Productivity in the nuts and bolts industry, 1958–90

Over the 1958–90 period, productivity growth accelerated in the bolts, nuts, screws, washers, and rivets industry, primarily reflecting changes in manufacturing processes, industry structure, and final demand

Ziaul Z. Ahmed
and
Mark Sieling

Output per employee hour in the bolts, nuts, screws, rivets, and washers industry increased at an average annual rate of 0.9 percent between 1958 and 1990, according to a new Bureau of Labor Statistics industry labor productivity measure.[1] Output increased by 1.5 percent a year over this period, while employee hours inched up at the rate of 0.6 percent annually.

The relatively low annual average increase in labor productivity for the industry over the period, however, masks a pattern of accelerating productivity growth. As table 1 shows, the annual rate of productivity growth was 0.5 percent between 1958 and 1973, 1.0 percent between 1973 and 1979, and 1.4 percent between 1979 and 1990.

During the 1958–79 period, annual changes in industry output were often matched by changes in employee hours. From the late 1970's through the early 1980's, however, both industry employment and employee hours declined faster than industry output declined, resulting in productivity increases. Faced with ebbing demand for domestically produced bolts and nuts caused primarily by growing competition from imports, many establishments—especially those employing 500 workers or more—shuttered their gates.

During the 1983–90 period, industry output increased at a 3.0-percent annual rate, primarily reflecting large gains in the output of small-sized establishments. Employee hours, however, increased by only 1.9 percent per year. Much of this improvement in output per employee hour stemmed from the growing use of more versatile and higher capacity boltforming machinery, improvements in machine durability, advances in bolt and nut design, and shifts in production processes.

Because demand for the industry's products is closely tied to activity in durable goods-manufacturing industries, year-to-year changes in output and employee hours tended to reflect general economic conditions. During the 1981–82 recession, for example, the industry's output declined by about 25 percent, while employee hours fell by almost 22 percent.[2]

The productivity indexes developed for this industry reflect the change over time in the ratio of a weighted output index to an employee hours index. The output index is developed using a deflated value technique. Data on value of shipments for various classes of products within the industry are converted to a constant-dollar basis using matching BLS Producer Price Indexes. Constant-dollar values of shipments are then combined at the industry level using fixed-period employee hour weights and are adjusted for industry coverage and net changes in inventories. Annual output indexes are also benchmarked every 5 years to the more comprehensive data available in the Census of Manufactures. (For a more complete description of this methodology, see the appendix.

Output and demand

Over the 1958–90 period, output of domestically produced nuts and bolts was strongly influenced by growing import penetration, increasing use of alternative joining technologies, improved fasteners, and the development of products requiring fewer fasteners.

Durable goods-manufacturing industries annually consume about four-fifths of total domestic fastener output.[3] Transportation equipment manufacturers account for about one-quarter of this

Ziaul Z. Ahmed and Mark Sieling are economists in the Division of Industry Productivity and Technology Studies, Bureau of Labor Statistics.

figure, with producers of electrical machinery and producers of nonelectrical machinery accounting for about one-fifth each.

In general, the annual output of the bolts and nuts industry parallels the annual output of durable goods industries. During the 1974–75 recession, for example, production of motor vehicles declined slightly more than 10 percent, while domestic output of bolts and nuts fell about 26 percent.[4] Since the 1970's, however, the output of durable goods has gradually outstripped the output of domestically produced bolts, nuts, screws, rivets, and washers.

During the period of study, an increasing proportion of demand was met by imports, rather than domestic production. In 1970, imported bolts, nuts, and rivets accounted for 7 percent of total apparent consumption; by the late 1970's, the proportion approached 25 percent, and in the mid-1980's, it reached about 60 percent.[5]

Increasing use of other types of fastening techniques, such as adhesives and welding, also dampened domestic output of bolts and nuts to a degree. In 1963, for example, adhesives and sealants accounted for about 19 percent of total fastening systems used by manufacturers, as measured in dollar terms.[6] In 1983, the proportion was 35 percent.[7]

