

# Industry productivity trends under the North American Industry Classification system

*The NAICS classification system presents a more consistent framework and a conceptual improvement for productivity measurement; while performance varied by industry, NAICS-based productivity measures show strong overall productivity growth during the 1990s and again after 2001—especially in manufacturing, trade, and in the newly defined information sector*

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The Bureau of Labor Statistics has recently completed converting its industry labor productivity measures to the North American Industry Classification System (NAICS).<sup>1</sup> The conversion mirrors efforts of the entire U.S. statistical system to more closely reflect the Nation's changing economy by better identifying service industries and new and emerging industries. This article describes the conversion effects on the industry productivity data, focusing on industry structure and data availability, and the resulting trends in industry labor productivity and related measures.

NAICS replaces the existing Standard Industrial Classification (SIC) system that had been in use since the 1930s.<sup>2</sup> While the SIC system was revised periodically over the years to reflect changes in the economy's industrial composition, its structure remained the same as first established in the 1930s. The focus remained on the goods-producing industries, particularly those in the manufacturing sector, which was prominent when the SIC was first introduced. The most recent major revision to the SIC occurred in 1987, and rapid changes since then in both the U.S. and world economies necessitated additional changes by the mid 1990s. The adoption of the North American Free Trade Agreement in 1994 highlighted the need for cooperation between the United States, Canada, and Mexico. The NAICS classification system was developed as a cooperative effort by the statistical agencies of these countries during the mid 1990s. The goal was to provide an improved industry classification sys-

tem that would offer common industry definitions based on a unified economic concept for the three countries—and which would give special attention to service industries and to new, emerging, and advanced-technology industries.

## Industry productivity measures

The Bureau of Labor Statistics has been measuring productivity for more than 100 years. A study of 60 manufacturing industries was published in 1898, and various other studies were conducted over the following years. Today's industry productivity program began in 1941, after Congress authorized the Bureau to undertake continuing studies of labor productivity. In 1959, BLS began producing labor productivity measures for the total private economy and major sectors on an annual basis; quarterly measures of these series were introduced in 1968.<sup>3</sup>

Labor productivity indexes measure the changes in the amount of goods or services produced relative to the labor hours used in producing that output. The indexes are calculated by dividing an index of output for an industry by an index of hours for that industry. Labor productivity measures reflect the joint effects of many influences—including changes in technology; capital investment; the use of purchased energy, materials, and services; the organization of production; capacity utilization; managerial skill; and the characteristics and effort of the workforce.

The conversion of the industry productivity measures to conform to the NAICS classification

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system is one in a series of recent improvements to the Bureau's industry productivity measurement efforts that began in the 1990s. In 1998, industry coverage was expanded to include labor productivity measures for all three- and four-digit SIC manufacturing industries. Compensation and unit labor cost measures for three-digit SIC industries were developed and published in 1999. In 2000, multifactor productivity measures were published for all three-digit SIC manufacturing industries. Industry labor productivity and cost measures were extended to cover all three- and four-digit SIC retail trade industries in 2001, and in 2002 for all three-digit SIC wholesale trade industries. During this time, the adoption of superlative, chain-weighted indexes for calculating output was accompanied by other changes aimed at streamlining and standardizing the industry labor productivity series.<sup>4</sup>

The transition to NAICS caused a discontinuation of the historical SIC-based data used for measuring industry productivity. In order to maintain consistent, continuous series for measuring industry productivity trends, the historical SIC-based industry measures were converted to a NAICS basis back to 1987. Converting industry productivity and cost measures to NAICS involved the separate conversion of output, employment, hours, and compensation for each industry.<sup>5</sup> Some NAICS industries are the same as their SIC counterparts, so that no special adjustments to data had to be made to convert the output measures.<sup>6</sup> For some other industries, the addition or removal of one or more products was all that was needed to convert the output measures to a NAICS basis. For other industries, however, constructing NAICS output series required greater data adjustments. In most cases where a NAICS industry was not a direct match to a corresponding SIC industry, the NAICS output series were derived by applying a constant conversion or "bridge" ratio to the entire historical series (see Appendix for details). These historical NAICS estimates thus are based on the assumption of fixed historical relationships between the SIC and NAICS series. Such an assumption may not be appropriate, particularly for new, emerging industries.<sup>7</sup> Revisions to current estimates based on ongoing research may be incorporated in future updates as more and better information becomes available.

## NAICS reclassification

NAICS represents a completely new system for classifying industries.<sup>8</sup> NAICS uses a six-digit code that is hierarchical like the SIC code, but is unrelated to the SIC code. In the six-digit NAICS code, the first two digits identify the sector; the third digit designates the subsector; the fourth designates the industry group; the fifth designates the international industry; and the sixth digit designates the national industry. (When the U.S. industry is the same as the five-digit NAICS industry,

the industry has a zero as the sixth digit.) The six-digit codes provide greater flexibility than the SIC, allowing for international comparability of industries at the five-digit level while still permitting individual countries to identify unique six-digit national industries.

There are fundamental differences between the NAICS and SIC systems, and some of the differences have important implications for the measurement of industry productivity. For example, NAICS represents a systematic restructuring of the industry economic classification system. NAICS creates a consistent system that classifies establishments based on similarities in their production processes. This approach considers the way an establishment uses its production technology to produce its final output. The SIC was less unified in its approach: SIC industry classifications were sometimes based on supply-side factors such as the nature of the production processes, while at other times were based on demand-side or market-based factors such as the nature or uses of the final products. Because productivity measures attempt to capture changes in the efficiency with which industries use their inputs to create final goods or services, the NAICS system of grouping together establishments with similar production processes represents an important improvement over the SIC classification system.

NAICS also differs from the SIC in its treatment of auxiliaries. NAICS classifies auxiliary units involved in management or support activities such as transportation, warehousing, accounting, payroll, or general management services into specialized industries rather than including them in the manufacturing, trade, or service industries they support, as in the SIC. This change also has an impact on the industry productivity measures. Under NAICS, the hours of workers employed in a headquarters office or a warehouse facility of a manufacturing firm, for example, are no longer counted as hours of the manufacturing industry. This reduces the overall number of workers in the manufacturing industry and increases the concentration of workers directly involved in the manufacturing process. As a result, the trend in labor hours (and therefore the trend in labor productivity) may be different for the manufacturing industry under NAICS, even if the output of the industry is classified the same as the SIC industry. As employment and hours of auxiliary establishments are reclassified into management and support industries under NAICS, the *levels* of employment and hours will be lower in the industries where they used to be classified. However, the effect on the *trends* in industry hours depends on how the growth in employment and hours of these auxiliary workers compares to that of the workers in the industries where they were previously classified.

