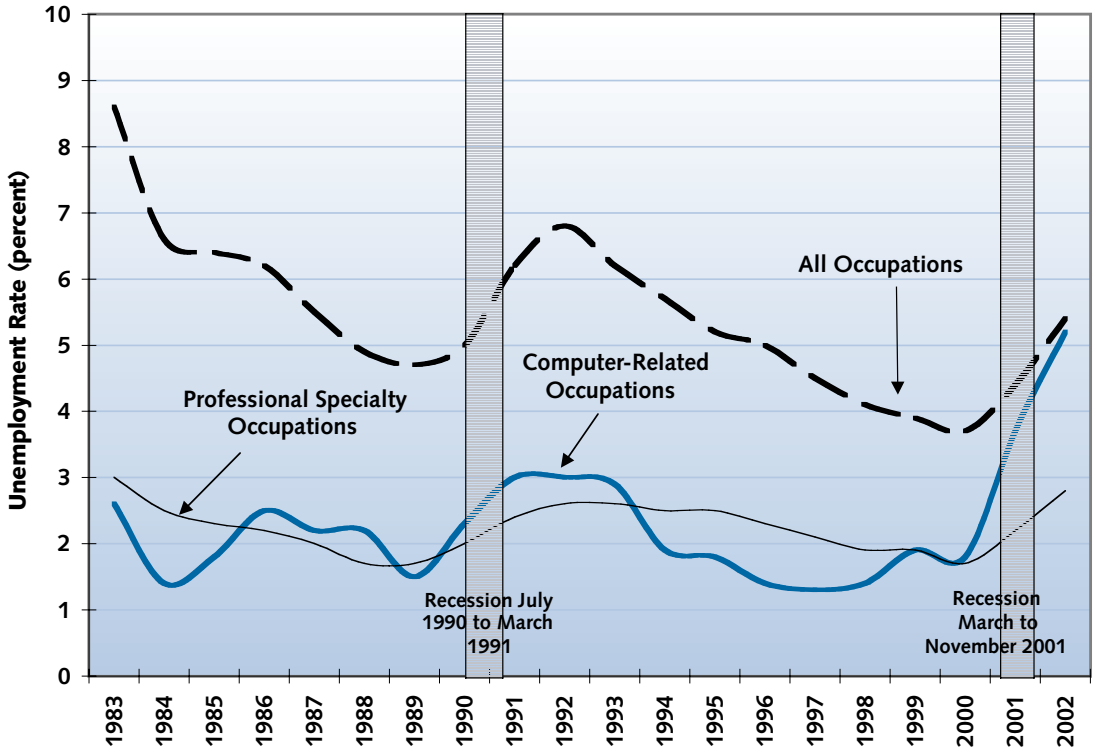
[16] Erica Groshen and Simon Potter, "Has Structural Change Contributed to a Jobless Recovery?" in *Current Issues in Economics and Finance* Federal Reserve Bank of New York, Vol. 9, No. 8, August 2003: 2–4. (http://www.newyorkfed.org/research/current_issues/ci9-8.html)

[17] These computer-related occupations account for about one-third of all IT-related occupations.

magnitude of change. During the same period, the unemployment rate for professional specialty occupations—a category that includes computer-related, engineering, legal, health, and other professional occupations that require similar, high levels of education and training—followed a similar trend. (Figure 2.4). After 2000, the unemployment rate of workers in computer occupations started to converge with the national average and diverge from the rate for professional specialty occupations.

The rapid increase in the unemployment rate in computer related occupations (between 2000 and 2002) relative to the national average suggests that factors in addition to the economic cycle could be influencing demand for workers in these occupations. The slowdown following the Y2K buildup is one likely explanation for the decline in demand, especially for computer programmers. Subsequently, the bursting of the dot.com bubble resulted in the loss of IT-related jobs. Also, recent growth in the number of foreign workers in computer and related occupations,

Figure 2.4. Unemployment Rates in Computer-Related Occupations Compared with Professional Specialty Occupations and the National Average



Note: Computer occupations include computer analyst, computer scientist, computer-systems planning, computer-systems analyst, data processing consultant, information scientist, software specialist, computer programmer, and related occupations. Professional specialty occupations include computer, engineering, legal, health, and other professional occupations that require similar education and training.

Source: Bureau of Labor Statistics Current Population Survey data.

specifically H-1B workers, could have displaced some IT workers.[18] Given the non-cyclical factors that have influenced the IT labor market (including offshoring discussed in the next section), it is unclear how soon unemployment rates for workers in computer-related occupations will return to pre-2000 levels.

