

Chapter III

Information Technology Industries in the New Economy

by David Henry and Donald Dalton*

The second half of 2000 marked a turning point in recent U.S. economic experience. GDP growth decelerated sharply from 4 percent (annualized) in the first half of 2000, to 1-1/2 percent in the second half of that year. In the third quarter of 2001, for the first time since 1992, the U.S. economy began to decline.

Though the speed of these events was surprising, economists had long anticipated a slowdown and suggested that its arrival would test broadly held notions about the long-term strength of the digital economy. In March 2000, Nobel Laureate Robert Solow observed that he would “feel better about the endurance of the productivity improvement after it [had survived] its first recession.”¹

This chapter is written during, rather than after a recession, and in the wake of an event that has deeply clouded the nation’s near-term economic future. In the midst of uncertainty, the chapter’s method is to seek clues about the way ahead by looking carefully at the way we have come. Simply put, its question is what can the last seven quarters of economic experience tell us about effects of IT on America’s long-term economic strength?

The chapter looks particularly at recent changes in industry contributions to U.S. economic growth,

recent developments in the composition of investment, and changing patterns of private sector R&D. It finds that IT-producing industries continued in 2000, as in prior years, to contribute disproportionately to overall economic growth. At the same time, sharply declining business demand for IT capital equipment and software accounted for much of the slowdown in overall growth that began in mid 2000.

Strength in IT-producing industries, however, is only one indicator of a new economy.² A second measure is the diffusion and increasingly productive use of IT goods and services both inside and outside the IT producing sector. Here, events of the last 2 years give reasons for optimism. While the rate of IT investment has fallen sharply, American businesses are still adding to the nation’s IT capital stock. Moreover, businesses are continuing to deploy more products and services (e.g., software and computer services) that can facilitate productive use of the IT hardware that has already been installed.

Together with the analyses in other chapters (especially Chapter IV on the contributions of non-IT producing industries to accelerated productivity growth), these findings suggest that even in this period of cyclical slowdown, U.S. industries

*Mr. Henry is a senior industry analyst and Mr. Dalton is an economist in the Office of Business and Industrial Analysis, Office of Policy Development, Economics and Statistics Administration.

¹ Louis Uchitelle quotes Solow in “Productivity Finally Shows the Impact of Computers,” *New York Times*, New York, March 12, 2000.

² We define the “new economy” as an economy in which IT and related investments drive higher rates of productivity growth. U.S. experience in the late-1990s suggests that new economies are capable of long periods of rapid growth with low inflation and low unemployment. Events since July 2000 indicate that IT-related changes in the organization of production and the composition of employment also support atypically high rates of productivity growth in periods of economic slowdown.

are continuing to discover and exploit IT's productive potential and to create the foundations of a structurally stronger economy.

In this chapter and throughout the report, IT-producing industries are defined as producers of goods and services that support IT-enabled business practices and processes across the economy, as well as the Internet and e-commerce. (The Appendix to Chapter 3 includes a more complete discussion of this definition.) The industries meeting these criteria are listed below. (Box 3.1.)

The chapter is divided into three major sections—the first examines output growth in the IT-producing sector during 2000 and its relation to the performance of the rest of the economy; the second looks at categories of demand for IT goods and services for the seven quarters ending in September 2001 (*i.e.*, patterns of business investment, but also consumer and government purchases of IT goods and services); and the third

considers recent changes in the composition of corporate R&D.

OUTPUT GROWTH IN IT PRODUCING INDUSTRIES AND IT'S RELATIONSHIP TO THE ECONOMY AT LARGE 1996-2000

IT Industries' Contribution to Economic Growth—1996-2000

In nominal and real (inflation adjusted) dollars, output³ from IT-producing industries as a group continued to grow at double-digit rates in 2000. (Tables 3.1 and 3.2) Growth was particularly strong in software and services, and communications equipment.

³ Output as measured by its Gross Product Originating (GPO). GPO equals an industry's total output less the cost of goods and services used to produce it. See the Appendix for a more detailed explanation of GPO and why it is used here.