In addition to this different industry structure, the NAICS system differs from the SIC system in its increased industry

detail, as well as its greater focus on service industries and emerging and high-tech industries. This shift in focus toward the service sector, which reflects the declining importance of manufacturing and the growing importance of services in the national economy, also has implications for productivity measurement. While NAICS adds industry detail, the increased detail does not translate into an immediate increase in industries for which productivity measures are available—for several reasons. Much of the industry detail that was added under NAICS is in service industries where productivity measurement is currently not feasible. For many of these industries, reliable data for measuring output or labor input have not been collected. For some industries, lack of data is further complicated by conceptual issues regarding the proper measurement of output.<sup>9</sup> For other industries, data have recently begun to be collected but are available for only a few years. Furthermore, in some sectors such as manufacturing, where data availability for detailed industries was excellent under the SIC, the conversion to NAICS has reduced the number of industries for which reliable source data are available. Data have been discontinued for some detailed industries under NAICS, or are available only for combinations of industries. This decline in the availability of historical industry data limits the number of NAICS industries for which labor productivity measures can be calculated. Within manufacturing, for example, data limitations reduced the number of detailed industries to 132 five-digit NAICS industries and 148 additional six-digit NAICS industries—down from 458 four-digit SIC industries.<sup>10</sup> Manufacturing also was affected by a reduction in detail at the four-digit NAICS “industry group” level. Although the Bureau continues to publish labor productivity measures for all manufacturing industry groups, the number of these groups dropped from 140 three-digit SIC groups to 86 four-digit groups (the comparable level of detail) under NAICS.

### The industry productivity database

The industry productivity database includes productivity and related measures for more than 480 unique industries at the six-, five-, four-, three-, and in a few cases, two-digit NAICS level. Labor productivity and related measures are currently available from 1987 to 2001, 2002, or 2003, depending on the industry.<sup>11</sup> These labor productivity measures account for nearly 58 percent of the four-digit NAICS industries in the nonfarm business sector of the economy and cover about 56 percent of employment.<sup>12</sup> Industry productivity measures cover 100 percent of employment in the mining, manufacturing, wholesale trade and retail trade sectors, and nearly 100 percent in the accommodation and food services sector.<sup>13</sup> Productivity measures are also available for selected industries in utilities, transportation and warehousing, information,

finance and insurance, real estate and rental and leasing, professional and technical services, accommodation and food services, and other services. As shown in table 1, employment coverage of the industry productivity measures varies for these other sectors.

The conversion to NAICS resulted in the emergence of several newly defined industries and sectors and the reorganization of some industries between sectors. For example, a new information sector was created under NAICS, bringing together industries involved in producing and distributing information and cultural products—industries that, under SIC, had been spread across the manufacturing, communications and utilities, and services sectors. The manufacturing sector lost several publishing industries that were reclassified into the information sector, and also lost the logging industry, which was transferred into the agriculture, forestry, fishing, and hunting sector under NAICS. The conversion to NAICS also resulted in the creation of a new accommodation and food services sector, as eating and drinking establishments were reclassified out of retail trade and grouped with hotels and other lodging places. In addition, under NAICS the criteria for defining wholesale and retail trade industries changed: whereas the SIC system focused on the class of customer, NAICS considers the method of selling. As a result, establishments were reclassified from wholesale to retail trade and vice-versa. These various changes are reflected in the NAICS industry productivity measures.

Because of the structural changes in industry classification that accompanied the conversion to NAICS, measures of NAICS industry employment, hours, output, compensation and

**Table 1. Employment coverage of BLS industry labor productivity measures by sector, 2001**

NAICS sector	Sector title	Employment coverage (percent)
	Private nonfarm business sector .....	56
21	Goods-producing .....	71
23	Mining .....	100
31–33	Construction .....	0
	Manufacturing .....	100
	Service-producing .....	51
22	Utilities .....	92
42	Wholesale Trade .....	100
44–45	Retail Trade .....	100
48–49	Transportation and warehousing .....	46
51	Information .....	71
52–53	Finance, insurance, and real estate .....	21
72	Accommodation and food services .....	100
54–56, 61–62, 71, 81	Other services .....	10

NOTE: Data for the nonfarm business sector exclude general government, owner-occupied housing, and nonprofit organizations.

productivity are not always comparable to their SIC counterparts. Differences are apparent even at the major sector level (two-digit NAICS). Table 2 shows employment in selected major industry groups for which BLS has complete or near complete coverage of industry productivity measures. Both the manufacturing and the wholesale trade sectors as defined under NAICS are smaller than under the SIC. In both of those sectors, employment in establishments and industries that moved out of the sector exceeded that which moved in. This reduction is partly due to the reclassification of auxiliary establishments. For example, a large number of manufacturing employees were reorganized into new auxiliary NAICS industries outside the manufacturing sector. In addition, employment levels changed as entire industries were reclassified into different sectors. The reclassification of several publishing industries into the new information sector under NAICS caused a noticeable reduction in manufacturing employment. Excluding the reclassification of auxiliary establishments, about 80 percent of the workers that were moved out of manufacturing in 2000 were reclassified into the new information sector. A noticeable net redistribution of employment also occurred between the wholesale and retail trade sectors, as the employment in establishments reclassified from wholesale trade to retail trade under NAICS exceeded that from retail trade to wholesale trade.

With the conversion to NAICS, productivity measures were developed for several new industries and industry groups. In manufacturing, for example, output per hour and related series are available for a new NAICS industry group, computer and electronic products manufacturing (NAICS 334). This group brings together establishments that produce such high-tech products as computers, semiconductors, and communication equipment, as well as measuring, analyzing, and

controlling instruments. Under the SIC, these firms had been primarily distributed among three different two-digit SIC groups. Labor productivity measures are also newly available for semiconductor machinery manufacturing (NAICS 333295) and printed circuit assembly manufacturing (334418). In wholesale trade, labor productivity measures have been developed for a new industry group, wholesale electronic markets and agents and brokers (NAICS 425), as well as for the two industries that compose that group: business to business electronic markets (NAICS 42511) and wholesale trade agents and brokers (NAICS 42512). In retail trade, labor productivity measures are available for a redefined industry group, health and personal care stores (NAICS 446), which includes a new NAICS industry: cosmetics, beauty supply, and perfume stores (NAICS 44612). Labor productivity measures are also newly available for electronic shopping and mail order houses (NAICS 4541). Within the information sector, productivity measures are available for a variety of publishing, broadcasting, and telecommunications industries. Under NAICS, the cable television industry has been divided into separate industries—cable programming (NAICS 5152) and cable distribution (NAICS 5175)—and labor productivity measures are available for both industries. Productivity measures are also available for a redefined industry group, publishing industries (NAICS 511), that includes the software publishing industry as well as industries involved in the more traditional publishing of books, periodicals, and databases.

