

Digital Economy 2000

Appendices



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DIGITAL ECONOMY 2000
APPENDICES

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DIGITAL ECONOMY 2000

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APPENDIX TO CHAPTER III

INFORMATION TECHNOLOGY PRODUCING INDUSTRIES

This Appendix describes the sources of data and methods used to assess the economic impacts of Information Technology (IT) Producing industries that were presented in Chapter III of the *Digital Economy 2000* (DE 2000) report.

DEFINING INFORMATION TECHNOLOGY PRODUCING INDUSTRIES

The IT-producing industries selected for the DE 2000 report are those “industries that produce, process, or transmit information goods and services as either intermediate demand (inputs to production of other industries) or as final products (goods and services bought by consumers, business investors, government or for exports).” The selected IT-producing industries also include those that supply the goods and services necessary for the Internet and electronic commerce (e-commerce) to operate—i.e., provide the products and services for the Internet infrastructure. IT-producing industries include manufacturers of some general and specialized electronic components, computers and peripheral equipment, specialized measuring and testing instruments, telecommunications equipment, and prepackaged software. IT-producing industries also include computer, software, and telecommunications service providers. (Appendix Table 3.1)

The IT-producing industries in this report follow the definitions in the Office of Management and Budget’s 1987 *Standard Industrial Classification* (SIC) manual. Annual estimates of Gross Product Originating (GPO) for the IT-producing sector by SIC industry and portions of SIC industries were developed for the 1990 through 2000 period.

The SIC basis was used even though Census of Manufacturers data for 1997 were released under the North American Industry Classification System (NAICS). SIC industry definitions for IT-producing industries were used, in this analysis, because of the greater availability of SIC industry time series data. Industry data under NAICS were only available for manufacturing sectors for 1997 and, in some cases, for 1992. Since Census *Annual Survey of Manufacturers’* shipments data for 1990, 1991, and 1993 through 1996 were released on an SIC basis, it was easier to convert the 1992 and 1997 NAICS data to an SIC basis than to convert data from all the other years to NAICS. Another reason for using SICs was

Appendix Table 3.1
Information Technology Producing Industries:
NAICS to SIC Concordance

Hardware Industries	<u>1997 NAICS</u>	<u>1987 SIC</u>
Computers and computer equipment and calculating and office machines	334111, 2, 3, 9, 334418pt 333311pt, 3pt	3571, 2, 5, 7pt, 3578, 9pt
Wholesale trade of computers	421430pt	5045pt
Retail trade of computers	443120pt	5734pt
Electron tubes	334411	3671
Printed circuit boards	334412	3672
Semiconductors	334413	3674
Passive electronic components	334414, 5, 6, 7, 8pt, 9	3675, 6, 7, 8, 9pt, 3661pt
Industrial instruments for measurement	334513	3823
Instruments for measuring electricity	334514pt, 334515	3825pt
Laboratory analytical instruments	334516	3826
Software/Service Industries		
Computer programming services	541511	7371
Prepackaged software	511210, 334611	7372
Wholesale trade of software	421430pt	5045pt
Retail trade of software	443120pt	5734pt
Computer integrated system design	541512	7373
Computer processing, data preparation	514210	7374
Information retrieval services	514191, 9	7375
Computer services management	541513	7376
Computer rental and leasing	532420	7377
Computer maintenance and repair	811212	7378
Computer related services, nec	541519	7379
Communications Services Industries		
Telephone and telegraph communications	513310, 21, 22, 30 40, 90	481, 4822, 4899
Radio broadcasting	513111, 2	4832
Television broadcasting	513120	4833
Cable and other pay TV services	513210, 20	4841
Communications Equipment Industries		
Household audio and video equipment	334310	3651, 3679pt
Telephone and telegraph equipment	334210, 334418pt	3661pt, 3577pt, 3679pt
Radio and TV communications equipment	334220, 334290	3663, 3679pt, 3699
Magnetic and optical recording media	334613	3695, 3577pt

that Census revenue data for computer, software, and telecommunications services industries were not yet converted to NAICS.

Differences in industry classifications between SIC industries and NAICS industries, however, caused problems in the developing of a consistent GPO time series for the IT-producing industries. For example, while 1997 industry shipments for Other computer peripheral equipment manufacturing, NAICS 334119, includes shipments data for its counterpart industry under the SIC system (SIC 3577), it also includes shipments for part of Calculating and Accounting Equipment (SIC 3578). These are manufacturers' shipments of Point of Sales Terminals and Fund Transfer Devices, products produced formerly under industry SIC 3578. The other part of shipments for the Calculating and Accounting Equipment (SIC 3578) industry is now included in Office Machinery Manufacturing (NAICS 333313). Thus, in 1997, a portion of shipments for the IT-producing industry Calculating and office machines (SICs 3578 and 3579) was added to the IT-producing industry Computers and equipment (SICs 3571, 3572, 3575, and 3577).

Another example of redistribution of shipments resulting from industry reclassification shows up for SIC 3577, Computer peripheral equipment. Portions of this industry are part of Telephone and telegraph equipment and Magnetic and optical recording media. In addition, portions of Office Machines (SIC 3579) reclassified under NAICS were clearly non IT-producers—Lead pencil manufacturing and Watch and clock manufacturing. The overall result of the differences between the SIC and the NAICS' classifications was that Computers and equipment and calculating and office machines (SICs 3571, 3572, 3575, 3577pt, 3578, and 3579pt) became an IT-producing industry, for this analysis.

Appendix Table 3.1 shows the reassignments of SICs and parts of SICs to the IT-producing sector. Six of the 29 IT-producing industries listed in the table had some reassignment of shipments, resulting in some slight shifting among industry estimates of GPO from the GPO estimates presented in previous EDE reports. All of the industry reassignments of shipments resulting from reclassification occurred within IT-producing industries.

Finally, while the industries presented as IT-producing industries in the DE 2000 report do not reflect any official U.S. government list of such industries, the industries selected as IT-producing, according to our best judgement, met the criteria listed above.

MEASURING INFORMATION TECHNOLOGY PRODUCING INDUSTRIES

The output of IT-producing industries was measured in terms of Gross Product Originating (GPO), often referred to as "value added." This GPO is defined as being equal to an industry's total revenue (measured by total shipments or receipts plus inventory change) less the cost of purchased goods and services used

in production.¹ GPO and value added can be thought of more directly as the sum of costs incurred by an industry, (*i.e.*, compensation of employees, net interest and indirect business taxes) and profits.

GPO by industry is the contribution of each private industry and government to Gross Domestic Income (GDI). Theoretically, the nominal dollar value of GDI, the income associated with the output of industries, should equal total final demand of the economy, or Gross Domestic Product (GDP). In practice, however, GDI and GDP do not match precisely.

The analysis of IT-producing industries used here is consistent with the definitions and conventions used in the Gross Product by Industry series published by the Bureau of Economic Analysis (BEA). Although GPO and value added are considered to be the same, value added data for manufacturing industries published by the Bureau of the Census are not the same as the BEA Gross Product by Industry time series. The difference between the two measures results from BEA subtracting industries' purchases of "Other services" (SIC 89) from total revenue along with all other purchased goods and services. Since the Census collects manufacturing data on an establishment basis and most purchases of other services are at the corporate level, the Census does not subtract these purchases in its value added calculation.²

The GPO estimates for the IT-producing industries developed for this report are derived from revenue, receipts, and shipments, *whether or not* all of the industry's production was used as an IT good or service. For example, not all semiconductors are used by the computer industry or other industries selected as IT-producing. Semiconductors are also used in automobiles, home appliances, and a variety of other consumer and industrial goods. However, to differentiate production into IT-producing and non IT-producing would be difficult, if not impossible, to do. For this reason, the GPO of the semiconductor industry is based on its *total* annual shipments and costs of production.

By using GPO for the IT-producing industries, double-counting of output is avoided when industry estimates are added together. If value of shipments, sales, or revenues of these industries were added together, there would be double-counting. For example, the value of shipments of the computer industry includes their spending on semiconductors. The semiconductor industry includes its sales to the computer industry, and all other industries, in its shipments data. Adding total shipments of the semiconductor industry to the shipments of the computer industry would double count the value of shipments of the semiconductor industry to the computer industry. Other industries provide goods and services used in production in the computer industry as well. Adding the shipments of these industries to the shipments of

¹ See page 133 of Yuskavage, "Improved Estimates of Gross Product by Industry, 1959-94," *Survey of Current Business*, August 1996 for a more detailed description of GPO and its relationship to Gross Domestic Product and Gross Domestic Income.

² See page XI of the 1992 Census of Manufactures MC92-S-1, *Subject Series General Summary*, for a description of the difference between gross product originating and value added.

the computer industry would similarly result in double counting due to mixing industry inputs and outputs. Thus, adding up only the GPO of these industries avoids double-counting.

GPO of IT-Producing Industries: 1990-97

The following is a description of the data and the methods used to derive GPO for IT-producing industries at the 4-digit SIC industry level for 1990 through 1997. (Appendix Table 3.2) Since published 4-digit SIC industry level data were not available for 1998-2000, the next section explains how industry growth estimates were used to determine GPO for those years.