Box 3.1

INFORMATION TECHNOLOGY PRODUCING INDUSTRIES

Hardware Industries

Computers and equipment
Wholesale trade of computers and equipment
Retail trade of computers and equipment
Calculating and office machines
Magnetic and optical recording media
Electron tubes
Printed circuit boards
Semiconductors
Passive electronic components
Industrial instruments for measurement
Instruments for measuring electricity
Laboratory analytical instruments

Communications Equipment Industries

Household audio and video equipment
Telephone and telegraph equipment
Radio and TV communications equipment

Software/Services Industries

Computer programming services
Prepackaged software
Wholesale trade of software
Retail trade of software
Computer-integrated system design
Computer processing, data preparation
Information retrieval services
Computer services management
Computer rental and leasing
Computer maintenance and repair
Computer related services, nec

Communications Services Industries

Telephone and telegraph communications
Cable and other TV services

* Although Radio and TV broadcasting industries were included as IT-producing industries in prior Digital Economy publications, they are not included in this report because they are now considered "content" providers, not IT infrastructure producing sectors.

Adjusted for inflation, output growth in IT-producing industries in 2000 was nearly 20 percent—roughly the same rate as in the previous four years. (Table 3.2) Growth in communications equipment jumped to almost 29 percent—near its 1997 peak. Growth in IT hardware, though down from its peak in 1998, remained exceptionally strong (28 percent).

During 2000, despite the overall economic slowdown, businesses continued to build real net capital stocks⁴ of information processing equipment and software at about the same rate as in the prior four years. (Table 3.3) However, this aggregate stability masked a considerable shift

in the composition of investment. Growth in the net stock of computer capital slowed dramatically, while additions to the net stock of software continued at about the same rate as in 1999, and additions to the net stock of communications equipment sharply accelerated. (Analysis in Chapter I indicates that U.S. businesses continued to add to net IT capital stocks in 2001, though at a much slower rate.)

In 2000, IT-producing industries continued as in 1996-99 to play an important role in economic growth. During 1996-99, when the economy grew by an average 4 percent, the IT-producing sector, which accounted for an average annual 7 percent of GDP, grew by an average 22 percent per year (in inflation adjusted dollars), and was responsible for an average 29 percent of the

⁴ Real net capital stock equals the value of installed capital, plus new investment, minus depreciation.

**TABLE 3.1: IT-PRODUCING INDUSTRIES, BY SECTOR:
GROSS PRODUCT ORIGINATING (GPO)**

	1996	1997	1998	1999	2000
(\$Billions)					
Total	522.0	588.4	646.9	718.2	796.6
Hardware	171.1	197.5	210.9	225.4	251.7
Software and services	131.5	153.9	185.6	214.0	245.7
Communications equipment	32.4	43.9	46.7	51.4	61.5
Communications services	186.9	193.2	203.7	227.4	237.8
(Annual Change – Percent)					
Total	10.8	12.7	9.9	11.0	10.9
Hardware	10.1	15.4	6.7	6.9	11.7
Software and services	18.1	17.0	20.6	15.3	14.8
Communications equipment	5.4	35.3	6.4	10.1	19.6
Communications services	7.8	3.4	5.4	11.6	4.6

Source: ESA estimates derived from BEA and Census data.

**TABLE 3.2: IT-PRODUCING INDUSTRIES, BY SECTOR:
REAL GPO GROWTH**

	1996	1997	1998	1999	2000
(percent)					
Total IT-producing	22.7	20.0	24.7	20.7	18.5
Hardware	46.9	43.4	50.4	32.4	28.1
Software and services	13.6	6.1	24.2	12.0	13.5
Communications equipment	24.0	35.3	23.2	19.7	28.8
Communications services	9.4	2.6	9.4	18.0	11.9

Source: ESA estimates derived from BEA and Census data.

**TABLE 3.3: NET STOCKS
OF INFORMATION PROCESSING EQUIPMENT AND SOFTWARE**

	1996	1997	1998	1999	2000
Information processing equipment and software	906.0	1,010.8	1,141.7	1,287.2	1,464.8
Computers and equipment	101.5	144.5	204.4	284.7	307.0
Software	173.7	201.9	238.1	275.2	315.2
Communication equipment	363.8	393.0	430.2	478.5	549.4
Instruments	175.0	182.1	191.4	200.7	209.8
Information processing equipment and software	10	12	13	13	14
Computers and equipment	39	42	41	39	8
Software	12	16	18	16	15
Communication equipment	7	8	10	11	15
Instruments	5	4	5	5	5