Material engineering and design advances, particularly in the 1980's, also influenced industry output. The use of higher strength steel bolts and nuts, for example, has allowed some durable goods to be assembled with fewer fasteners. Product redesign, as well, has often reduced the number of fasteners needed to assemble a given product.[8]

Table 1. **Productivity and related indexes for the bolts, nuts, screws, rivets, and washers industry, 1958–90**

[1982 = 100]

Year	Output per employee hour	Output	All employee hours	Employees
1958	90.7	86.2	95.0	93.4
1959	104.1	112.9	108.5	101.0
1960	104.2	108.9	104.5	101.0
1961	98.8	97.6	98.8	95.1
1962	97.9	106.8	109.0	101.6
1963	92.3	102.6	111.2	103.7
1964	98.8	113.6	115.0	106.0
1965	99.3	121.6	122.4	110.1
1966	98.9	131.0	132.5	117.5
1967	92.3	122.2	132.4	121.2
1968	92.3	123.6	133.9	123.5
1969	83.7	117.7	140.6	127.6
1970	80.2	100.8	125.7	119.5
1971	87.8	97.3	110.8	106.4
1972	95.5	115.5	120.9	111.5
1973	97.4	130.5	134.0	119.8
1974	98.0	132.1	134.8	122.4
1975	92.3	96.7	104.8	103.1
1976	98.7	110.8	112.3	105.8
1977	102.7	122.8	119.6	110.9
1978	105.6	135.5	128.3	118.1
1979	103.6	142.4	137.4	127.2
1980	105.6	133.6	126.5	120.4
1981	109.1	134.2	123.0	117.7
1982	100.0	100.0	100.0	100.0
1983	112.8	113.1	100.3	95.1
1984	113.1	127.9	113.1	103.7
1985	118.1	132.0	111.8	103.7
1986	122.4	132.4	108.2	98.6
1987	133.6	142.3	106.5	96.7
1988	129.1	148.9	115.3	103.9
1989	121.3	144.9	119.5	106.6
1990	121.2	138.9	114.6	106.0
	Average annual rates of change			
1958–90	0.9	1.5	0.6	0.4
1958–73	.5	2.8	2.3	1.7
1973–79	1.0	1.5	.4	1.0
1979–90	1.4	–.2	–1.6	–1.6

Industry structure

The industry experienced a significant shift in its structure from 1958 to 1987. During this period, the number of small-sized establishments (those employing fewer than 100 workers) increased considerably, as did their share of industry employment and their value of shipments.[9] Conversely, the number of large-sized establishments (those employing 500 or more workers) declined significantly.[10] As table 2 shows, both the number of establishments employing fewer than 100 workers and the number of employees working in such establishments more than doubled between 1958 and 1987. In 1958, small-sized establishments accounted for 76 percent of all establishments, but for only 21 percent of industry value of shipments and 17 percent of total industry employment.[11] By 1987, they accounted for 86 percent of establishments, 38 percent of value of shipments, and 37 percent of industry employment. On the other hand, the number of establishments employing 500 or more workers fell by two-thirds over the 1958–87 period, as did their total employment. In 1958, large-sized establishments made up 6 percent of all establishments, but accounted for 41 percent of industry value of shipments and 48 percent of industry employment.[12] By 1987, they represented only 1 percent of all establishments, 15 percent of value of shipments, and 18 percent of employment.

Establishments also differed in capital and labor intensity and in types of production processes. While small-sized establishments generally tend to employ less capital per employee than larger sized facilities, productivity levels, as defined by value added per employee, are about the same.[13] In 1958, for example, value added per employee in small-sized establishments amounted to $10,240, compared with $8,790 for establishments employ-

Table 2. **Structure of the bolts, nuts, screws, rivets, and washers industry, 1958–87**