GPO for Hardware and Communications equipment IT-producing industries, all in manufacturing, were derived beginning with Census data on value of shipments, at the 4-digit SIC level of detail. GPO was derived by deducting the cost of materials and the value of purchased services used in production from the value of shipments and then adjusting for inventory change.

Beginning with BEA's Fall 1999 comprehensive revision of the national accounts, industry purchases of software and software services were considered as an investment, rather than as an expense of production.³ Thus, industry spending on software and software services became, for the first time, a part of GDP. The estimates of GPO for the IT-producing industries in Appendix Tables 3.2 and 3.3 reflect this change.

In general, data used to estimate GPO for IT-producing industries in the manufacturing sector are from the Census *1990-91 and 1993-96 Annual Survey of Manufactures* and from the more detailed 1992 and 1997 *Economic Census of Manufactures*. The Economic Census reports contain more detailed data, particularly on the cost of materials and purchased services used in production, so that data for these two years are used to adjust the shipments data for the Annual Survey years when data are less detailed. Thus, for 1990-91 and 1993-96 GPO was estimated from the published shipments data in the Annual Surveys and then adjusted for inventory change and costs of materials and purchased services estimated from the average relationship of inventory change and materials costs to production in the Economic Census years.

The more detailed data available in the Economic Census years include costs of materials, beginning and end of year inventories, and costs of selected purchased services. Data on selected purchased services include software services (see above), repair of buildings, repair of machinery, communications, legal services, accounting and bookkeeping, advertising, and refuse removal. Since this industry's spending for services only represents a portion of its purchased services, industry spending for all other services was estimated using the distribution of spending on services from BEA's 1992 Benchmark Input-Output (I-O) table. The distribution and the portion of the industry's output that was purchased services, from the I-O

³ See Seskin, "Improved Estimates of the National Income and Product Accounts for 1959-98, Results of the Comprehensive Revision," *Survey of Current Business*, December 1999.

Appendix Table 3.2
Information Technology Producing Industries:
Gross Product Originating

Industry*	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(Millions of \$, except as noted)										
Total Gross Domestic Income	5,772,700.0	5,966,600.0	6,275,200.0	6,578,600.0	6,995,800.0	7,374,000.0	7,780,300.0	8,303,900.0	8,807,500.0	9,381,300.0	9,831,602.4
Year-to-Year GDI Change (%)		3.4%	5.2%	4.8%	6.3%	5.4%	5.5%	6.7%	6.1%	6.5%	4.8%
Hardware											
Computers and equipment, calc. machines	27,091.0	23,144.8	24,101.7	23,495.0	26,330.1	31,036.0	32,927.6	36,139.0	39,210.8	42,622.1	46,330.2
Computers and equipment wholesale sales	33,835.9	35,999.0	39,743.2	42,573.0	43,553.9	51,113.8	61,559.9	70,270.7	75,084.2	81,105.9	88,162.2
Computer and equipment retail sales	1,870.3	1,887.8	1,914.9	2,293.3	2,720.8	2,860.5	2,797.0	3,188.8	3,407.3	3,686.7	4,007.5
Electron tubes	1,169.4	1,038.5	1,053.3	1,019.3	1,186.5	1,205.6	1,255.8	1,258.6	1,316.5	1,402.0	1,493.2
Printed circuit boards	4,407.7	3,143.3	3,555.7	3,710.8	4,380.9	4,406.2	5,056.3	5,070.3	5,526.7	5,604.0	5,682.5
Semiconductors	15,812.0	18,466.7	18,308.2	23,702.6	31,639.5	40,836.2	43,553.0	54,131.5	57,054.6	60,763.2	64,712.8
Passive electronic components	11,565.7	12,720.7	13,493.6	14,350.9	16,034.9	15,310.2	13,347.4	11,313.7	12,071.7	12,880.5	13,743.5
Industrial instruments for measurement	2,331.8	2,386.1	2,551.5	2,343.8	2,436.4	2,526.2	2,943.3	4,597.9	4,873.8	5,214.9	5,580.0
Instruments for measuring electricity	3,318.6	3,460.4	3,493.3	3,096.9	3,551.6	3,980.7	4,907.2	7,761.8	8,382.7	8,952.7	9,561.5
Laboratory analytical instruments	1,871.6	1,987.9	1,834.8	1,858.3	1,933.4	2,133.8	2,770.4	3,746.0	3,985.7	3,982.0	4,232.8
Total Hardware	103,273.9	104,235.2	110,050.3	118,443.7	133,768.1	155,409.4	171,117.8	197,478.2	210,913.8	226,214.1	243,506.1
Software/Services											
Computer programming services	15,896.5	17,442.5	18,624.4	20,399.0	23,162.9	26,119.5	31,370.1	37,295.3	47,796.1	55,013.3	62,715.2
Prepackaged software	11,322.9	12,552.9	14,554.5	17,263.4	19,775.9	22,768.3	26,926.5	29,511.7	34,496.8	40,016.2	46,418.8
Prepackaged software wholesale sales	1,810.1	1,927.7	2,127.2	2,278.8	2,330.2	2,733.0	3,291.7	3,607.7	4,217.1	4,891.9	5,674.6
Prepackaged software retail sales	99.8	100.9	102.3	122.5	145.3	152.6	149.2	163.6	191.2	221.8	257.3
Computer integrated system design	10,052.6	10,709.5	11,813.9	12,619.8	13,257.3	13,598.8	15,736.9	20,314.2	24,691.5	28,419.9	32,597.6
Computer processing, data preparation	10,939.9	11,563.8	12,554.2	14,561.7	17,908.4	21,843.6	25,181.1	26,582.1	28,062.2	32,299.5	37,047.6
Information retrieval services	2,597.6	2,704.8	2,879.2	3,132.7	3,338.0	3,910.0	5,058.5	6,637.4	8,977.4	10,333.0	11,852.0
Computer services management	1,460.3	1,616.6	1,910.2	1,872.9	1,941.8	2,090.0	2,134.1	2,478.6	2,942.1	3,386.3	3,884.1
Computer rental and leasing	1,693.8	1,535.9	1,528.0	1,590.2	1,702.4	1,880.1	2,125.4	2,463.0	2,944.3	3,388.9	3,887.1
Computer maintenance and repair	4,558.9	4,509.0	4,989.3	5,400.5	6,040.5	6,949.2	7,871.8	8,786.9	10,029.4	11,543.8	13,240.8
Computer related services, nec	3,206.5	3,461.0	4,406.4	5,545.2	7,267.3	9,305.2	11,644.3	16,023.4	21,261.1	24,471.5	28,068.8
Total Software and Services	63,638.8	68,124.6	75,489.6	84,786.6	96,869.9	111,350.2	131,489.6	153,863.8	185,609.1	213,986.2	245,643.8
Communications											
Household audio and video equipment	1,631.9	1,784.4	1,871.6	2,024.0	2,034.4	1,944.7	1,617.6	2,217.1	2,288.0	2,313.2	2,338.6
Telephone equipment, exc. ext. modems	8,313.5	8,005.2	10,250.9	10,734.9	10,949.7	12,138.7	15,034.4	21,069.1	21,806.5	22,591.6	23,404.9
Radio & TV communications equipment	9,806.1	8,763.0	10,134.2	9,480.7	13,020.2	14,309.8	13,839.4	18,646.4	20,641.6	22,251.6	23,987.3
Magnetic and optical and recording media	1,442.3	1,644.5	1,713.4	1,878.8	2,014.4	2,381.6	1,953.4	1,951.8	1,973.3	1,995.0	2,084.8
Total Communications Hardware	21,193.8	20,197.2	23,970.1	24,118.3	28,018.6	30,774.8	32,444.7	43,884.5	46,709.5	49,151.4	51,815.6
Telephone and telegraph communications	119,338.7	123,947.9	129,959.9	134,869.7	142,384.8	145,491.0	157,314.6	158,917.8	159,712.4	189,399.7	199,108.5
Radio broadcasting	4,946.5	5,318.1	4,968.7	6,565.4	7,040.3	8,047.0	8,619.4	9,417.3	10,048.2	11,553.9	12,870.5
Television broadcasting	12,222.4	11,625.6	11,648.8	14,755.4	16,274.9	18,441.6	18,947.2	20,560.2	22,739.6	23,520.4	26,551.2
Cable and other pay TV services	10,524.7	13,661.9	14,992.3	19,822.5	19,331.9	21,778.0	23,008.1	26,486.9	29,797.8	32,265.9	35,231.0
Total Communications Services	147,032.3	154,553.5	161,569.7	176,013.0	185,031.9	193,757.7	207,889.4	215,382.2	222,298.0	256,740.0	273,761.2
Total IT Producing Industries	335,138.8	347,110.5	371,079.7	403,361.7	443,688.5	491,292.1	542,941.5	610,608.7	665,530.4	746,091.8	814,726.7
Share of the Economy (%)	5.8%	5.8%	5.9%	6.1%	6.3%	6.7%	7.0%	7.4%	7.6%	8.0%	8.3%

*See industry SIC classification in Appendix Table 3.1.