### Productivity trends in major sectors

Productivity often exhibits predictable patterns over the course of the business cycle, rising during expansions and declining during recessions. This occurs as businesses

**Table 2. Employment in selected major industries in 2000, NAICS and SIC**

NAICS sector	2000 employment (000s)	Percent of private nonfarm business	SIC sector	2000 employment (000s)	Percent of private nonfarm business
Private nonfarm business	59200.8	100.0	Private nonfarm business	60954.8	100.0
Manufacturing (NAICS 31–33)	17262.9	29.2	Manufacturing (SIC 20–39)	18394.4	30.2
Wholesale trade (NAICS 42)	5933.2	10.0	Wholesale trade (SIC 50–51)	7024.0	11.5
Retail trade (NAICS 44–45) Retail trade excluding eating and drinking places	15279.8	25.8	Retail trade (SIC 52–59) Retail trade excluding eating and drinking places (SIC 52–57, 59)	15193.1	24.9
Accommodation and food services (NAICS 72)	10026.5	16.9	Eating and drinking places (SIC 58) Hotels (SIC 701)	8113.7 1845.3	13.3 3.0

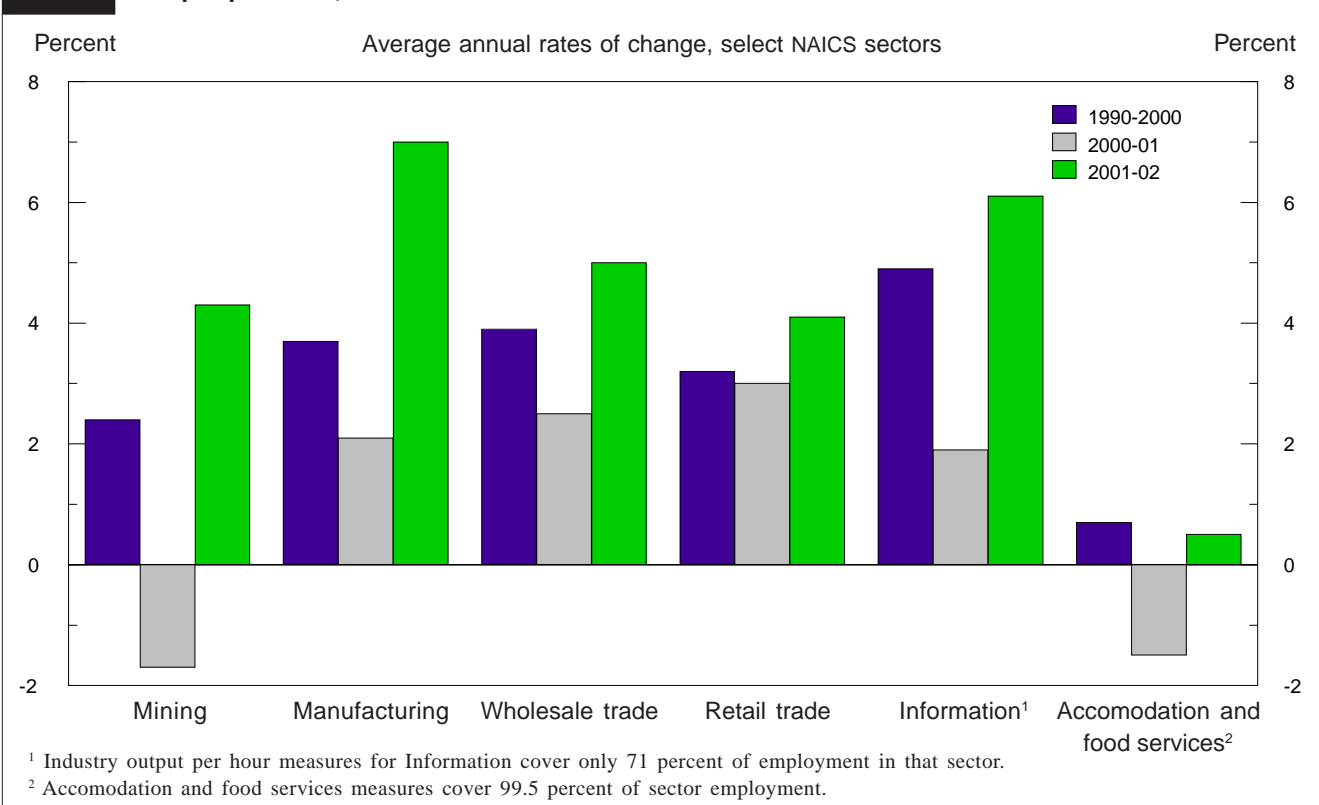
adjust their use of inputs to changes in the demand for their goods and services. At the beginning of an expansion, for example, employment increases often lag behind output increases, while at the beginning of a recession reductions in output cause employers to cut back on employment and hours, but also with a lag. To minimize the cyclical effects on productivity trends, it is appropriate to analyze productivity changes over the course of a full cycle. The decade of the 1990s represents such a period. Economic activity in the United States peaked in July 1990 and again in March 2001. This article reviews the NAICS industry productivity performance between 1990 and 2000. Analyzing productivity trends between these years, when the economy was at similar peak stages of the business cycle, reduces the effect of cyclical factors such as differences in capacity utilization on productivity change. The effect on industry productivity of the recession that began in 2001 is discussed later in the article.

Chart 1 shows labor productivity change in major industry sectors for which BLS has complete coverage or covers a high percentage of the industry. Led by the information sector, labor productivity growth was strong over the 1990–2000 period in most of these sectors, compared with the private non-

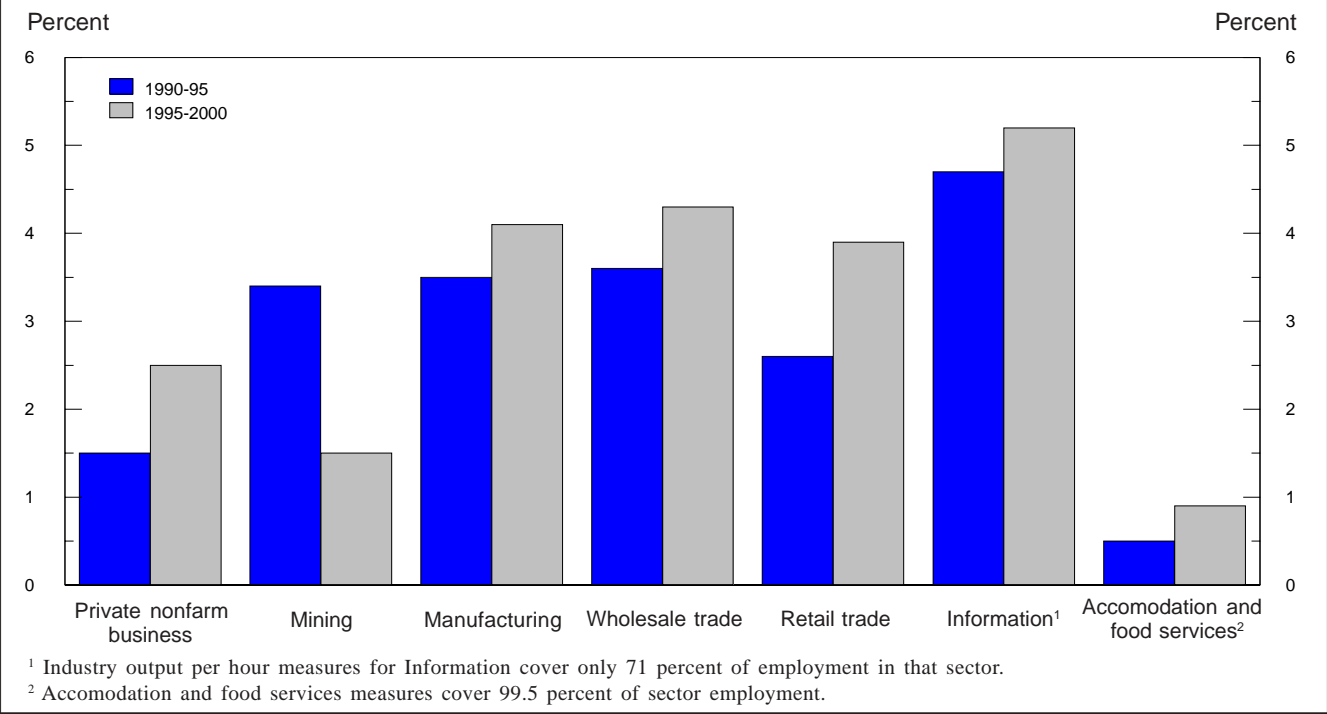
farm business sector as a whole, where labor productivity grew at an annual average of 2.0 percent. Manufacturing, wholesale trade, and retail trade also showed strong growth, while productivity grew slowly in the accommodation and food services industries. Productivity growth typically slows in recession years, and in the recession year of 2001 output per hour growth slowed considerably in all of these sectors, and actually declined in mining and accommodation and food services. Productivity growth is typically unusually strong as an economic recovery begins. For most of the sectors considered here, productivity not only sped up after 2001, but exceeded the growth over the 1990–2000 period. The exception was the accommodation and food services sector—although output per hour in that sector rose 0.5 percent in 2002, the growth that year was less than the average 0.7 percent growth from 1990 to 2000.