Year	Establishment size		
	1–99 employees	100–499 employees	500 or more employees
Number of establishments:			
1958	401	93	31
1963	438	105	30
1967	507	123	32
1972	525	128	26
1977	697	142	18
1982	773	117	13
1987	808	118	11
Thousands of employees:			
1958	9.0	18.6	25.5
1963	10.3	21.6	25.8
1967	12.4	25.2	29.5
1972	13.4	27.5	19.7
1977	16.0	30.1	14.8
1982	17.8	23.2	11.1
1987	19.4	23.5	9.2
Percent of industry value of shipments:			
1958	20.8	38.3	40.9
1963	21.4	39.1	39.5
1967	20.7	39.5	40.1
1972	24.5	47.2	28.3
1977	28.1	51.9	20.0
1982	37.1	46.0	16.9
1987	37.8	47.7	14.5

ing 500 workers or more. In 1987, the respective figures were $52,530 and $56,590.

The ratio of production to nonproduction workers within an establishment is also fairly constant regardless of size. Over the 1958–87 period, for example, production workers accounted for about three-quarters of total employment in small-, medium-, and large-sized establishments.

On the other hand, small- and medium-sized establishments are more likely than their larger sized counterparts to use in-line production processes, and, as described in the next section, in-line processing appears to be more efficient than other types of manufacturing processes.[14]

Manufacturing techniques, technologies

The manufacture of bolts and screws involves a series of steps that can be performed either by a number of specialized machines or by a single piece of machinery called a boltmaker.[15] A metal wire or rod is first cut into blanks about the size of the finished bolt or screw. These blanks are then fed into die presses that form the head of the bolt or screw. Next, the modified blanks are trimmed to the correct length, pointed, and threaded. Finally, the products are heat treated and then galvanized or plated.

During the late 1970's and throughout the 1980's, new generations of boltforming machinery were gradually adopted by the industry. In contrast to older machines, these models operate at much higher speeds, typically producing two to three times the number of bolts per hour as their predecessors.[16] They also produce more precise products, which reduces the need for metalcutting operations to achieve specified tolerances. Less maintenance is also required on these machines, because they use high-strength carbon-steel parts.[17] Productivity gains registered by the industry since the late 1970's, however, did not stem entirely from the introduction of new machinery.[18] In 1989, the average age of production machinery used in the industry was still about 25 years.[19]

Changes in production processes, retrofitting older machinery, and the introduction of statistical process-control techniques also contributed to gains in output per employee hour. In some cases, significant reductions in unit labor requirements were achieved by changing the manufacturing process from one in which products were passed from one fabrication stage to the next in batches to a process in which a single operator was responsible for all the functions needed to produce a particular product (called in-line processing).[20] In other cases, older production machinery was retrofitted with computer-assisted devices to reduce material-handling operations and improve machine-operating speeds.[21] In addition, the introduction of statistical process-control techniques has increased machinery utilization rates and product quality in many instances, while reducing the need for quality control inspectors.[22]

Other factors contributing to productivity gains, particularly during the 1980's, were the increasing use of computer-aided design and engineering technologies,[23] better control of inventories and orders,[24] changes in work rules,[25] and the automation of certain office functions, such as payroll and accounts payable and receivable.

Indicative of the increased use of computers in the industry in a variety of areas, such as office functions, manufacturing processes, and inventory control, annual investments in computers more than quadrupled between 1977 and 1987. In current-dollar terms, the industry spent $1,600,000 for computer equipment in 1977, or 1.7 percent of total capital equipment expenditures that year. In 1987, computer expenditures totaled $7,200,000, or 5.8 percent of capital expenditures.

Employment and hours

Between 1958 and 1990, the number of persons engaged in the bolts, nuts, screws, rivets, and washers industry increased from 45,400 to

51,500, an average annual rise of 0.4 percent. Changes in employment varied by size of establishment. As previously mentioned, employment growth was strongest in establishments employing fewer than 100 workers. In these facilities, employment grew 2.6 percent per year between 1958 and 1987. In medium-sized establishments (those employing 100 to 499 workers), employment advanced by an average of 0.8 percent a year, while in establishments employing 500 workers or more, employment declined by an average of 3.5 percent yearly.