Source: ESA estimates derived from BEA and Census data for 1990-97;
 ESA estimates for 1998-2000 from Commerce's International Trade Administration.

table, were adjusted to accommodate the selected purchased services published in the 1992 and 1997 Economic Censuses. The “adjusted” ratio was applied to total annual industry shipments for the remaining years in the time period to estimate the cost of purchased services, not including software.

GPO for wholesale trade of computer equipment (part of SIC 5045) was added to the category called IT-producing hardware industries since over half of wholesale trade of computers comes directly from computer manufacturers’ branch offices. Although counted by the Census as a wholesale sale and not a manufacturer’s shipment, the actual sale is primarily a direct manufacturer’s sale. The nominal value of computer sales from branch offices of manufacturers has been twice that of computer sales directly from manufacturing facilities throughout the 1990s.

Annual source data for 1990-91 and 1993-97 for wholesale trade of computers and equipment were available at the 3-digit SIC industry level in the Census Current Business Report called the *Annual Benchmark Report for Wholesale Trade*. In this report, gross margins (sales less costs of goods sold) by wholesale industries were reported under SIC 504, Wholesale sales of professional and commercial equipment and supplies.

Data for wholesale trade of computers and computer equipment in 1992, at the 4-digit SIC industry level, are available from the Census *1992 Economic Census of Wholesale Trade* and were used to derive the GPO for SIC 5045, Wholesale sales of computer equipment (and software). The *1997 Economic Census of Wholesale Trade* was not available at the time of this assessment. In the 1992 report, data for SIC 5045 include sales and purchased operating expenses from merchant wholesalers, manufacturer’s sales from branch offices, and agents, brokers, and commission merchants. This Census report also separates sales and purchased operating expenses for computers, into *both* equipment and software.

The ratios of manufacturer’s branch office sales to total wholesale sales of computer equipment (part of SIC 5045) and to the corresponding purchased operating expenses were used to distribute the gross margin data of the annual reports (SIC 504). This procedure was used to estimate the GPO of manufacturer sales of computer equipment from branch offices for 1990-91 and 1993-1997 at the 4-digit SIC level.

GPO for the retail trade of computer equipment and software (SIC 5734) was derived in much the same way as the wholesale estimates described above. The Census *Annual Benchmark Report for Retail Trade* contains total sales and gross margins for the 3-digit SIC sector (SIC 573). Data on purchased operating expenses, as well as the distribution between equipment and software from the *1992 Census of Retail Trade*, were then used to disaggregate the 3-digit SIC sector to the 4-digit SIC 5734 for 1990-91 and 1993-97. Again, the *1997 Census of Retail Trade* was not available.

GPO for the computer software and computer services IT-producing industries for the 1990-91 and 1993-98 periods was derived using the *1992 Census of Service Industries* and the Current Business

Report entitled the *Service Annual Survey*. Similarly to the derivation of GPO for the wholesale and retail trade of computer equipment and software, 4-digit SIC data on revenue and operating expenses from the 1992 Census of Service Industries were used as a pattern to derive annual estimates from 3-digit SIC “controls” for 1990-91 and 1993-98.

The 1992 *Census of Service Industries* includes a Subject Series report called *Sources of Receipts and Revenue* that was used to compute the cost of goods sold. For most of the software and computer services IT-producing industries, the cost of *goods* sold was less than 2 percent of total receipts. However, three of the computer services industries derived a significant portion of their revenue from the sale of goods: Computer rentals and leasing (SIC 7377), where the cost of goods sold represented 8.6 percent of total receipts; Computer maintenance and repair (SIC 7378), 7.6 percent; and Computer services, not elsewhere classified (SIC 7379), 2.4 percent. The costs of these goods (computers and equipment) were deducted from the total receipts of these service industries to arrive at a gross margin estimate. The 1992 Census report also provides a Subject Series report called *Capital Expenditures, Depreciable Assets, and Operating Expenses*. That report lists operating expenses for 4-digit SIC Software and service IT-producing industries.

GPO for the Software and service IT industries, in 1992, is computed by subtracting cost of goods sold and purchased operating expenses from total receipts for the 4-digit sectors. This distribution is then applied to 4-digit receipts data from the annual reports for these industries to obtain GPO estimates for 1990-91 and 1993-98.

GPO for Software wholesale sales (part of SIC 5045) and Retail sales (part of 5734) were derived using data from the *Census Annual Benchmark Reports for Wholesale Trade and for Retail Trade* for 1990-91 and 1993-96 and the *Census 1992 Economic Census of Wholesale Trade and Census of Retail Trade*. GPO estimates of Software and computer services industries were adjusted for the new treatment of purchased software and software services in much the same way as the GPO estimates were adjusted for the IT-producing industries in the manufacturing sector.

GPO for the Communications services IT-producing industries was derived from the 1992 *Census of Transportation, Communications, and Utilities* and the 1990-91 and the 1993-98 *Annual Survey of Communications Services*.⁴ Revenue and cost of purchased services data from these reports, and the value and distribution of the costs of purchased services from BEA’s 1992 Benchmark Input-Output table, were used to derive estimates of GPO adjusted for consistency with the new treatment for software purchases.

⁴ BEA’s GPO data for communications were used in last year’s EDereport. However, they not used here because the BEA released their rebenchmarked GPO series after the publication of the *DE 2000* report. Rebenchmarked GPO data for all industries are now available on the BEA web site and in the June issue of the *Survey of Current Business* (Lum, Moyer, and Yuskavage, pp. 24-54).

GPO of IT-Producing Industries: 1998-2000

Estimates were made of GPO for IT-producing industries for 1998-2000. Industry specialists from the Department of Commerce's International Trade Administration (ITA) provided estimates of annual growth in industry shipments from 1998 through 2000. These estimates were ultimately published in the "U.S. Industry and Trade Outlook, 2000" (*Outlook*)—jointly published by the ITA and DRI/McGraw-Hill.

Annual GPO to shipments ratios for 1990 through 1997 (or 1998 when data were available) were calculated. ITA estimates of shipments (or sales, revenues, and receipts) were converted to GPO based on a lagged 3-year moving average of the GPO to shipments ratios. Thus, for example, the shipments estimates for 1998 were converted to GPO based on the average ratio of GPO to shipments for 1995 through 1997. In 1999, the ratios for 1996, 1997 and the estimated ratio for 1998 were averaged to calculate GPO for that year. Similarly, the GPO for 2000 was projected by using the average of the ratio for 1997 and the estimated ratios for 1998 and 1999.

Real Dollar GPO of IT-Producing Industries

Chained-weighted 1996 dollar GPO for IT-producing industries are computed by deflating nominal GPO with price indexes obtained from BEA's Gross Product by Industry program.⁵ Real dollar GPO for IT-producing industries is not estimated beyond 1998 since price indexes for these industries were not available. A composite Fisher-type price index for Computers and computer equipment and Calculating and office machines and a deflator for Semiconductors were developed from BEA's quality-adjusted "hedonic" deflators. These quality-adjusted deflators relate prices of these products to their performance characteristics and their cost of production.

The 1990 through 1998 composite price indexes used in this analysis of IT-producing industries for Computers and computer parts and Calculating and Office Machines are as follows:

Computers and computer parts, Calculating and office machines

SIC 3571, 3572, 3575, 3577pt, 3578, and 3579pt

Year	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>
Deflator	3.077	2.791	2.364	1.944	1.696	1.385	1.000	0.710	0.469

⁵ The Industry and Wealth Data portion of the BEA web site (<http://www.bea.doc.gov>) provides the GPO by Industry series. The rebenchmarked GPO series was not available until after the publication of DE 2000.

Appendix Table 3.3
Information Technology Producing Industries:
Real Gross Product Originating