Source: Bureau of Economic Analysis

country's overall real economic growth. In 2000, when the economy also grew rapidly, the IT-producing sector, now 8 percent of GDP, grew by 19 percent and accounted for 26 percent of real economic growth. (Table 3.4)

IT Investment Spending in the Current Economic Slowdown

Experience since the beginning of 2001 suggests that the dynamism of IT-producing industries is double-edged. Just as the extraordinary growth in these industries made their share of overall growth much larger than their share of the economy in the period before December 2000, so rapidly slowing demand for IT capital goods has contributed substantially to economic weakness in 2001. (Table 3.5) During the first three quarters of 2001, for the first time in a decade, reductions in business spending on information processing equipment and software had a negative effect on economic growth.⁵ Because real information processing (IP) business spending was es-

⁵ This chapter's analysis of annual data through 2000 has used total U.S. IT industry output sold to business, government, consumers, and export markets. To examine 2001, however, because industry output data are not yet available, we must turn to current quarterly data on U.S. business investment spending. These data are the best available proxy for current trends in the U.S. IT industry, but have important limitations: they not only exclude government and consumers, but also business spending on intermediate IT inputs; they also include imports for business investment and exclude exports. Nonetheless, because U.S. business spending for investment represents the largest single market for IT producers' output, it provides a useful indication of the importance of IT in 2001.

entially unchanged between the third and fourth quarter of 2001, it made no contribution up or down to growth in the fourth quarter.

DEMAND FOR IT GOODS AND SERVICES THROUGH THE THIRD QUARTER OF 2001

Business Investment

Despite slowing output growth and slower growth in business investment overall, business spending on information processing equipment and software continued to grow at double-digit rates through end of 2000. In the first quarter of 2001, however, demand for IT equipment and software turned sharply negative, declining by 14 percent (at an annual rate). This was the first decline in business spending for IT equipment since mid-1990 when such spending declined at a 4 percent annual rate and quickly recovered. Business investment for IT equipment and software continued to decline at double-digit annual rates in the second and third quarters of 2001, before flattening in the fourth quarter. (Table 3.6)

Nonetheless, because IT spending remained strong through the end of 2000, unlike other investment, IT investment contributed more than four-fifths of the 11-percent growth in total real U.S. equipment and software spending for 2000 as a whole. (Table 3.7)

The decline in business investment in the first three quarters of 2001 was led by a precipitous drop in IP business investment. (Table 3.8) The stabilization of real IP business investment in the

TABLE 3.4: CONTRIBUTION TO REAL ECONOMIC GROWTH

	1996	1997	1998	1999	2000
(1) Changes in Real Gross Domestic Income*	3.5	4.5	5.0	4.5	4.7
	(Percent)				
(2) IT Contribution	1.1	1.1	1.5	1.2	1.2
(3) All Other Industries	2.4	3.4	3.5	3.3	3.5
	(Percentage Points)				
(4) IT Share of GDI change (2)/(1)	32	25	29	28	26
	(Percentage Share)				

*GDI is equal to the income that originates from the production of goods and services in the U.S.

Sources: ESA estimates derived from BEA and Census data.

**TABLE 3.5: BUSINESS SPENDING
ON INFORMATION PROCESSING EQUIPMENT AND SOFTWARE:
CONTRIBUTION TO GDP GROWTH**
(Annualized rates)

	2000				2001			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
(1) Change in real Gross Domestic Product	2.3	5.7	1.3	1.9	1.3	0.3	-1.3	0.2
	(Percent Change)							
(2) Business spending on information processing equipment and software (IPE&S)	1.2	0.9	0.6	0.6	-0.6	-1.0	-0.5	0.0
(3) All other spending in the economy	1.1	4.8	0.7	1.3	1.9	1.2	-0.8	0.2
	(Percentage Points)							
(4) IPE&S share of GDP change (2)/(1)	52	16	46	32	-46	-333	38	0
	(Percentage Share)							

Source: ESA calculations using BEA data.