Chart 2 divides the 1990–2000 period in half and depicts the productivity growth rate for private nonfarm business and other major sectors in each of the subperiods. The chart shows that, of the sectors that have full or near-full employment coverage, almost all experienced a productivity speedup from 1995 to 2000. Retail trade in particular showed a large increase in the productivity growth rate in

**Chart 1. Output per hour, 1990–2002**



**Chart 2. Average annual rate of change in labor productivity, 1990–95 and 1995–2000**



the second half of the decade. Mining was the only sector that experienced a falloff of productivity growth in the latter half of the 1990s. The average annual rate of change in mining productivity fell from 3.4 percent in 1990–95 to 1.5 percent in 1995–2000.

The changes in industry composition under NAICS result in some differences in sector productivity trends when compared with the comparable SIC sectors. Table 3 shows labor productivity change over the 1990–2000 period for several sectors as defined under both classification systems. Productivity growth rates were the same or very close for private non-farm business and for manufacturing, but differed somewhat for wholesale and retail trade. In both the wholesale and retail trade sectors, output per hour grew more rapidly under the NAICS system than under the SIC system. The reclassification of some auxiliary establishments out of the sectors, including those involved in warehousing, may be one reason for the increase in productivity growth for both retail and wholesale trade under NAICS. The eating and drinking places sector, so classified under the SIC system, was moved out of retail trade and combined with the accommodation industries under NAICS to form the accommodation and food services sector—and thus productivity trends are not comparable between those NAICS and SIC categories.

### Industry productivity and cost trends

1990–2000. Labor productivity increased from 1990 to 2000 in most of the detailed industries published by BLS.<sup>14</sup> Output per hour rose in 156 of the 169 industries analyzed in this article, representing 92 percent of the industries and employment covered. Output increased in 89 percent of the industries, while hours increased in 63 percent of the industries. The wide-ranging, but generally positive, industry productivity performance during the period is reflected in chart 3. The chart shows the distribution of average annual productivity growth rates for the 1990–2000 period for all the published industries (all four-digit NAICS industries together with additional published industries for which component four-digit series have not been computed). The chart reflects a strong central tendency despite a wide range of productivity performance. Roughly two-thirds of the industries experienced average annual rates of change in labor productivity that ranged from 0.0 percent per year to an increase of 3.9 percent per year.

Although labor productivity trends for individual industries were largely positive during the 1990s, there was some variation by industry and by sector. Of the NAICS industries for which measures are available, productivity performance ranged from an average annual decline of 1.8 percent per year in drinking places, alcoholic beverages (NAICS 7224) to an

**Table 3. NAICS vs. SIC labor productivity trends in selected major sectors, 1990–2000**

[Average annual rates of change]

NAICS sector	Output per hour 1990–2000	SIC sector	Output per hour 1990–2000
Private nonfarm business .....	2.0	Private nonfarm business .....	2.0
Manufacturing (NAICS 31–33) .....	3.7	Manufacturing (SIC 20–39) .....	3.8
Wholesale Trade (NAICS 42) .....	3.9	Wholesale trade (SIC 50–51) .....	3.4
Retail Trade .....		Retail trade .....	2.4
Retail trade excluding eating and drinking places (NAICS 44–45) .....	3.2	Retail trade excluding eating and drinking places (SIC 52–57, 59) .....	2.9
		Eating and drinking places (SIC 58) .....	.3
Accommodation and food services (NAICS 72) .....	.7	Hotels (SIC 701) .....	1.7
Information (NAICS 51) .....	4.9	Information .....	–

NOTE: Dash indicates data not available.

average annual increase of 31.7 percent per year in computer and peripheral equipment manufacturing (NAICS 3341).