Industry*	1990	1991	1992	1993	1994	1995	1996	1997	1998
	(Millions of 1996\$, except as noted)								
Total Gross Domestic Income	6,648,000	6,647,300	6,843,600	6,986,400	7,276,900	7,516,700	7,780,300	8,147,900	8,541,700
Year-to-Year GDI Change (%)		0.0%	3.0%	2.1%	4.2%	3.3%	3.5%	4.7%	4.8%
Hardware									
Computers and equipment, calculating machines	8,804.4	8,292.7	10,195.3	12,085.9	15,524.8	22,408.7	32,927.6	50,899.9	83,605.0
Computers and equipment wholesale sales	10,996.4	12,898.2	16,811.8	21,899.7	25,680.4	36,905.3	61,559.9	98,972.8	160,094.2
Computer and equipment retail sales	2,053.1	1,969.6	1,936.0	2,291.0	2,688.9	2,827.0	2,797.0	3,236.8	3,407.3
Electron tubes	1,170.9	1,027.2	1,067.2	1,043.3	1,196.1	1,204.4	1,255.8	1,259.8	1,344.7
Printed circuit boards	3,812.9	2,750.0	3,166.2	3,420.1	4,156.4	4,286.2	5,056.3	5,270.6	6,073.3
Semiconductors	3,794.6	4,997.7	5,967.5	8,801.6	13,828.5	27,133.7	43,553.0	71,413.6	120,115.0
Passive electronic components	10,495.2	11,564.3	12,189.3	12,975.5	14,657.2	14,416.4	13,347.4	11,711.9	12,910.9
Industrial instruments for measurement	2,620.0	2,605.0	2,726.0	2,449.1	2,514.3	2,593.7	2,943.3	4,408.3	4,593.6
Instruments for measuring electricity	3,712.0	3,757.3	3,704.5	3,232.7	3,650.2	3,980.7	4,907.2	7,700.2	8,332.7
Laboratory analytical instruments	2,021.2	2,119.3	1,921.2	1,923.7	1,983.0	2,157.5	2,770.4	3,705.2	3,938.5
Software and Services									
Total Software and Services	75,687.9	79,213.0	82,510.2	92,950.6	102,199.6	115,910.3	131,537.8	148,957.6	173,393.8
Communications Hardware									
Household audio and video equipment	2,065.7	2,139.6	1,997.5	2,026.0	1,846.1	1,511.1	1,617.6	2,032.1	2,000.0
Telephone equipment, exc. ext. modems	6,546.1	6,394.0	8,499.9	9,089.7	9,638.8	8,609.0	15,034.4	21,720.8	23,247.9
Radio & TV communications equipment	10,376.8	9,147.2	10,309.4	9,509.2	12,942.5	14,338.5	13,839.4	18,480.1	20,621.0
Magnetic and optical and recording media	2,236.2	2,243.5	2,306.0	2,366.2	2,156.7	2,334.9	1,953.4	1,921.1	1,999.3
Communications Services									
Telephone and telegraph communications	124,440.7	129,112.4	133,841.3	137,903.6	142,384.8	143,059.0	157,314.6	165,712.0	159,712.4
Radio broadcasting	6,540.7	7,010.2	6,340.1	7,785.7	8,204.1	8,921.0	8,619.4	8,438.5	8,325.7
Television broadcasting	16,161.4	15,324.6	14,863.9	17,498.0	18,965.1	20,444.4	18,947.2	18,423.3	18,841.3
Cable and other pay TV services	13,916.6	18,008.9	19,130.1	23,507.0	22,527.4	24,143.1	23,008.1	23,734.1	24,689.6
Total IT Producing Industries**	272,637.4	287,157.7	312,035.1	348,983.3	389,391.3	451,683.0	542,941.5	657,356.8	778,647.9

*See Table Appendix Table 3.1 for SIC Industry classification.

**Real chain weighted 1996 dollars are not directly additive.

Source: ESA estimates derived from BEA and Census data.

This composite price index for computers was developed by using the price indexes associated with each of the sectors, along with their nominal shipments, to develop real (1996 chain-weighted) dollar shipments by individual sector. Total nominal dollar shipments of these sectors were then divided by an aggregate real chain-weighted dollar value of shipments to produce the implicit deflator shown. The aggregation of the real chain-weighted dollar values of shipments was estimated by using a Fisher-Ideal quantity index formula.⁶ This price index was also applied to wholesale sales of computers (SIC 5045pt) since these were mostly manufactures' sales.

The hedonic price index for semiconductors for 1990 through 1998 is as follows:

Semiconductors									
SIC 3674									
Year	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993</u>	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>
Deflator	4.167	3.695	3.056	2.693	2.286	1.505	1.000	0.758	0.475

Total real chain-weighted dollar estimates for all IT-producing industries were also estimated using the Fisher-Ideal quantity index formula (See footnote 5).

Price Effects of IT-Producing Industries

An implicit deflator for all IT-producing industries was calculated by dividing its aggregate nominal dollar value by its aggregate real chain-weighted 1996 dollar estimate. A Fisher-of-Fishers calculation was used to aggregate the real dollar estimate of the IT-producing sector. The nominal dollar value for the rest of the economy was calculated as Gross Domestic Income (GDI) less the GPO of IT-producing industries. A *residual* (GDI less the IT sector) implicit price deflator was then developed for the non IT-producing portion of GDI using a Fisher chain-type calculation.⁷

⁶ See page 142 of Yuskavage, "Improved Estimates of Gross Product by Industry, 1959-94," *Survey of Current Business*, August 1996 for a description of the Fisher-Ideal quantity index formula.

⁷ In last year's EDereport, the price changes for individual non IT-producing industries and government were calculated using BEA's Gross Product by Industry series. An aggregate non-IT producing price index was then developed and compared with the price index of the IT-producing sector. This method, however, could not be done this year since the re-benchmarked GPO data was not available. The alternative, if less accurate, method (described above) was developed incorporating a residual deflator for the rest of the economy. The form of the residual deflator formula is shown on page 142 of the August 1996 BEA *Survey of Current Business* article cited previously.

The change in the annual deflator for GDP (the GDP deflator is used to deflate GDI) was then compared to the change in the annual deflator for the rest of the economy (GDI less the IT-producing sector). The difference between the growth rates was attributed to the IT-producing sector.⁸

IT-Producing Industries: Contribution to Real Economic Growth

Growth in real production of IT-producing industries is measured in chain-weighted dollars that are not additive, so that their contribution to real economic growth cannot be directly calculated from these chain-dollar measures. The appropriate method requires calculating the contribution of IT-producing industries to the percent change in GDP. A new method, distinct from the method used in the last EDE report, was used for these computations; the new formula produces estimates that are very close to those produced by the previous formula.⁹

Industry Investments in IT Equipment and Software

Industry investments, in current and constant (chained 1996 dollars) dollars, in IT equipment and software are from BEA's published series on Private Fixed Investment by Type—Tables 5.4 and 5.5, respectively, in the *Survey of Current Business*. Four types of equipment and software are identified in these tables: (1) Information processing equipment and software, (2) Industrial equipment, (3) Transportation equipment, and (4) Other. For presentation purposes, investments of Industrial equipment and Other equipment were added together (using the Fisher-Ideal formula) and compared with the other two categories.

The contribution of IT equipment (Information processing and related equipment) to the growth in capital expenditures (investments) was calculated based on the same formula used to calculate the contribution to real economic growth of the IT-producing industries. Information equipment and software is further broken down into Computers and peripheral equipment, Software, and Other in BEA's tables 5.4 and 5.5.

⁸ This calculation differs from the BEA measure of 'contribution to inflation' which finds that an industry with zero inflation makes a zero contribution to inflation. This calculation does not take zero inflation as its point of reference, but instead takes inflation of the non-IT portion of the economy as its reference point. If inflation in the IT sector had been the same as inflation in the non-IT sector, overall inflation would have been the same as in the non-IT sector. Because IT inflation was substantially below inflation in the non-IT sector, overall inflation was lower than inflation in the non-IT sector.

⁹ See Moulton and Seskin, "A Preview of the 1999 Comprehensive Revision of the National Income and Product Accounts, Statistical Changes," *Survey of Current Business*, October 1999. The new formula to calculate component contributions to economic growth is on page 16.

RESEARCH & DEVELOPMENT IN IT-PRODUCING INDUSTRIES

R&D data are from the National Science Foundation. Appendix Table 3.4 provides company-funded R&D spending for IT-producing industries.

Appendix Table 3.4
**Information Technology Producing Industries:
Research and Development Expenditures, Company-funded**

Industry Group	SIC	1992	1993	1994	1995	1996	1997	1998
		(millions\$)						
All Industries		94,388	94,591	97,131	108,652	121,015	133,611	145,016
Manufacturing		71,025	69,901	73,375	81,236	91,845	101,202	102,211
IT Producing		25,179	25,721	28,523	32,523	39,650	44,933	45,739
Office, computing, and accounting	357	10,614	4,917	4,078	4,669	8,132	12,787	8,890
Communications equipment	366	3,381	3,954	4,939	3,845	4,359	7,377	10,173
Electronic components	367	3,320	5,105	5,870	9,628	12,497	10,786	9,776
Telephone communications	481	4,131	4,320	4,177	4,756	3,970	1,884	1,768
Computer, data processing, eng. services	737,871	3,733	7,425	6,459	9,595	10,026	11,319	14,298
IT Share of Total R&D (percent)		26.7	27.2	29.4	28.9	32.8	33.6	31.5

Source: National Science Foundation.

APPENDIX TO CHAPTER V

THE INFORMATION TECHNOLOGY WORKFORCE

This appendix contains supplemental data, data sources and methodologies for estimating the employment effects of information technologies as described in Chapter 5 of *Digital Economy 2000*.

IT-PRODUCING INDUSTRY EMPLOYMENT

Most of the employment estimates used in this analysis are from the Current Employment Statistics (CES) survey, conducted monthly on a sample of nonfarm establishments by the Bureau of Labor Statistics (BLS) in conjunction with state employment security agencies. (Appendix Table 5.1) Private nonfarm employment includes all full and part-time employees except those in the agricultural and government sectors. These data are published bi-annually in odd years in the November *Monthly Labor Review* (along with 10-year projections) and monthly in *Employment & Earnings*. These data can also be downloaded directly from the BLS website (<http://www.bls.gov>).