Offshoring and IT Job Losses

The information technology revolution that gave rise to the growth in demand for IT workers is now enabling the shift of some types of IT jobs to other countries. This practice of "offshoring" or "foreign outsourcing" occurs when a U.S. company either relocates part of its operations physically outside of U.S. borders, outsources work to a company located in another country, or outsources to another U.S.-based company that then sends the work offshore. Lack of adequate data makes it difficult to determine the extent of offshoring, but press reports of company announcements and private surveys support the contention that IT offshoring has contributed to the recent decline in demand for IT workers.[19]

According to most accounts, offshoring is occurring in countries where many people speak English as a first or second language such as Canada, India, Ireland, Israel, and the Philippines. Some IT jobs have also moved to China. The types of jobs being outsourced abroad have evolved from low skilled, low wage call-center jobs to high skilled, high wage programming and software development jobs. The availability and declining cost of high speed communications systems are facilitating this trend.

No government data measure the extent to which U.S. companies are moving jobs to other countries. However, a growing number of private research firms are offering forecasts of IT job losses based on proprietary surveys of U.S. companies. These research studies are not comparable in scope or measurement techniques and the findings vary widely, indicating the difficulty in tracking labor mobility and its economic effects. But the common theme throughout is that many U.S. companies that are not already offshoring are planning to do so in the near future.

- Forrester Research estimates that 3.3 million U.S. services jobs will be relocated abroad over the next 15 years, accounting for $136 billion in wages. Over 400,000 will be IT-related jobs, with the greatest level of outsourcing expected in software development and customer service/call centers.[20]

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[18] The H-1B visa program allows foreign workers to enter the country for the purpose of temporarily filling skilled jobs (a large share of which are IT jobs). The original annual limit on visa approvals was set at 65,000. Congress raised the limit to 115,000 for FY1999 and FY2000 and to 195,000 in FYs 2001, 2002 and 2003. The cap reverted to 65,000 on October 1, 2003.

According to the Office of Immigration Statistics, H-1B petitions increased each year the cap was raised until FY2002, when H-1B petition approvals dropped by more than half to 89,000. This suggests that H-1B workers in computer-related occupations are beginning to feel the impact of the weak economy, too.

[19] In light of concern about offshoring, Congress has requested that the General Accounting Office conduct a study of the economic implications of offshoring.

[20] John McCarthy, *et al.*, "3.3 Million U.S. Services Jobs to go Offshore," *Forrester Research Tech Strategy Brief* (November 11, 2002): 1. (http://www.forrester.com)

- Goldman Sachs estimates the cumulative services jobs lost to offshoring at 200,000, but projected job losses could reach 6 million over the next decade. They suggest that while businesses could realize cost savings and higher profits in the short-term, over time competition will erode the cost savings. In the end, they contend increased offshoring would reduce labor demand, raise imports, and place downward pressure on the value of the dollar.[21]
- A survey of hiring managers conducted by the Information Technology Association of America (ITAA) found that 12 percent of IT companies had opened outsourcing operations overseas. The ITAA survey also revealed that most of the foreign outsourcing was being conducted by large IT companies and that programming and software engineering positions topped the list of types of positions most likely to be outsourced.[22]
- Gartner Inc. expects one in 10 jobs at IT services firms to move offshore by the end of 2004 and that many of the job losses will be structural. Despite the short-term fiscal advantages of offshoring, they warn that companies need to consider the long-term implications of offshoring including the loss of seasoned IT professionals, the loss of intellectual assets, and the effect of offshoring on the functioning of their organizations.[23]

McKinsey Global Institute (MGI) attempted to quantify the benefits from offshoring. For example, despite the job losses associated with offshoring, U.S. consumers could benefit from lower prices as businesses pass on the cost savings. Also, offshoring could raise the standard of living in other countries, whose residents would be able to import goods and services from the United States. MGI found that overall, the positive effects outweigh the costs in lost jobs. In addition, MGI notes that Forrester Research's estimated job losses over the next 10 years (about 200,000 per year) are less than the number of mass layoffs that typically occur in a dynamic, global economy for reasons other than offshoring. MGI also suggests that offshoring might help to ease domestic labor supply issues expected to result as the U.S. population ages.[24]

Effects of Productivity Improvements and Automation

Despite the positive benefits of technological advances such as higher productivity growth, which leads to faster economic and wage growth, job displacement can occur. Technological advances can contribute to job displacement by either eliminating the job or automating processes so that they require fewer workers. Such labor saving innovations result in productivity improvements that allow firms to produce more with the same number of workers or maintain current output with fewer workers. Often the types of jobs displaced by technology

[21] Andrew Tilton, "Offshoring: Where have all the Jobs Gone?" *Goldman, Sachs & Co. U.S. Economics Analyst, Issue 03/38* (September 19, 2003): 6.