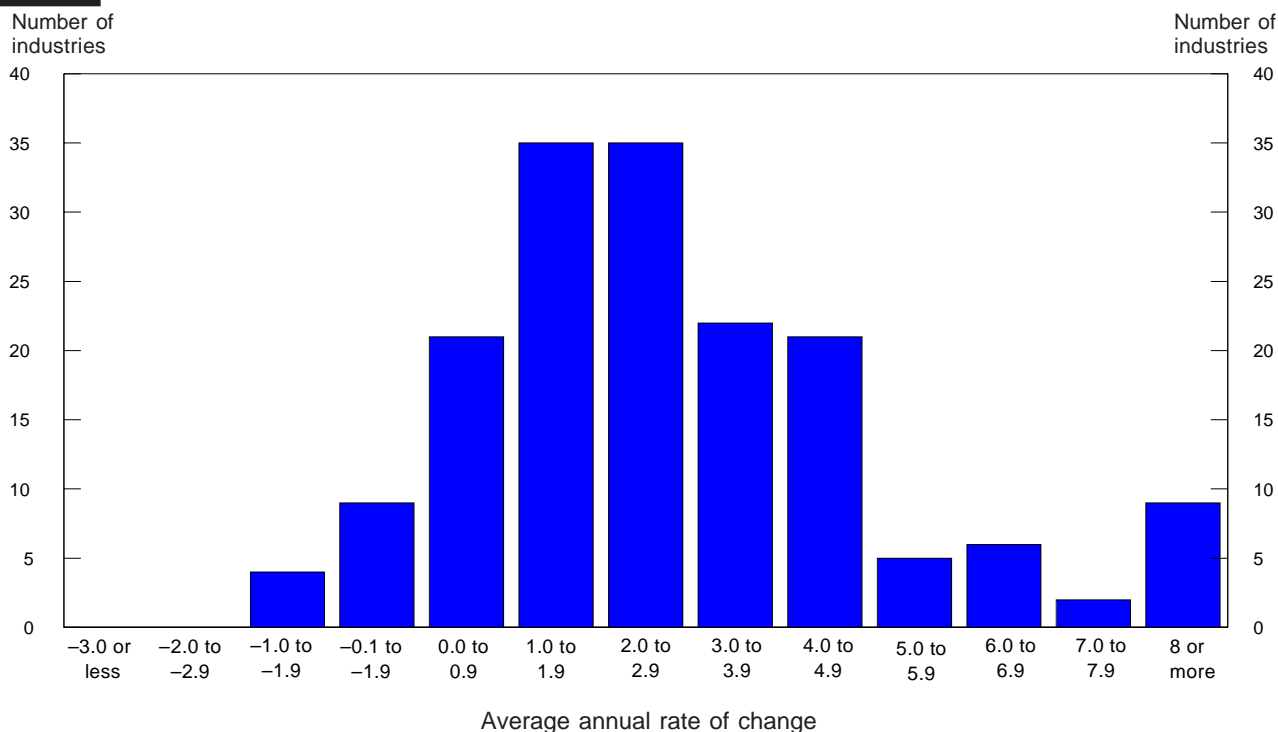
As seen in chart 3, the majority of industries experienced labor productivity growth that averaged between 1 and 5 percent per year. Table 4 lists the eight industries with the highest productivity growth rates over the 1990–2000 period. Each of the industries in that table experienced growth in output per hour of more than 12 percent per year, on average. Only three of the eight industries are manufacturing industries, but two of those experienced the fastest labor productivity growth of all the measured industries. Output per hour grew 31.7 percent per year, on average, in computer and peripheral equipment manufacturing and 27.0 percent per year in semiconductor and other electronic component manufacturing (NAICS 3344). The list of industries with the most rapid productivity growth re-

flects the importance of the high-tech sector on the U.S. economy during the 1990s, and includes industries that were major users or distributors of high-tech equipment as well as the industries producing those goods. After computer and semiconductor manufacturing, productivity grew most rapidly for professional and commercial equipment wholesalers (this industry includes establishments engaged in the distribution of such products as computers and other equipment); electronics and appliance stores; electronic shopping and mail-order houses; software publishers; communications equipment manufacturing; and electric goods wholesalers. After these eight industries, the next 14 fastest growing industries experienced average annual rates of change in labor productivity ranging from 5.0 percent per year for both audio and video equipment manufacturing (NAICS 3343) and line-haul

**Table 4. Industries with the highest productivity growth rates between 1990 and 2000**

NAICS code	Title	2001 Employment (000's)	Average annual percent change, 1990–2000			
			Output/Hour	Output	Hour	ULC
3341	Computer and peripheral equipment manufacturing .....	286	31.7	29.0	–2.1	–21.5
3344	Semiconductor and other electronic component manufacturing .....	645	27.0	29.3	1.9	–18.3
4234	Professional and commercial equipment and supplies merchant wholesalers .....	710	16.2	18.3	1.8	–9.2
443	Electronics and appliance stores .....	593	14.5	17.5	2.6	–8.0
4541	Electronic shopping and mail-order houses .....	263	13.9	21.0	6.3	–6.7
5112	Software publishers .....	269	13.8	25.9	10.7	–3.6
3342	Communications equipment manufacturing .....	234	13.4	14.0	0.6	–6.8
4236	Electrical and electronic goods merchant wholesalers .....	414	12.4	14.3	1.6	–6.1