For some IT-producing industries, employment data were not available at the 4-digit SIC level, but instead at the 2- or 3-digit SIC level. In four cases, SIC 357 - Computer and office equipment, SIC 367 - Electronic components and accessories, SIC 737 - Computer and data processing services and SIC 48 - Communications, all of the 4-digit sub-industries were identified as IT-producing industries. Therefore, industries for which data were missing could be computed as a residual from the 2- or 3-digit aggregates. For example, all of SIC 48 (Communications services) are IT-producing industries, but CES data are only available for 481, 4832, 4833, and 4841. After subtracting employment levels in SICs 481, 4832, 4833 and 4841 from SIC 48, the residual was reported as employment in a combined industry including SICs 482 and 489.

BLS also collects employment data through the Covered Employment and Wages (ES202) program, a Federal-State cooperative program that counts all employees covered by unemployment insurance programs. These data are published annually in *Employment and Wages, Annual Averages* and are available on the BLS website (<http://www.bls.gov/cewhome.htm>). When CES employment figures were not available at the necessary level of detail (4-digit SIC level) and a residual could not be calculated, employment levels were estimated by applying the 4-digit SIC level employment distribution of the ES202 numbers to the aggregate (3-digit SIC level) CES numbers. When CES employment numbers were not available at the 3-digit SIC level, ES202 employment numbers were used.

**Appendix Table 5.1
Information Technology Producing Industries: Employment Trends, 1992 to 1998**

	SIC Code	1992	1993	1994	1995	1996	1997	1998	Change 1992-98	AAG-% 1992-98
		(Units: 000s)								
Total private employment		89,956	91,872	95,036	97,885	100,189	103,133	106,007	16,051	2.8%
Year to year percent change			2.1%	3.4%	3.0%	2.4%	2.9%	2.8%		
Hardware										
Electronic computers	3571	241.9	216.1	201.1	190.0	189.3	197.2	199.9	-42.0	-3.1
Computers and equipment wholesalers	5045pt.	277.0	270.4	271.2	285.1	304.7	334.8	367.2	90.2	4.8
Computers and equipment retailers	5734pt.	75.4	78.2	84.5	93.7	102.4	115.7	126.3	50.8	9.0
Computer storage devices & peripheral equipment	3572,7	91.3	93.2	97.9	104.5	114.2	118.7	118.5	27.2	4.4
Computer terminals, office and accounting machines	3575,8,9	57.8	54.1	55.2	57.7	58.3	60.0	60.7	2.9	0.8
Electron tubes	3671	26.9	24.8	24.5	24.0	22.9	21.9	20.4	-6.5	-4.5
Semiconductors	3674	217.4	213.8	220.5	235.2	259.6	277.2	284.0	66.6	4.6
Printed circuit boards, electronic capacitors	3672,5-8	156.6	161.6	168.2	187.0	195.7	205.0	207.9	51.3	4.8
Electronic components, n.e.c.	3679	126.5	127.5	131.0	134.6	138.4	146.2	147.7	21.2	2.6
Industrial instruments for measurement	3823	61.0	60.5	62.0	64.2	66.2	66.5	67.0	6.0	1.6
Instruments for measuring electricity	3825	76.1	72.8	71.2	71.2	74.3	75.4	76.9	0.8	0.2
Analytical instruments	3826	28.1	28.1	26.9	28.1	29.7	31.3	32.0	3.9	2.2
Total Hardware		1,436.0	1,401.1	1,414.3	1,475.3	1,555.6	1,649.9	1,708.4	272	2.9
Software and Computer Services										
Computer programming services	7371	168.6	188.3	209.9	245.3	276.2	321.8	369.8	201.2	14.0
Prepackaged software wholesalers	5045pt.	14.6	14.2	14.3	15.0	16.0	17.6	19.3	4.7	4.8
Prepackaged software retailers	5734pt.	3.8	4.0	4.3	4.7	5.2	6.1	6.6	2.8	9.7
Prepackaged software	7372	130.8	144.8	157.4	180.8	201.0	224.5	252.2	121.4	11.6
Computer integrated systems design	7373	102.5	109.5	116.4	129.9	143.5	161.3	178.4	75.9	9.7
Computer processing and data preparation	7374	204.4	207.3	209.5	223.1	230.0	242.9	254.0	49.6	3.7
Information retrieval services	7375	45.2	46.2	48.0	56.9	70.2	83.1	98.3	53.1	13.8
Computer maintenance and repair	7378	42.8	41.8	44.5	48.6	53.3	57.9	60.0	17.2	5.8
Computer services management, rental and leasing	7376,7,9	141.2	154.9	172.9	205.3	253.5	317.9	386.6	245.4	18.3
Total Software and Computer Services		853.9	911.0	977.1	1,109.6	1,248.9	1,433.1	1,625.3	771	11.3
Communications Equipment										
Household audio and video equipment	3651	59.8	59.5	59.9	55.7	54.8	53.8	55.0	-4.8	-1.4
Telephone and telegraph equipment	3661	109.6	110.0	109.5	111.7	114.5	120.0	125.9	16.3	2.3
Radio and TV communications equipment n.e.c.	3663,9	128.9	129.0	138.3	153.2	155.8	157.3	155.7	26.8	3.2
Magnetic and optical recording media 1/	3695	18.3	18.2	18.8	16.7	16.8	17.9	15.9	-2.4	-2.3
Total Communications Equipment		316.6	316.7	326.5	337.3	341.9	349.0	352.5	36	1.8
Communications Services										
Telephone communications	481	885.2	879.0	893.4	899.7	911.4	970.9	1,006.8	121.6	2.2
Telephone and telegraph communications	482,489	25.6	24.4	24.7	26.7	28.4	31.2	34.7	9.1	5.2
Radio broadcasting	4832	112.9	113.3	113.5	113.0	113.3	113.9	115.6	2.7	0.4
Television broadcasting	4833	114.6	116.2	118.7	122.7	127.5	129.1	131.2	16.6	2.3
Cable and other pay TV services	4841	130.6	136.2	144.5	155.5	170.0	174.2	181.1	50.5	5.6
Total Communications Services		1,268.9	1,269.1	1,294.8	1,317.6	1,350.6	1,419.3	1,469.4	201	2.5
Total IT Producing Industries		3,875.4	3,897.9	4,012.8	4,239.9	4,497.0	4,851.3	5,155.6	1,280	4.9
Year to year percent change			0.6%	2.9%	5.7%	6.1%	7.9%	6.3%		
Share of total private employment		4.3%	4.2%	4.2%	4.3%	4.5%	4.7%	4.9%		

Source: Bureau of Labor Statistics

AAG- average annual rate of growth

Estimates of employment by wholesale and retail sellers of computer equipment and software (SICs 5045 and 5734) were divided among the computer hardware and software and computer services categories using the same distribution as value added -- 95 percent to computer hardware and 5 percent to software and computer services.

IT-PRODUCING INDUSTRY WAGES

Industry level wage data are collected through the BLS ES202 program and include gross wages and salaries, bonuses, stock options, tips and other gratuities and in some cases the value of meals and lodging.¹⁰ These estimates along with industry employment were used to compute annual wages per worker. (Appendix Table 5.2) Since employment estimates are from the CES survey and wages are from the ES202 survey, they do not exactly match employment per worker estimates using ES202 employment numbers (as published by the American Electronics Association and Business Software Alliance).

Wage estimates presented in this report are for 1992 to 1998. Estimates for 1991 and earlier are not comparable to recent estimates because of changes in reporting requirements. (See *Covered Employment and Wages Annual, 1997*.) Note that these simple averages are for purposes of comparing relative wages across industries and should not be interpreted as official BLS estimates of mean or median earnings. Estimates of wages per worker include all occupations in each industry and should not be confused with earnings for specific occupations which are discussed below.

IT OCCUPATIONAL EMPLOYMENT

Occupations considered to be essential to IT and to electronic commerce were selected based on consultations with BLS and are the same as those used for the original EDE report. Our definition of IT occupations is broader than the “core” IT occupations *i.e.*, computer scientists, engineers, programmers and systems analysts used by the Technology Administration, National Science Foundation, Information Technology Association of America and others. This is because the definition of IT occupations used in this analysis covers occupations not only involved in conducting electronic commerce, but in maintaining the infrastructure that enables it. See box below.