TABLE 3.6: REAL BUSINESS SPENDING ON EQUIPMENT AND SOFTWARE
(2000-2001, by Quarter)

	2000				2001			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	(Billions of chained (1996) dollars)							
Total Equipment and software	1,058.3	1,089.6	1,102.3	1,099.3	1,087.7	1,043.2	1,019.4	1,005.9
IT Equipment and Software	573.6	601.5	621.0	641.8	620.9	588.1	572.1	572.9
Industrial Equipment	159.0	160.5	165.1	165.6	170.7	161.2	151.3	146.7
Transportation Equipment	200.6	200.8	193.2	176.2	177.4	174.4	174.0	171.8
Other	141.8	146.7	146.1	144.1	143.3	141.1	142.3	137.1
	(percent annualized change from previous quarter)							
Total Equipment and software	18.1	12.4	4.7	-1.1	-4.2	-15.4	-9.1	-5.3
IT Equipment and Software	31.3	20.9	13.6	14.1	-12.4	-19.5	-10.9	0.6
Industrial Equipment	28.3	3.8	12.0	1.2	12.9	-20.5	-22.4	-12.2
Transportation Equipment	-4.3	0.4	-14.3	-30.8	2.8	-6.6	-0.9	-0.2
Other	5.5	14.6	-1.6	-5.4	-2.2	-6.0	3.4	-14.6

Source: Bureau of Economic Analysis

fourth quarter resulted from a hefty rebound in computers offset by continued weakness in communications equipment.

Demand for IT Other Than Business Investment

In assessing demand for IT, it is important to note that data for business spending for information processing equipment and software capture only expenditures counted as investment. They do not encompass business spending for intermediate IT goods and services (e.g., communications services), consumer spending, government consumption, and international trade. These other sources of demand for IT goods and services are substantial.

In 2000, business investment in IT equipment and software totaled \$467 billion. In addition, we estimate that businesses spent a further \$258 billion on communications services, which are not counted as investments. (Table 3.9) Consumers spent another \$165 billion on computers and communication services and government spent about \$20 billion. Imports of IT goods and services exceeded exports by about \$76 billion. (See Chapter VI.)

Moreover, in contrast to business investment, personal and government consumption of IT-goods and services tend to be relatively constant. During the first three quarters of 2001, while business expenditures for information processing equipment and software declined, personal

**TABLE 3.7: CONTRIBUTION OF IT EQUIPMENT AND SOFTWARE*
TO GROWTH IN CAPITAL EQUIPMENT AND SOFTWARE SPENDING**

	1996	1997	1998	1999	2000	2001
(1) Change in real spending for capital equipment	11.0	13.3	14.6	11.8	11.7	-14.0
			(Percent)			
(2) Contribution of real spending on IT equipment	7.6	9.1	9.7	7.8	9.5	-4.9
			(Percentage Points)			
(3) Contribution from all other types of capital equipment	3.4	4.2	4.9	4.0	2.2	-9.1
(4) IT contribution to the change in real capital equipment spending	68.7	68.4	66.6	66.4	81.4	34.7
			(Percent)			

*Defined by BEA as information processing and related equipment

Source: Bureau of Economic Analysis

**TABLE 3.8: REAL BUSINESS SPENDING ON INFORMATION PROCESSING
EQUIPMENT AND SOFTWARE, BY TYPE**

	2000				2001			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	(Billions of chained (1996) dollars)							
Total IT Equipment and Software	573.6	601.5	621.0	641.8	620.9	588.1	572.1	572.9
Computers/peripheral equipment	253.9	284.5	305.2	317.6	314.4	287.3	265.7	289.2
Software	181.0	183.5	189.7	196.0	192.9	191.1	193.1	191.3
Communication equipment	124.2	131.5	132.2	137.7	122.6	107.4	99.7	94.6
	(percent annualized change from previous quarter)							
Total IT Equipment and Software	31.3	20.9	13.6	14.1	-12.4	-19.5	-11.8	0.5
Computers/peripheral equipment	43.9	57.6	32.4	17.3	-4.0	-30.3	-30.1	35.4
Software	14.4	5.6	14.2	14.0	-6.2	-3.7	4.2	-3.7
Communication equipment		25.7	2.1	17.7	-37.2	-41.1	-25.7	-18.9

Source: Bureau of Economic Analysis

demand and government consumption of IT goods and services remained quite stable, increasing in each case by 1 to 2 percent. In addition, while data on business spending for expensed IT goods

and services (e.g., communications and computer services other than software) are not available, this spending tends to be less discretionary and, therefore, also more stable than investment

TABLE 3.9: SPENDING FOR IT GOODS AND SERVICES*, 2000

Major Activity	2000
	(\$billions)
Business Investment	466
Business spending on communications	258**
Personal consumption	165
Government consumption	20
Exports	166
Imports	242

* Other than business investment and trade, spending by the other major activities do not encompass all spending on IT, but are provided here to give a sense of the importance of other sources of IT demand.