**Chart 3. Distribution of average annual rates of change for output per hour, 1990-2000**



**Chart 4. Distribution of average annual rates of change for output per hour, 2000-01**

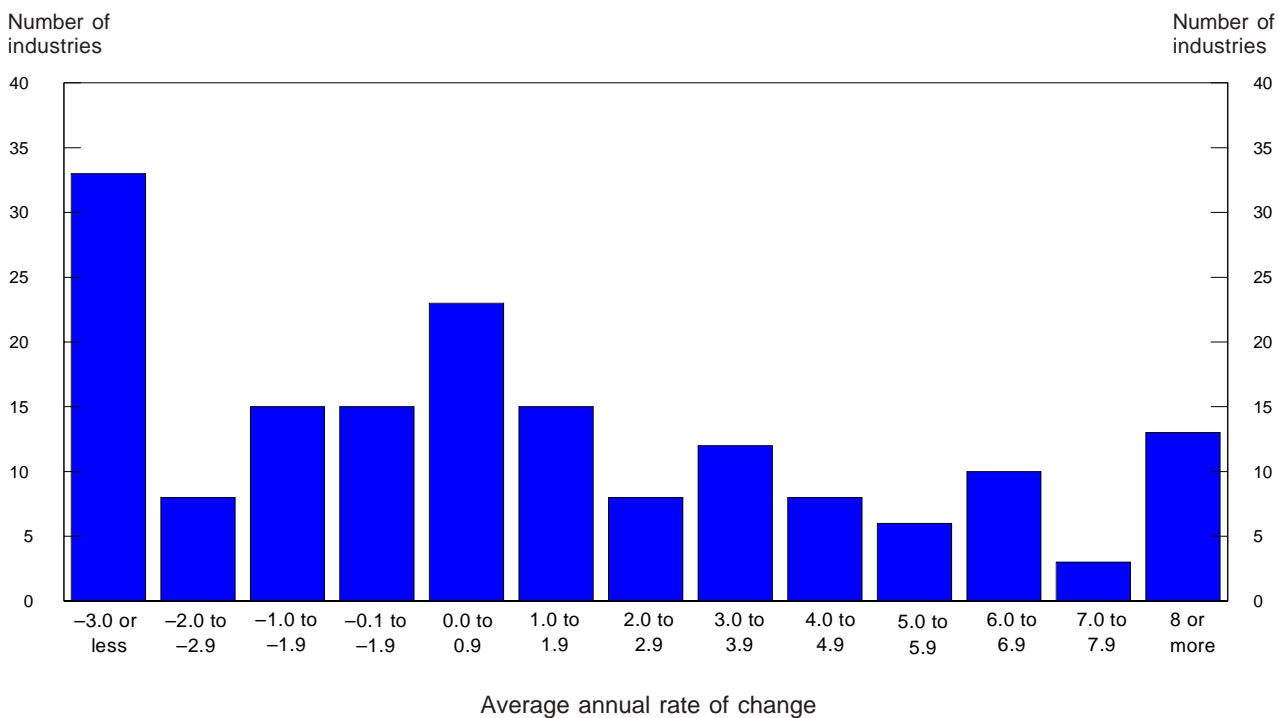




Table 5. Largest industries by 2001 employment size						
NAICS code	Title	2001 employment (000's)	Average annual percent change, 1990-2000			
			Output/hour	Output	Hours	ULC
7221	Full-service restaurants .....	4020	0.2	2.4	2.2	3.4
7222	Limited-service eating places .....	3616	.2	2.4	2.2	3.4
4451	Grocery stores .....	2618	-.2	.2	.4	3.0
7211	Traveler accommodation .....	1832	2.6	4.2	1.5	1.4
4521	Department stores .....	1769	2.4	4.3	1.9	.7
4411	Automobile dealers .....	1273	1.5	3.2	1.7	2.9
52211	Commercial banking .....	1258	2.6	1.8	-.8	3.7
8111	Automotive repair and maintenance .....	1134	1.6	3.2	1.6	1.8
4529	Other general merchandise stores .....	1091	9.0	9.8	.7	-5.6
56172	Janitorial services .....	1072	3.4	4.5	1.0	-0.1
4441	Building material and supplies dealers .....	1027	3.4	5.8	2.3	.2
446	Health and personal care stores .....	1014	1.8	3.6	1.8	2.3
4481	Clothing stores .....	1000	5.8	5.4	-.4	-1.5
447	Gasoline stations .....	946	2.3	1.7	-.6	.9
491	Postal service .....	873	.9	1.9	1.0	2.1
48412	General freight trucking, long-distance .....	849	1.8	4.8	3.0	.3

railroads (NAICS 482111) to 9.0 percent per year for other general merchandise stores (NAICS 4529).

The overall upward trend in productivity during the 1990s was reflected in the productivity performance of the largest industries. Table 5 presents the average annual rate of change in output per hour and related indexes for industries with more than 800,000 employees in 2001, in order of employment size. Together, these 16 industries account for nearly 42 percent of the employment covered by the industry labor productivity measures. Output increased in each of these large industries between 1990 and 2000, and productivity increased in all but one. Productivity declined in grocery stores (NAICS 4451) despite rising output, as labor hours increased more rapidly.

Unit labor costs represent the cost of producing one unit of output. The measure is calculated by dividing an index of labor compensation by an index of real output, or by dividing an index of compensation per hour by an index of output per hour (labor productivity). The latter ratio reveals an inverse relationship between labor productivity and unit labor costs: when labor productivity increases, it offsets increases in hourly compensation so that unit labor costs rise less rapidly than compensation. If labor productivity declines or rises more slowly than hourly compensation, unit labor costs will increase, but if output per hour increases faster than hourly compensation, unit labor costs will fall. From 1990 to 2000, labor compensation increased in about 95 percent of the industries examined in this article.<sup>15</sup> However, unit labor costs increased in only about 70 percent of the industries, as labor productivity increased more rapidly than hourly compensation in a number of industries. Unit labor costs declined in each of the eight industries with the fastest growing produc-

tivity rates. In contrast, all of the industries with declining productivity over the period recorded increases in unit labor costs.

*The recession of 2001 and beyond.* The performance of industry output, hours, and labor productivity after 2000 contrasts with the positive performance of the previous decade. Output per hour grew in only about 57 percent of the industries in 2001, compared to more than 92 percent of industries with productivity growth from 1990 to 2000. Output declined in 2001 in nearly 70 percent of the industries examined here, while hours declined in 77 percent. In 2001, a greater proportion of the industries experiencing productivity growth did so by reducing hours rather than by increasing output. Whereas output grew in more than 90 percent of the industries that increased their productivity from 1990 to 2000, output increased in only 44 percent of the industries where productivity rose in 2001. Instead, declining hours were the major impetus for productivity growth in 2001, with more than 81 percent of industries reducing hours in that year, compared with only about 40 percent of industries where productivity grew from 1990 to 2000.

The reaction of labor productivity to the downturn in the economy that began in 2001 is also apparent in comparing the distribution of industry productivity growth rates in 2001 (see chart 4) to the distribution of average annual productivity growth rates for 1990-2000 (see chart 3). During the 1990s, nearly 60 percent of the industries examined here experienced labor productivity growth of 2 percent per year or more, and none showed productivity declines of -2.0 percent or more. Chart 4, which reflects the cyclical effects of the beginning of

the recession, shows a decidedly less positive productivity picture. Productivity grew 2.0 percent or better in only about 36 percent of industries in 2001, while productivity declined by -2.0 percent or more in 24 percent of industries in that year.

While industry productivity data are not yet available through 2002 for detailed manufacturing industries, labor productivity for the manufacturing sector as a whole grew rapidly in 2002. Data for other industries suggest that productivity improvements were widespread. Output per hour increased for almost 79 percent of the mining, trade, and service-providing industries for which output per hour measures are available. The improvement in labor productivity was accompanied by increases in industry output as well as continuing reductions in hours. Although output rose in more than 55 percent of the industries measured in 2002, hours declined in nearly 70 percent of the industries.

## Conclusion

THE CONVERSION TO NAICS HAS IMPACTED the industry productivity measures in a number of ways. The NAICS classification system is a more consistent framework and a conceptual improvement for productivity measurement. At the same time,

the conversion has reduced the number of industries and industry groups for which productivity measures are calculated in certain sectors, such as manufacturing. In addition, the assumption of a fixed relationship between NAICS and SIC industries that underlies the conversion for many industries may not be appropriate, particularly for new and emerging industries. Nonetheless, a comparison of productivity trends for several major sectors where BLS maintains extensive coverage of productivity measures shows similar productivity trends throughout the 1990s as compared to comparable SIC sectors. Like the SIC-based data, the NAICS productivity measures also continue to show a productivity speedup in the latter half of the 1990s, compared to the first half. Recognizing current data limitations, improvements to current estimates based on ongoing research will be incorporated in future updates as more and better information becomes available, and efforts to expand industry productivity coverage to new industries will continue. Meanwhile, NAICS provides an improved road map for classifying industries. By more accurately reflecting the current structure of the economy and underlying similarities in production processes, NAICS enhances our understanding of current productivity developments. □

## Notes

<sup>1</sup> Productivity and cost measures for 180 mainly four-digit NAICS industries were first released on September 18, 2003. Since that time the Bureau has revised and updated the measures for many industries and added measures for more than 300 additional industries at the six-, five-, three-, and two-digit NAICS level.

<sup>2</sup> Executive Office of the President (1998), *North American Industry Classification System, United States, 2002*, Washington, DC, U.S. Office of Management and Budget. Copies of the manual can be obtained from the National Technical Information Service (NTIS) on the Internet at [www.ntis.gov/products/bestsellers/naics.asp](http://www.ntis.gov/products/bestsellers/naics.asp). For more information about the NAICS structure, see the Bureau of the Census on the Internet at <http://www.census.gov/epcd/www/naics.html>.

<sup>3</sup> Joseph P. Goldberg and William T. Moye, *The First Hundred Years of the Bureau of Labor Statistics*, Bulletin 2235 (Bureau of Labor Statistics, September 1985), pp. 169, 203, and 249.