¹⁰ Bureau of Labor Statistics, *BLS Handbook of Methods*, April 1997. (<http://www.bls.gov/pdf/homch5.pdf>)

Appendix Table 5.2

Information Technology Producing Industries: Annual Wages Per Worker, 1992 to 1998

	SIC	1992	1993	1994	1995	1996	1997	1998	Change 1992-98	AAG-% 1992-98
Average All Private Industries		\$25,400	\$25,700	\$26,200	\$27,200	\$28,300	\$29,800	\$31,400	\$6,100	3.6
IT-Producing Industries		\$41,300	\$42,500	\$43,900	\$46,400	\$49,200	\$52,900	\$58,000	\$16,700	5.8
Hardware										
Electronic computers	3571	\$52,400	\$54,700	\$55,600	\$59,600	\$62,400	\$69,800	\$83,900	\$31,500	8.2
Computer equipment wholesalers	5045pt.	\$52,500	\$52,900	\$52,900	\$54,300	\$56,700	\$62,200	\$69,700	\$17,200	4.8
Computer equipment retailers	5734pt.	\$32,200	\$30,500	\$32,100	\$33,800	\$35,000	\$37,300	\$40,400	\$8,200	3.9
Computer storage devices & peripheral equipment	3572,7	\$41,200	\$42,700	\$42,900	\$46,500	\$51,000	\$58,400	\$57,400	\$16,300	5.7
Computer terminals, office and accounting machines	3575,8,9	\$43,300	\$44,800	\$44,300	\$46,600	\$49,500	\$52,900	\$56,900	\$13,600	4.7
Electron tubes	3671	\$38,400	\$37,600	\$39,800	\$41,900	\$41,000	\$44,200	\$46,400	\$8,100	3.2
Semiconductors	3674	\$44,500	\$47,400	\$49,500	\$53,800	\$54,400	\$59,700	\$64,400	\$19,900	6.4
Printed circuit boards, electronic capacitors	3672,5-8	\$25,700	\$26,500	\$27,500	\$28,300	\$29,400	\$31,600	\$32,900	\$7,200	4.2
Electronic components, n.e.c.	3679	\$29,700	\$30,700	\$31,900	\$32,900	\$33,900	\$35,600	\$37,500	\$7,800	4.0
Industrial instruments for measurement	3823	\$35,100	\$35,800	\$37,000	\$38,400	\$40,500	\$43,200	\$46,400	\$11,300	4.8
Instruments for measuring electricity	3825	\$42,500	\$44,000	\$48,200	\$51,600	\$54,500	\$59,300	\$62,900	\$20,400	6.8
Laboratory analytical instruments	3826	\$38,700	\$39,200	\$42,600	\$44,200	\$50,100	\$49,900	\$54,300	\$15,500	5.8
Hardware		\$42,400	\$43,300	\$44,200	\$46,300	\$48,300	\$52,800	\$58,000	\$15,600	5.4
Software and Computer Services										
Computer programming services	7371	\$46,200	\$47,600	\$50,100	\$52,700	\$56,900	\$60,000	\$64,700	\$18,400	5.8
Prepackaged software	7372	\$57,000	\$54,500	\$57,000	\$63,700	\$70,100	\$79,200	\$94,100	\$37,100	8.7
Prepackaged software wholesalers	5045pt.	\$52,500	\$52,900	\$52,900	\$54,300	\$56,700	\$62,200	\$69,700	\$17,200	4.8
Prepackaged software retailers	5734pt.	\$32,200	\$30,500	\$32,100	\$33,800	\$35,000	\$37,300	\$40,400	\$8,200	3.9
Computer integrated systems design	7373	\$48,600	\$49,700	\$52,700	\$54,700	\$59,400	\$62,000	\$65,400	\$16,800	5.1
Computer processing and data preparation	7374	\$34,400	\$36,100	\$36,600	\$39,700	\$43,300	\$44,700	\$45,800	\$11,400	4.9
Information retrieval services	7375	\$36,700	\$38,900	\$38,600	\$42,200	\$45,300	\$48,500	\$63,700	\$27,000	9.6
Computer maintenance and repair	7378	\$36,600	\$37,500	\$37,200	\$37,800	\$39,500	\$40,100	\$41,200	\$4,600	2.0
Computer services management, rental and leasing	7376,7,9	\$46,000	\$46,800	\$48,900	\$51,800	\$54,600	\$58,700	\$64,100	\$18,100	5.7
Software and Computer Services		\$44,300	\$45,300	\$47,200	\$50,700	\$54,900	\$58,800	\$65,300	\$20,900	6.7
Communications Equipment										
Household audio and video equipment	3651	\$32,700	\$33,900	\$36,900	\$32,400	\$35,100	\$39,300	\$40,700	\$8,100	3.7
Telephone and telegraph equipment	3661	\$42,400	\$45,400	\$46,800	\$49,900	\$54,600	\$57,400	\$62,400	\$20,100	6.7
Radio and TV communications equipment n.e.c.	3663,9	\$39,100	\$40,300	\$40,100	\$42,700	\$44,400	\$48,000	\$52,100	\$13,000	4.9
Magnetic and optical imaging devices	3695	\$37,500	\$38,800	\$39,300	\$39,200	\$45,700	\$43,000	\$45,800	\$8,400	3.4
Communications Equipment		\$38,900	\$40,800	\$41,700	\$43,200	\$46,400	\$49,700	\$53,700	\$14,800	5.5
Communications Services										
Telephone communications	481	\$41,400	\$43,300	\$45,100	\$46,800	\$48,700	\$50,900	\$53,700	\$12,400	4.4
Telephone and telegraph communications	482,489	\$41,700	\$44,100	\$47,200	\$48,500	\$52,900	\$54,600	\$56,200	\$14,500	5.1
Radio broadcasting	4832	\$23,500	\$24,300	\$26,000	\$27,200	\$29,300	\$31,300	\$34,200	\$10,700	6.5
Television broadcasting	4833	\$41,400	\$42,200	\$43,700	\$47,200	\$51,100	\$51,000	\$54,600	\$13,200	4.7
Cable and other pay TV services	4841	\$29,600	\$30,500	\$31,400	\$34,600	\$35,500	\$37,900	\$42,200	\$12,600	6.1
Communications Services		\$38,600	\$40,100	\$41,800	\$43,700	\$45,700	\$47,800	\$50,900	\$12,300	4.7

Source: ESA calculations based on BLS data.

AAG- average annual rate of growth

IT-Related Occupations

Engineering, science, and computer systems managers	Electrical and electronics engineers
Database administrators	Computer engineers
Systems analysts	Computer support specialists
Computer programmers	All other computer scientists
Broadcast technicians	Electrical and electronics technicians
Computer equipment operators	Duplicating, mail and other office machine operators
Data processing equipment repairers	Billing, posting and calculating machine operators
Communications equipment operators	Data entry keyers
Electrical powerline installers and repairers	Electronics repairers, commercial and industrial equip.
Telephone and Cable TV installers and repairers	Electrical and electronic equipment assemblers, precision
Central office and PBX installers and repairers	Electromechanical equipment assemblers, precision
	Electronic semiconductor processors

The source for employment by occupation and industry is the BLS *National Industry-Occupation Matrix 1992, 1994, 1996 and 1998*, compiled by the Office of Employment Projections (OEP). Employment by occupation is published biannually in the November (odd year) issue of the *Monthly Labor Review*. Employment by occupation *and* industry are available on the BLS website (<http://www.bls.gov/emphome.htm>.)

Employees in IT occupations were counted across all industries, including Government. The net employment estimate for the IT workforce of 7.8 million was derived by combining employment of IT industries with employment of workers with IT occupations and subtracting workers with IT occupations in IT industries.

EDUCATION AND TRAINING REQUIREMENTS BY OCCUPATION

The Bureau of Labor Statistics classifies occupations into 1 of 11 categories that describe the education and training needed by most workers to become fully qualified *Note that these education and training categories were not intended to be measured as skills.* The eleven categories include occupations that require training ranging from short-term on-the-job training to a first professional degree. The box below shows the 11 BLS categories and how they correspond to the three levels of training intensity presented in Appendix Table 5.3. Because of changes in the OES survey methodology, 1998 employment estimates for some computer occupations are not comparable to those for 1996 and earlier.

Concordance of BLS and ESA Education and Training Requirement Levels	
BLS Categories	ESA Intensity Levels
First professional degree	High
Doctoral degree	High
Master's degree	High
Work experience, plus a bachelor's or higher degree	High
Bachelor's degree	High
Associate's degree	High
Post-secondary vocational training	Moderate
Work experience in a related occupation.	Moderate
Long-term on-the-job training	Moderate
Moderate-term on-the-job training	Low
Short-term on-the-job training	Low

**Appendix Table 5.3
Information Technology Occupations:
Employment and Education/Training Requirements, 1992 to 1998**

(000s)