** Intermediate industry demand is not counted as final demand in GDP and therefore, it cannot be added to other major activities in this table.

Sources: ESA estimates using BEA data and University of Maryland INFORUM model results.

TABLE 3.10: COMPANY FUNDED R&D SPENDING

	1997	1998	1999	2000	1997-2000
	(\$billions)				(AA %*)
Total R&D, including Federal	212.4	226.9	244.1	264.2	7.5
All Industries	133.6	145.0	160.3	180.4	10.5
Manufacturing	101.2	102.2	99.9	110.8	3.2
Non-manufacturing	32.4	42.8	60.4	69.7	29.5
IT-Producing**	37.3	40.4	37.6	48.0	9.7
IT-Hardware	25.0	26.4	21.3	29.5	8.3
Computers	7.7	8.3	4.1	5.2	-5.3
Communication equipment	2.8	8.4	5.8	11.2	87.4
Semiconductors and electronic components	14.0	9.1	10.6	12.8	0.7
Other electronics	0.5	0.6	0.8	0.3	-3.1
IT-Services**	12.3	13.9	16.3	18.5	14.6
Software publishing	7.2	9.2	10.9	12.6	20.6
Computer systems design	3.0	2.9	4.0	4.9	19.0
Telecommunications***	2.1	1.8	1.4	1.0	-21.7
	(percent)				
IT-Producing Share of Industry R&D	28.0	28.0	23.4	26.6	

* Average annual percent change

** Data collected using NAICS categories

*** Includes broadcasting

Source: National Science Foundation

spending. (See Employment chapter that shows IT service employment is much more stable than IT goods employment.)

R&D SPENDING IN THE NEW ECONOMY

During the 1990s, the surge in business investment in capital equipment was accompanied by sharp increases in R&D investment in the economy as a whole and IT-producing industries in particular. Between 1994 and 2000⁶, total U.S. R&D investment grew at an annual average inflation-adjusted rate of 6 percent, in contrast to roughly 0.3 percent between 1988 and 1994. Patents, another indicator of innovation, grew at an annual rate of 8.6 percent after 1994, compared with a sluggish growth rate of 1.2 percent between 1988 and 1994.

Between 1997 and 2000, R&D spending by IT-producing industries increased rapidly, accounting for an average 26 percent share of overall private R&D spending. (Table 3.10) IT-related R&D accounted for an indeterminate amount of public R&D spending. Within the IT-sector, R&D spending in IT hardware and IT services industries grew by 8.3 percent and 14.6 percent, respectively.⁷ This pattern mirrored changes in to-

⁶ R&D expenditures for 2000 are based on projections published by the National Science Foundation. Actual data for total R&D and industry are available only through 1999. Industry has accounted for nearly all the growth in R&D since 1988, while the Federal share has been declining, reaching a low point of 26 percent in 1999.

⁷ Part of the decline in R&D in the computer industry was due to consolidation in the PC industry, with commodity-type producers gaining market share from integrated companies serving all industry segments.

tal private R&D. During 1997-2000, total industrial R&D surged at an annual rate of 10 percent, with robust growth in non-manufacturing R&D (29.5 percent) and slower growth (3.2 percent) in manufacturing R&D.

Particularly strong growth in R&D occurred in three IT-producing industries: communications equipment, software publishing, and computer systems design. Companies in both the computer industry and the telecommunications services industry scaled back their R&D over this period.

NEAR-TERM PROSPECTS CLOUDED, LONG-TERM PROSPECTS ENCOURAGING

In view of recent uncertainty, this chapter makes no estimates of likely levels of output of IT-producing industries for 2001 and beyond. Even before the human tragedy and economic shock of September 2001, the Administration, the Congressional Budget Office, and a host of respected private economic forecasters had been revising downward their forecasts of GDP for 2001. The events of September have made it more difficult to see the way ahead and to anticipate with any confidence the timing and strength of a rebound in IT investment and production.

Nonetheless, preceding analysis shows that despite the economic slowdown, U.S. industries have continued to build the nation's stock of IT capital, to spend heavily on IT goods and services that can make the installed base of IT hardware increasingly productive, and to create as a result the enduring foundation of a stronger economy.