[22] Information Technology Association of America, *2003 IT Workforce Survey* (Arlington, VA: ITAA, May 5, 2003): 11. (http://www.itaa.org/workforce/studies/03execsumm.pdf)

[23] Diane Morello, "U.S. Offshore Outsourcing: Structural Changes, Big Impact," *Gartner Research Note Commentary COM-20-4837* (July 15, 2003): 2. (http://www4.gartner.com/Init)

[24] McKinsey Global Institute, "Offshoring: Is It a Win-Win Game?" August 2003: 10–12. (http://www.mckinsey.com/knowledge/mgi/)

are low-skilled jobs or repetitive tasks that become automated. Office and administrative functions that were once performed by workers in those occupations can now be done by individual staff members. For example, software and the Internet can allow workers to secure travel, training, and other services directly rather than using administrative personnel. In Chapter IV of this report, the authors describe job losses in office and administrative occupations among IT-intensive industries.[25]

High skilled IT occupations can also be affected by changes in technology. For example, an occupation that requires narrowly specialized training can become obsolete when a platform or operating system changes. Newer generations of software provide self-testing features that once required someone to conduct the testing. In the case of communications, repairing a problem with a telephone line used to require that a person physically go to the site and inspect the telephones and lines. Now testing and problem-solving can be done remotely. In Chapter IV, the authors note that within businesses services, an IT-intensive industry, job losses were not only concentrated among office and administrative occupations, but in higher skilled installation, maintenance, and repair occupations and computer and mathematical occupations.

Sprint PCS is a firm-level example of how technology has increased productivity and replaced workers. Sprint PCS, a wireless carrier, substituted voice recognition software for human operators. Sprint's productivity increased by 15 percent from 2001 to 2002 as it shed 11,500 workers.[26]

Conclusion

After almost a decade of rapid job growth during the 1990s, demand for IT workers has fallen sharply during the past two years. Recent job losses have been widespread across almost all IT-producing industries and IT-related occupations. Job losses have been both cyclical and structural. The recent recession and continued economic sluggishness have slowed the return of some IT jobs. However, productivity improvements and foreign outsourcing of IT jobs mean some types of IT job losses may be permanent.

[25] See Chapter IV, Digital Economy 2003, Appendix Table 4.B for a complete ranking of IT-intensive industries.

[26] Del Jones and Barbara Hansen, "Companies Do More With Less," *USAToday online*, 14 August 2003: 3.

Appendix 2.A
The North American Industrial Classification System

In 1997, the North American Industrial Classification System (NAICS) was created from a joint effort by the statistical agencies of the United States, Canada, and Mexico. NAICS classifies in the same industry, establishments with similar production processes. Thus, NAICS focuses on how products and services are created, as opposed to the Standard Industrial Classification (SIC), which focused on what is produced.

The NAICS approach created significantly different industry groupings than those under the SIC system, especially for services, and thus more accurately reflects the workings of the U.S. economy. The pace of NAICS adoption has differed across statistical organizations. The Bureau of the Census was the first U.S. statistical agency to adopt NAICS; however, since 1997, NAICS has been revised and the Bureau of Labor Statistics (BLS), which had not implemented the 1997 NAICS, went directly to the 2002 NAICS. The 2002 NAICS includes further revisions that include new industries. Therefore, the industry classifications listed in Box A-2.1 and used in this chapter are not exactly comparable to those used in Chapter 1, which are grouped according to the 1997 NAICS.

BLS revised *some* of their estimates historically according to NAICS (e.g., the Current Employment Survey (CES) data used to estimate IT-producing industry employment). However, the Covered Employment and Wages (CEW) survey that is used to compile IT-producing industry wages have not been revised historically and are currently available for only 2001 and 2002.

Box A-2.1. Information Technology-Producing Industries (2002 NAICS)

NAICS CODE	Computer Hardware
334111	Electronic Computers
334112	Computer Storage Devices
334113	Computer Terminals
334119	Other Computer Peripheral Equipment
423430	Computer and Software Wholesalers (part)
443120	Computer and Software Stores (part)
334411	Electron Tubes
334412	Bare Printed Circuit Boards
334413	Semiconductor and Related Devices
334414	Electronic Capacitors
334417	Electronic Connectors
334418	Printed Circuit Assembly
334415,6,9	Miscellaneous Electronic Components
334513	Industrial Process Control Instruments
334515	Electricity Measuring and Testing Equipment
334516	Analytical Laboratory Instruments
333295	Semiconductor Machinery
333313	Office Machinery Manufacturing
	Communications Equipment
334210	Telephone Apparatus
334220	Broadcast and Wireless Communications Equipment
334310	Audio and Video Equipment
335921	Fiber Optic Cables
334611	Software Reproducing
334613	Magnetic and Optical Recording Media

NAICS CODE	Software and Computer Services
511210	Software Publishers
518111,2	Internet Service Providers and Web Search Portals
518210	Data Processing, Hosting, and Related Services
423430	Computer and Software Wholesalers (part)
443120	Computer and Software Stores (part)
541511	Custom Computer Programming
541512	Computer Systems Design
541513	Computer Facilities Management
541519	Other Computer Related Services
532420	Office Machinery and Equipment Rental and Leasing
811212	Computer and Office Machine Repair and Maintenance
	Communications Services
517110	Wired Telecommunications Carriers
517212	Cellular and Other Wireless Carriers
517310	Telecommunications Resellers
517510	Cable and Other Program Distribution
517410,910	Satellite and Other Telecommunications
811213	Communications Equipment Repair and Maintenance