	1992	1994	1996	1998	AAG-% 1992-98	AAG-% 1994-98
All Occupations	121,279	127,143	132,444	140,514	2.5	2.5
All IT Occupations	4,336	4,498	4,740	5,308	3.4	4.2
Education and Training Requirements -- HIGH*	2,251	2,364	2,508	3,196	6.0	7.8
Computer scientists, engineers and systems analysts	666	827	933	1,530	14.9	16.6
Computer programmers	555	537	568	648	2.6	4.8
Engineering, natural science, and computer and information systems managers	337	337	343	326	-0.5	-0.8
Electrical and electronics engineers	370	349	367	357	-0.6	0.6
Electrical and electronic technicians and technologists	323	314	297	335	0.6	1.6
Education and Training Requirements -- MODERATE	1,207	1,208	1,315	1,260	0.7	1.1
Broadcast and sound technicians	35	42	46	37	0.8	-3.4
Data entry keyers	448	414	436	435	-0.5	1.2
Central office and PBX installers and repairers	70	84	81	44	-7.3	-14.7
Data processing equipment repairers	83	75	80	79	-0.7	1.4
Electronic semiconductor processors	32	33	58	63	12.1	17.7
Electronics repairers, commercial and industrial equipment	68	66	60	72	0.9	2.0
Telephone and cable TV line installers and repairers	165	191	201	180	1.5	-1.4
Electrical powerline installers and repairers	108	112	108	99	-1.5	-3.1
Electromechanical equipment assemblers, precision	48	47	51	50	0.5	1.3
Electrical and electronic equipment assemblers, precision	150	144	194	201	5.0	8.7
Education and Training Requirements -- LOW	878	926	917	852	-0.5	-2.1
Communications equipment operators	327	319	328	297	-1.6	-1.7
Computer operators	296	289	291	251	-2.7	-3.5
Duplicating, mail, and other office machine operators	162	222	196	197	3.3	-2.9
Billing and posting clerks and machine operators	93	96	102	107	2.3	2.6

High: Associate degree, bachelor's degree or work experience plus a bachelor's degree or higher

Moderate: long-term on-the-job training, work experience in a related occupation or post secondary vocational training

Low: short to moderate-term on-the-job training

AAG- average annual rate of growth

*The grouping of education and training categories into high, moderate and low requirement levels reflects the author's interpretation of training intensity. BLS classifies occupations into 11 categories that describe education and training needed by most workers to become fully qualified. A description of these education and training categories can be found in the November 1999, Monthly Labor Review, p. 76.

Source: Bureau of Labor Statistics.

IT OCCUPATIONAL WAGES

Wages are collected as part of the Occupational Employment Statistics (OES) survey. The OES survey is conducted in a three year cycle, during which one-third of the sample is surveyed each year. Because of changes in methodology, 1998 wage and employment estimates for some computer occupations are not comparable to those for 1996 and earlier. The 1998 mean wage estimates for each occupation are shown in Appendix Table 5.4 and are available at the OES website (<http://www.bls.gov/oeshome.htm>).

Median weekly earnings for selected IT occupations are published in the January *Employment & Earnings*. These estimates are from a household survey and are not directly comparable to the OES estimates, which are from an establishment survey.

**Appendix Table 5.4
Information Technology Occupations: Wages, 1998**

Occupation	Description of Duties	Mean Annual Wages
Engineering, science, and computer systems managers	Plan, coordinate, and direct research, development, design, production and computer-related activities.	\$71,900
Electrical and electronic engineers	Design, develop, test, and supervise the manufacture of electrical and electronic equipment, including computer hardware and communications and video equipment.	\$59,700
Computer engineers	Design hardware, software, networks, and processes to solve technical problems.	\$59,900
Systems analysts	Solve computer problems and enable computer technology to meet the specific needs of an organization.	\$54,100
Computer programmers	Develop and write computer programs to store, locate, and retrieve specific documents, data, and information.	\$53,400
Database administrators	Use database management systems to coordinate changes to, testing, or implementing computer data bases. May coordinate measures for system security.	\$50,500
Computer support specialists	Provide technical assistance and training to computer system users and investigate and resolve computer software and hardware problems;	\$40,600
Electrical and electronic technicians	Help design, develop, test, and manufacture electrical and electronic equipment including computers.	\$38,100
Computer operators	Oversee the operation of computer hardware systems and must anticipate problems, take preventive action and solve problems that occur.	\$26,900
Broadcast technicians	Repair, set up, and operate electronic equipment used to record and transmit radio and television programs.	\$31,800
Communications equipment operators (telephone and switchboard operators, etc.)	Relay incoming, outgoing, and interoffice calls, supply information to callers, record messages, and may perform routine clerical work.	\$19,100 to \$28,400
Duplicating, mail, and other machine operators	Operate a variety machines that produce copies and machines that print names, addresses, etc. on envelopes or forms.	\$19,600
Billing, posting, and calculating machine operators	Operate machines that automatically perform mathematical processes to calculate and record billing, accounting, statistical, and other numerical data.	\$21,300
Data entry keyers, composing	Operate photocomposing or comparable data entry composing machines.	\$21,300
Central office and PBX installers and repairers	Install, test, analyze, and repair telephone or telegraph circuits and equipment.	\$42,900
Data processing equipment repairers	Repair, maintain, and install electronic computers (mainframes, minis, and micros) and peripheral equipment.	\$31,500
Electronics repairers, commercial and industrial equipment	Install and repair industrial controls, including communications and medical diagnostic equipment.	\$35,800
Electrical and electronic equipment assemblers, precision	Assemble electrical or electronic equipment, such as computers, numerical control machine tools and telemetering systems or appliances.	\$23,400
Electromechanical equipment assemblers, precision	Assemble, test, and prepare electromechanical equipment such dynamometers, magnetic drums and tape drives, according to specifications.	\$24,200
Telephone and cable television line installers and repairers	String and repair telephone and television cable and other equipment for transmitting messages or TV programming.	\$34,500
Electrical powerline installers and repairers	Install and repair cables or wires used in electrical power or distribution systems.	\$42,600
Electronic semiconductor processors	Process materials used in manufacture of electronic semiconductors, e.g., load semiconductor materials into special purpose furnaces or chemical baths.	\$26,070

Source: Bureau of Labor Statistics.

Appendix to Chapter VI

**TRADE IN INFORMATION TECHNOLOGY
GOODS AND SERVICES**

Appendix Table 6.1
U.S. Trade in IT Goods – Exports

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					(Units: \$ Billions)					
Total U.S. Exports	57.6	59.8	63.7	69.8	83.6	100.8	107.5	124.7	120.6	130.6
Computer and Office Equipment										
Electronic computers	7.6	7.6	7.9	7.6	8.7	9.2	9.4	10.1	8.4	8.3
Computer storage devices	2.7	2.9	3.1	3.1	3.4	3.8	3.3	3.5	3.4	3.4
Computer peripheral equipment, nec	12.7	13.4	13.9	14.5	16.9	21.3	24.9	27.9	26.4	26.8
Calculating and accounting equipment	0.5	0.5	0.6	0.4	0.4	0.5	0.6	0.7	0.7	0.7
Office machines, nec	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8	0.7
Total Computer and Office Equipment	24.0	25.0	26.1	26.3	30.1	35.5	39.0	42.9	39.7	39.8
Audio, Video, and Communications Equipment										
Household audio and video equipment	2.1	2.3	2.5	2.7	3.1	3.3	3.5	4.1	4.5	3.8
Telephone and telegraph apparatus	2.4	2.5	3.3	4.0	4.8	5.8	6.6	7.3	7.9	9.1
Radio and TV communications equipment	2.8	2.8	3.1	4.1	5.3	6.8	6.4	8.6	8.2	8.2
Total Audio, Video, and Comm. Equipment	7.3	7.6	8.9	10.8	13.2	15.9	16.5	20.1	20.6	21.1
Electronic Components and Accessories										
Electron tubes	0.6	0.8	0.8	0.9	1.2	1.5	1.7	2.3	2.5	2.4
Printed circuit boards	1.8	1.4	1.1	1.0	1.4	1.7	1.7	2.0	2.2	2.4
Semiconductors and related devices	10.7	10.9	11.4	13.7	17.6	22.7	24.0	29.0	29.0	36.6
Electronic capacitors	0.5	0.6	0.6	0.7	0.8	1.1	1.3	1.6	1.4	1.7
Electronic resistors	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6
Electronic coils and transformers	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5
Electronic connectors	1.0	1.0	1.0	1.2	1.6	1.7	1.9	2.3	2.1	2.3
Electronic components, nec	2.3	2.6	2.8	3.1	4.2	5.4	5.0	6.1	5.3	5.6
Total Electronic Components and Accessories	17.4	17.5	18.1	21.0	27.3	34.7	36.4	44.2	43.5	52.1
Scientific Instruments										
Process and control instruments	2.0	2.0	2.1	2.5	2.9	3.1	3.1	3.7	3.7	4.0
Instruments to measure electricity	2.6	2.7	2.9	3.0	3.2	3.9	4.4	5.2	5.1	5.7
Analytical instruments	1.3	1.7	1.9	2.0	2.1	2.4	2.6	2.8	2.8	3.0
Total Scientific Instruments	6.0	6.5	6.9	7.5	8.3	9.5	10.1	11.7	11.6	12.7
Magnetic Recording Media	1.7	1.8	1.7	1.7	1.7	2.0	2.7	2.6	2.0	1.7
Prepackaged Software	1.2	1.5	2.0	2.5	3.1	3.2	2.8	3.3	3.2	3.3

Source: International Trade Administration, U.S. Department of Commerce.