<sup>4</sup> For example, output measures based on the deflated value of output were adopted for most industries (made possible by the expansion in coverage of producer price indexes during the 1980s and 1990s). Previously, a large number of industries were based on physical quantity of output. The expansion of the Bureau's industry productivity series was also accompanied by a decision to use BLS employment and hours data from the Current Employment Statistics survey for measuring labor input for all manufacturing industries, rather than using Census data for some industries as had been done in the past.

<sup>5</sup> Industry employment and hours data from the BLS Current Employment Statistics (CES) survey were converted to a NAICS basis by the Bureau's Office of Employment and Unemployment Statistics with the release of May 2003 data in June 2003. CES industry employment and hours data were converted to NAICS back to 1990 for most industries, and to earlier years for some industries. The Office of Productivity and Technology extrapolated these estimates back to 1987 for many industries.

<sup>6</sup> Slightly less than half of the six-digit NAICS industries included in the industry productivity database are industries that are direct matches to comparable SIC industries. More than half of the mining and wholesale trade industries, and almost half of the manufacturing industries, were direct matches to the SIC industries. For other sectors, less than half the industries covered were direct matches.

<sup>7</sup> Recent work by researchers at the Bureau of the Census and the Federal Reserve Board has attempted to assign historical records of individual manufacturing establishments from each of the quinquennial Censuses of Manufactures for 1963 through 1992 to NAICS industries. These recoded data are used to calculate new conversion ratios that reflect the changing relationship between SIC and NAICS shipments in those years. Kimberly Bayard and Shawn Klimek, "Creating a Historical Bridge for Manufacturing between the Standard Industrial Classification System and the North American Industry Classification System." Paper presented at the Annual Meeting of the American Statistical Association, San Francisco, August 2003.

<sup>8</sup> Executive Office of the President (1998), *North American Industry Classification System...*

<sup>9</sup> Mark Sherwood, "Problems in Measuring Service Industry Output," *Monthly Labor Review*, March 1994, pp. 11-19

<sup>10</sup> Some industry detail has been collapsed or discontinued under NAICS in the BLS Current Employment Statistics data. In addition, some six-digit manufacturing industry detail will be collapsed in the 2003 Annual Survey of Manufactures data from the Bureau of the Census.

<sup>11</sup> Productivity measures are available through 2001 for detailed manufacturing industries, although measures for total manufacturing and for durable and non-durable manufacturing are available for later years. Productivity series are available through 2003 for wholesale trade, retail trade, and food service and drinking places industries. For all other industries covered, productivity measures are available through 2002.

<sup>12</sup> Percentages represent the proportion of paid employees in the sector that are in the industries covered by the productivity indexes, as measured in the BLS Current Employment Statistics establishment survey. The percentage of proprietors and unpaid family workers covered by the productivity measures is not explicitly included in the ratios of employment coverage, but assumed to be the same as for paid employees.

<sup>13</sup> Industries with labor productivity measures in the accommodation and food services sector represent 99.5 percent of employment in the sector.

<sup>14</sup> This article focuses on published industries at the mainly three- and four-digit NAICS level. Indexes and rates of change in output per hour, output per worker, output, hours, all workers, labor compensation, and unit labor costs for

these industries are available from the BLS Productivity and Costs Web site on the Internet at <http://www.bls.gov/lpc/home.htm>. Comparable productivity and cost measures for NAICS five- and six-digit industries, as well as underlying data on the number of employees, total industry hours, and the value of net production for published and unpublished industries are available upon request by sending E-mail to [dipsweb@bls.gov](mailto:dipsweb@bls.gov), or by calling the Division of Industry Productivity Studies (202-691-5618). SIC-based industry data also are available on the BLS Web site or by request. Historical productivity and related series for three- and four-digit SIC industries through 2000 will continue to be maintained, but will no longer be updated.

<sup>15</sup> Five of the eight industries with declines in labor compensation were in textile manufacturing.

## APPENDIX: Methods and data underlying the series

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Labor productivity is calculated as output per employee hour or output per hour of all persons working in the industry. The indexes of output per hour are computed by dividing an index of output by an index of aggregate hours. Industry output is measured as “sectoral output,” the total value of goods and services leaving the industry. Depending on the industry, hours can refer to hours of employees or hours of all workers. “All workers” include self-employed and unpaid family workers as well as employees. For industries where there are few self-employed and unpaid family workers, such as manufacturing industries, output per employee hour is measured. NAICS-based output and labor input series are created at the most detailed industry level possible; measures for more aggregate industries are aggregated from the detailed industry series.

*Tornqvist indexes.* Wherever possible, a Tornqvist formula is used to aggregate the various products or services produced in an industry in order to derive an output measure for the industry. The Tornqvist formula aggregates the growth rates of the various products or services between two periods with weights based on the products’ shares in industry value of production. The weight for each product equals its average value share in the two periods. The Tornqvist formula yields the ratio of output in a given year to that in the previous year. Ratios for successive years are chained together to form an output index.

The quantities of products used in the output index are measured either with deflated values of production or with actual physical quantities. For most industries in manufacturing, communications, wholesale and retail trade, and services, output indexes are derived from detailed data on the value of industry output or sales, adjusted for price change (that is, the deflated value of production). Tornqvist aggregations of these deflated values are then calculated to derive output indexes. For industries in utilities, and for many mining and transportation industries, physical quantity output indexes are derived as Tornqvist aggregations of quantities of component products. The Tornqvist aggregation method is used in calculating the output index for most industries; one notable exception is commercial banking, in which the annual changes in different outputs are combined using employment weights that are changed every 5 years.

*Annual output indexes based on deflated values of production.* Annual deflated value measures of real output are estimated by dividing current dollar value of production or revenues by appropriate price indexes. For most manufacturing industries, current dollar industry production (calculated as shipments adjusted for inventory change, intra-industry transfers, and resales) is distributed to product classes based on shares of wherever-made product class shipments. These values are deflated by appropriate price deflators (mostly BLS pro-

ducer price indexes). The resulting estimates of constant dollar production by product class are Tornqvist aggregated to create industry output indexes for each six-digit NAICS industry.

Similarly, current dollar retail trade industry sales are distributed to individual merchandise lines based on their relative value shares, and then deflated with appropriate price deflators (mainly BLS consumer price indexes). The resulting constant dollar values by merchandise line are aggregated into a single industry output measure according to the Tornqvist formula.

For wholesale trade industries also, current dollar sales are deflated with appropriate price indexes. For each wholesale trade industry, total sales by *merchant wholesalers* and by *manufacturers sales and branch offices (MSBOs)* are deflated with aggregate price indexes constructed by weighting together different producer price indexes (and in the case of *merchant wholesalers*, also some import price indexes). Once deflated, the annual sales of the two types of wholesalers are aggregated according to the Tornqvist formula. A similar procedure is used to develop and separately deflate sales of business-to-business electronic markets and wholesale trade agents and brokers, and then to aggregate the constant dollar values into an index for the electronic markets and agents and brokers industry group.