Average hours of all persons employed in the industry remained fairly constant over the 1958–90 period—about 40 hours per week, very similar to the average for all manufacturing combined. Also, average weekly production worker hours did not vary significantly by size of establishment.[26] In 1987, for example, workers in small-sized establishments averaged 40.1 hours per week, compared with 40.7 hours per week for workers in facilities employing at least 500 persons.

Occupational structure

Production workers account for about 70 percent of the bolts, nuts, screws, rivets, and washers industry's total work force. Numerically, among the most important occupations are machine tool setters and setup operators, machine tool operators, and inspectors. In general, production workers in the industry tend to be older and better educated than their counterparts in all manufacturing industries as a whole.[27] In 1977, for example, 54 percent of bolts and nuts production workers had completed high school, compared with 37 percent for the all-manufacturing production work force. Nuts and bolts production workers also were slightly older, with 44 percent more than 44 years old, as against 38 percent for all manufacturing combined.

The occupational structure of the industry changed significantly during the 1970's and 1980's. Primarily reflecting improved manufacturing technologies, which reduced the amount of hand-finishing operations involved in producing standard bolts and nuts, the number of production workers engaged in grinding, polishing, and finishing operations declined significantly over this period. In 1971, approximately 7,270 employees performed these tasks, accounting for about 1 in every 5 production workers; by 1987, only 3,770 workers were thus engaged, or about 1 in every 10 production workers.

Capital stock and investments

As table 3 shows, the proportion of metalforming machinery used in the industry, such as forging machines and thread rollers, that was less than 10 years old increased between 1963 and 1968 and then slowly declined until 1983.[28] Conversely, the proportion of machinery more than 20 years old declined during the 1963–68 period and then slowly increased until 1983. During the 1983–89 period, the industry reversed course, increasing its stock of new production equipment and retiring older machines, so that by 1989, 1 in every 5 metalforming machines in use was less than 5 years old. (In 1983, the proportion was about 1 in 16.)

While annual investments in plant and equipment varied considerably over the 1958–90 period, on average, about four-fifths of such investments were for equipment, rather than for land or structures.[29] In constant-dollar terms, annual investments in equipment increased an average of 1.4 percent a year over the 1958–67 period, decreased 5 percent a year during the 1967–83 period, and increased an average of 8.9 percent yearly between 1983 and 1987.[30] In addition to varying over time, annual capital investments also varied by size of establishment. As table 4 shows, annual capital investments per employee were often highest in establishments employing fewer than 100 workers and lowest in those employing 500 or more workers. However, given the growth in the number of small-sized establishments over the 1958–87 period, a large proportion of the annual capital expenditures of these establishments was probably devoted to purchases of land and structures. □

Table 3. **Average age of metalforming machinery in SIC 345**

Year	Percent of machinery—		
	Less than 10 years old	10 to 19 years old	20 years old and older
1963	24	37	39
1968	35	40	25
1973	32	35	33
1977	26	36	38
1983	20	38	43
1989	28	32	38

SOURCE: *American Machinist* magazine, various issues.

Table 4. **Capital expenditures per employee, current dollars**

Year	Establishment size		
	1–99 employees	100–499 employees	500 or more employees
1958	$1,455	$978	$471
1967	1,032	1,222	919
1977	2,113	1,924	1,392
1987	2,567	3,166	2,848

Footnotes

[1] The bolts, nuts, screws, rivets, and washers industry is designated as SIC 3452 by the 1987 *Standard Industrial Classification Manual* of the Office of Management and Budget. The industry consists of establishments engaged primarily in manufacturing standard bolts, nuts, screws, rivets, and washers, formed and threaded wire goods, and special industrial fasteners typically made in very high volumes and used for multiple purposes. Establishments manufacturing fasteners primarily on a custom or job order basis are classified in SIC 3451, screw machine products. In 1990, the bolts, nuts, screws, rivets, and washers industry employed about 51,500 workers; in the same year, all-manufacturing employment totaled 19,111,000.

Average annual rates of change are based on compound rates of change between pairs of index numbers. Extensions of the indexes will appear in the annual Bureau of Labor Statistics bulletin, *Productivity Measures for Selected Industries*.