Appendix Table 6.1 (cont'd)
U.S. Trade in IT Goods – Imports

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Units: \$ Billions)									
Total U.S. Imports	69.0	74.4	85.1	99.0	122.0	151.2	154.1	167.1	171.5	196.4
Computer and Office Equipment										
Electronic computers	2.6	4.0	4.6	5.5	5.2	4.9	6.4	7.3	7.2	10.1
Computer storage devices	6.0	6.3	8.5	9.3	11.0	14.2	16.4	19.5	18.1	16.9
Computer peripheral equipment, nec	6.3	7.2	8.7	10.8	18.4	21.4	24.6	28.6	29.2	33.9
Calculating and accounting equipment	1.0	0.9	1.0	1.2	1.2	1.2	1.3	1.4	1.5	1.4
Office machines, nec	0.9	0.8	0.9	1.0	1.2	1.5	1.4	1.3	1.4	1.3
Total Computer and Office Equipment	16.7	19.2	23.7	27.7	37.1	43.2	50.0	58.1	57.4	63.6
Audio, Video, and Communications Equipment										
Household audio and video equipment	10.9	11.3	12.8	13.4	16.6	18.0	16.9	18.5	21.2	23.8
Telephone and telegraph apparatus	4.1	4.5	5.2	5.6	5.9	5.9	6.3	7.2	7.8	9.7
Radio and TV communications equipment	4.4	4.3	4.1	4.7	5.8	6.6	6.8	6.1	6.7	10.5
Total Audio, Video, and Comm. Equipment	19.4	20.2	22.1	23.7	28.4	30.5	30.0	31.7	35.7	44.0
Electronic Components and Accessories										
Electron tubes	0.8	0.8	0.9	1.0	1.2	1.4	1.2	1.1	1.0	0.9
Printed circuit boards	1.9	1.9	1.2	1.3	1.5	1.9	1.9	2.1	2.0	2.2
Semiconductors and related devices	12.1	13.0	15.4	19.6	26.1	39.2	37.0	37.0	33.7	37.8
Electronic capacitors	0.5	0.5	0.6	0.7	0.8	1.1	1.0	1.2	1.3	1.7
Electronic resistors	0.4	0.4	0.4	0.5	0.5	0.7	0.6	0.6	0.6	0.7
Electronic coils and transformers	0.5	0.5	0.6	0.7	0.8	0.9	0.9	1.1	1.1	1.2
Electronic connectors	1.2	1.1	1.2	1.4	1.7	2.1	2.0	2.3	2.2	2.5
Electronic components, nec	11.1	11.7	13.4	16.2	16.6	22.1	20.7	22.3	26.2	30.9
Total Electronic Components and Accessories	28.4	30.0	33.7	41.3	49.2	69.3	65.4	67.8	68.1	77.8
Scientific Instruments										
Process and control instruments	1.1	1.2	1.4	1.8	2.6	2.9	2.8	3.0	3.4	3.7
Instruments to measure electricity	1.1	1.2	1.2	1.3	1.5	1.8	2.1	2.4	2.5	2.7
Analytical instruments	0.7	0.8	0.8	0.8	0.9	1.1	1.2	1.4	1.7	1.9
Total Scientific Instruments	3.0	3.1	3.5	3.9	4.9	5.8	6.0	6.8	7.5	8.3
Magnetic Recording Media	1.5	1.7	1.7	1.9	1.9	1.9	2.1	2.1	2.1	2.2
Prepackaged Software	0.2	0.2	0.3	0.4	0.5	0.6	0.5	0.6	0.6	0.5

Source: International Trade Administration, U.S. Department of Commerce.

Appendix Table 6.1 (cont'd)
U.S. Balance in IT Goods – (Exports minus Imports)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Units: \$ Billions)									
U.S. Balance in IT Goods	-11.5	-14.6	-21.4	-29.2	-38.4	-50.4	-46.6	-42.5	-50.9	-65.9
Computer and Office Equipment										
Electronic computers	5.0	3.6	3.3	2.1	3.4	4.3	3.0	2.8	1.1	-1.8
Computer storage devices	-3.3	-3.4	-5.4	-6.2	-7.6	-10.4	-13.1	-16.0	-14.7	-13.5
Computer peripheral equipment, nec	6.4	6.2	5.2	3.8	-1.6	-0.1	0.3	-0.7	-2.7	-7.1
Calculating and accounting equipment	-0.4	-0.3	-0.4	-0.7	-0.8	-0.7	-0.7	-0.7	-0.7	-0.8
Office machines, nec	-0.4	-0.3	-0.3	-0.4	-0.5	-0.8	-0.6	-0.5	-0.6	-0.6
Total Computer and Office Equipment	7.3	5.8	2.3	-1.4	-7.0	-7.7	-11.1	-15.2	-17.7	-23.8
Audio, Video, and Communications Equipment										
Household audio and video equipment	-8.8	-9.0	-10.4	-10.7	-13.5	-14.6	-13.4	-14.4	-16.7	-20.1
Telephone and telegraph apparatus	-1.7	-2.0	-1.9	-1.6	-1.2	-0.1	0.3	0.2	0.1	-0.6
Radio and TV communications equipment	-1.5	-1.6	-1.0	-0.6	-0.5	0.2	-0.4	2.6	1.5	-2.3
Total Audio, Video, and Comm. Equipment	-12.1	-12.6	-13.2	-12.9	-15.2	-14.5	-13.4	-11.6	-15.2	-23.0
Electronic Components and Accessories										
Electron tubes	-0.1	-0.1	-0.2	-0.1	0.0	0.2	0.5	1.1	1.5	1.5
Printed circuit boards	0.0	-0.5	-0.2	-0.3	-0.1	-0.2	-0.2	-0.1	0.1	0.1
Semiconductors and related devices	-1.4	-2.2	-4.0	-5.9	-8.5	-16.5	-13.0	-8.1	-4.8	-1.2
Electronic capacitors	0.0	0.1	0.1	0.0	0.0	0.0	0.3	0.4	0.2	0.0
Electronic resistors	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3	-0.2	-0.1	-0.1	0.0
Electronic coils and transformers	-0.3	-0.3	-0.4	-0.5	-0.5	-0.7	-0.6	-0.7	-0.7	-0.7
Electronic connectors	-0.2	-0.2	-0.2	-0.2	-0.1	-0.3	-0.2	-0.1	-0.1	-0.2
Electronic components, nec	-8.8	-9.2	-10.6	-13.1	-12.4	-16.7	-15.7	-16.2	-20.9	-25.3
Total Electronic Components and Accessories	-11.0	-12.5	-15.6	-20.3	-21.9	-34.6	-29.0	-23.6	-24.7	-25.7
Scientific Instruments										
Process and control instruments	0.9	0.9	0.7	0.7	0.3	0.2	0.3	0.7	0.4	0.3
Instruments to measure electricity	1.5	1.5	1.8	1.7	1.8	2.1	2.4	2.7	2.6	3.0
Analytical instruments	0.6	1.0	1.0	1.2	1.2	1.4	1.4	1.4	1.1	1.1
Total Scientific Instruments	3.0	3.4	3.5	3.6	3.3	3.7	4.0	4.9	4.1	4.4
Magnetic Recording Media	0.2	0.1	0.0	-0.3	-0.2	0.1	0.6	0.5	-0.1	-0.5
Prepackaged Software	1.0	1.3	1.7	2.1	2.6	2.6	2.3	2.7	2.6	2.8

Source: International Trade Administration, U.S. Department of Commerce.

**Appendix Table 6.2
U.S. Trade in IT Services**

	1990	1991	1992	1993	1994	1995	1996	1997	1998
	(Units: \$ Billions)								
Total U.S. Exports	4.0	5.5	5.4	5.8	6.7	7.4	8.2	10.2	10.9
Telecommunications services	2.7	3.3	2.9	2.8	2.9	3.2	3.3	3.9	3.7
Computer-related services	1.3	2.2	2.5	3.0	3.8	4.1	4.9	6.2	7.2
Software royalties*	-	-	1.1	1.3	1.5	1.7	2.1	2.7	3.2
Computer and information services	1.3	2.2	1.4	1.7	2.3	2.4	2.8	3.5	4.0
Total U.S. Imports	5.7	6.8	6.3	6.8	7.3	7.9	8.9	9.2	9.1
Telecommunications services	5.6	6.6	6.1	6.4	6.9	7.3	8.3	8.4	8.1
Computer-related services	0.1	0.2	0.2	0.4	0.4	0.6	0.6	0.9	1.0
Software royalties*	-	-	0.1	0.2	0.2	0.3	0.2	0.5	0.5
Computer and information services	0.1	0.2	0.1	0.2	0.2	0.3	0.4	0.4	0.5
U.S. Balance in IT Services	-1.6	-1.3	-0.8	-1.0	-0.6	-0.5	-0.7	0.9	1.8
Telecommunications services	-2.8	-3.3	-3.2	-3.6	-4.1	-4.1	-5.0	-4.4	-4.4
Computer-related services	1.2	2.0	2.3	2.6	3.4	3.6	4.3	5.3	6.2
Software royalties*	-	-	1.1	1.1	1.3	1.4	2.0	2.2	2.8
Computer and information services	1.2	2.0	1.3	1.5	2.1	2.1	2.4	3.1	3.5

*For 1990 and 1991, software royalties are included in the data for computer and information services.

Source: Bureau of Economic Analysis.