For some industries in information and services, detailed categories of revenues are available and are deflated with BLS producer price indexes and then aggregated to the industry level using the Tornqvist index formula. For other information and services industries, and for some mining and transportation industries, where less detail is available, data on the value of total industry revenues for each year are divided by industry-level producer price indexes or consumer price indexes to derive measures of changes in the industry’s real output.

*Annual output indexes based on physical quantities of production.* For utilities and for many mining and transportation industries, industry output reflects estimates of the physical quantity of production. Physical quantity indexes are, in all possible cases, Tornqvist aggregations of the quantities of component products, using the finest level of detail available. Examples of such products include tons of coal, BTUs of electricity, or revenue passenger miles and freight ton miles.

*Indexes of labor input.* The indexes of industry labor input used as the denominator in the productivity formula are developed mainly from basic data compiled by BLS. Data on employment and average weekly hours are used to construct measures of total hours for different categories of workers. Data from the Current Employment Statistics Survey (a monthly establishment survey in which 390,000 representative establishments report employment, hours, and earnings data to BLS and

supportive State agencies) are supplemented with data from the Current Population Survey (a monthly survey of approximately 60,000 households conducted by the Bureau of the Census for BLS).

Industry hours represent all employee hours or all worker hours. For manufacturing and mining industries, estimated hours of production workers and nonproduction workers are combined. For the trade, transportation, and service industries where self-employed are important, estimates of the hours of partners, proprietors, and unpaid family workers are added to estimated hours of supervisory and nonsupervisory workers. Employee hours for different types of workers are treated as homogenous and are directly aggregated. The indexes of hours are developed by dividing the aggregate hours for each year by the base-period aggregate.

*Unit labor costs.* Unit labor cost indexes reflect the cost of labor input required to produce one unit of output. Unit labor costs are calculated as the ratio of current dollar labor compensation to real or constant dollar output. The indexes of unit labor costs for each industry are computed by dividing an index of current dollar compensation by an index of constant dollar output.

Compensation is a measure of the employer's cost for securing the services of labor. It is defined as payroll plus supplemental payments. Payroll includes salaries, wages, commissions, dismissal pay, bonuses, vacation and sick leave pay, and compensation in kind. Supplemental payments are divided into legally required expenditures and payments for voluntary programs. The legally required expenditures include employers' contributions to Social Security, unemployment insurance taxes, and workers' compensation. Payments for voluntary programs include all programs not specifically required by legislation, such as the employer portion of private health insurance and pension plans.

For manufacturing industries, annual compensation data are derived from the Annual Survey of Manufactures and the Census of Manufactures produced by the U.S. Bureau of the Census. For industries outside of manufacturing, annual wage and salary data from the BLS Quarterly Census of Employment and Wages (QCEW) program are used. Because these data exclude supplemental payments, they are adjusted with ratios of compensation to payroll from the quinquennial census data, or (for utilities) from the Bureau of Economic Analysis (BEA), U.S. Department of Commerce. For a few industries, compensation data are obtained from other sources: for railroad transportation, for example, labor compensation comes from the Surface Transportation Board; for air transportation, labor compensation comes from the Office of Airline Information of the U.S. Department of Transportation, and for the Postal Service, labor compensation comes from the U.S. Postal Service.

## Conversion to NAICS

The conversion of industry productivity measures to the NAICS system required the separate conversion of output and labor input measures. The timing of this conversion was guided by the availability of historical BLS NAICS-based employment and hours estimates, as well as the necessary data for converting historical output series to NAICS. Both output and labor input measures were converted to NAICS at the most detailed industry level possible.

*Output.* Industry output indexes are prepared from basic data published by various public and private agencies, using the greatest level of detail available. Data from the Bureau of the Census, U.S. Department of Commerce, are used extensively in developing output series for manufacturing, trade, information, and service-providing industries, as well as in developing compensation and unit labor cost series for manufacturing industries. The 1997 Economic Census conducted by the Census Bureau was the first major U.S.

statistical program to implement NAICS, and data from the 1997 Census were used extensively in the NAICS conversion of the industry output measures. The 1997 Economic Census questionnaires were designed to permit the classification of establishments according to both NAICS and SIC. As a result, the Census Bureau tabulated and published 1997 industry data on both a NAICS and SIC basis for some variables. These dual-coded data were used to calculate conversion ratios relating NAICS industry values to SIC industry values. The conversion ratios were used primarily in converting output for manufacturing and trade industries, and for converting compensation for manufacturing industries. Conversion ratios were applied to SIC-based historical industry sales—or in the case of manufacturing industries, to values of shipments, inventories and labor compensation—to obtain estimates for NAICS-based industries for 1987 to 1996. For retail trade and merchant wholesalers, the Census Bureau provided data on a NAICS basis back to 1992, so additional estimates for NAICS-based industries were only necessary for 1987–91. Data were then aggregated according to NAICS industry definitions. The NAICS industry data estimated in this way were used in constructing the deflated value indexes for each industry.

For manufacturing industries, product shipment categories are used to distribute industry production prior to aggregation with the Tornqvist formula. Where NAICS product classes were not direct matches with SIC product classes, historical SIC-based product class shipments were converted to NAICS using conversion ratios developed by BLS. These conversion ratios were estimated using an SIC-to-NAICS product concordance developed by the Census Bureau, together with recent-year SIC and NAICS product shipments values.

*Price indexes.* For the majority of industries, output indexes are developed from data on the value of industry output adjusted for price change. This is done by dividing the annual value of the detailed product or service by an appropriate price index, often a BLS producer price index. For many industries, the NAICS-based revenue or shipment values are equivalent on an SIC and NAICS basis. In these cases, the SIC-based producer price series was used. Where NAICS industry or product data prior to 1997 were estimated, NAICS-based price series had to be estimated. In these cases, NAICS-based deflators were constructed as Tornqvist-weighted indexes of the component SIC-based PPIs. For service or trade industries where consumer price indexes (CPIs) are used to deflate revenues, the product CPIs are not coded by industry and therefore did not need to be converted.

*Labor hours.* The BLS Current Employment Statistics (CES) survey is the primary source of data used in estimating labor hours for each industry. The CES survey provides NAICS industry employment and average weekly hours data for production and nonsupervisory workers, and employment data for all employees, back to 1990 for all industries maintained by that program. NAICS data for years prior to 1990 were available for some industries. Where NAICS industry employment and hours data were not available prior to 1990, the series were estimated back to 1987 by the industry productivity staff using methods and conversion ratios similar to those used by the CES program. Industry labor productivity measures were calculated only for industries for which the CES program maintains employment and hours series.

*Compensation.* Compensation data used in calculating unit labor costs for manufacturing industries come from the Annual Survey of Manufactures and the Census of Manufactures of the U.S. Bureau of the Census. NAICS estimates for manufacturing industries for years prior to 1997 were calculated using conversion ratios similar to those described in the Output section above. Compensation data for non-manufacturing industries are based on wage data from the Bureau of Labor Statistics, together with fringe ratios from the Bureau of the Census. Compensation data for nonmanufacturing industries were converted using methods similar to those used in converting BLS employment and hours data.