[2] All economic cycles mentioned in this article are those defined by the National Bureau of Economic Research, Inc.

[3] Standard fasteners are manufactured in accordance with product specifications established by a variety of institutions. Prior to 1864, fastener threads were not standardized, and hence, bolts and screws made by different manufacturers were not interchangeable. Since then, a number of institutions, such as the American Society of Mechanical Engineers and the International Organization for Standardization, have refined and updated specifications for standard bolts, nuts, screws, washers, and rivets. For a concise history of fasteners and the growth and development of standards, see *The Heritage of Mechanical Fasteners* (Cleveland, Industrial Fastener Institute, 1974).

[4] Just prior to the 1974–75 recession, durable goods manufacturers had accumulated large stockpiles of fasteners in anticipation of shortages. During the recession, manufacturers drew down these stocks, resulting in a disproportionate decline in orders for new fasteners. See Margaret Price, "John Selby Is Fed Up with the Fastener Roller Coaster," *Industry Week*, July 9, 1979, pp. 33–36; and *Bolts, Nuts, and Large Screws of Iron and Steel*, Publication 847 (International Trade Commission, December 1977), p. A–36.

[5] *The Threat from Substandard Fasteners: Is America Losing Its Grip?*" Report of the Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce, U.S. House of Representatives, July 1988.

[6] Industrial adhesives and sealants used as fastening systems by manufacturers are produced by establishments in SIC 2891, adhesives and sealants.

[7] George A. Weimer, "Increasing Innovation Will Make Joining More than Nuts and Bolts," *Iron Age*, January 13, 1982, pp. 40–43.

[8] "Design and Assembly," *Machine Design*, November 1988, pp. 5–20.

[9] The increase in the number of small-sized establishments seems to be part of a larger movement among metalcutting and metalforming industries. In 1978, for example, establishments employing fewer than 100 workers accounted for one-third of all metalforming and metalcutting machinery; by 1983, they accounted for about two-fifths, and by 1988, about two-thirds. See "The 14th Inventory of Metal Working Equipment, Special Report 808," *American Machinist*, November 1989, pp. 96–101.

[10] Some of these establishments were subsidiaries of large steel companies, such as Bethlehem, Armco, and Republic, which typically supplied them with raw materials, for example, steel rods and wires. See Robin P. Bergstrom, "Sundown on U.S. Boltmaking," *Production*, June 1990, p. 36.

[11] Establishments employing 50 to 99 workers account for about one-half of employment in small-sized establishments in the bolts, nuts, screws, washers, and rivets industry. Over the 1958–87 period, employment growth in the industry was fairly uniform among different-sized small establishments. In 1958, for example, 600 workers were in establishments employing fewer than 10 employees; by 1987, the number had reached 1,200. Similarly, the number of workers in establishments employing between 10 and 49 employees increased from 3,800 in 1958 to 9,700 in 1987, while in establishments employing between 50 and 99 employees, the number of workers grew from 4,600 to 8,500.

[12] These concentration ratios had been essentially unchanged since the 1940's. In 1947, for example, large-sized establishments accounted for 8 percent of all establishments, 48 percent of industry value of shipments, and 51 percent of industry employment.

[13] Industry sources.

[14] *Ibid.*

[15] Department of Labor, *Bolts, Nuts, and Large Screws of Iron or Steel* (Public Version of Report to the President, Investigation No. TA-224–37, under Section 224 of the Trade Act of 1974), pp. 3–4.

[16] Michael A. Verspej, "Fastener Firms Learn to Fight Back," *Industry Week*, September 17, 1979, pp. 69–74.

[17] George A. Weimer, "U.S. Primary Defense in Fastener War: Technology," *Iron Age*, July 9, 1979, pp. 45–50.

[18] This emphasis on changes in production processes and machinery that have occurred since the late 1970's should not obscure the fact that in previous periods many individual establishments were actively striving to improve production processes and equipment. For accounts of some of these activities during the late 1940's and early 1950's, see Seymour Rand, *Case Study Data on Productivity and Factory Performance, Cold Formed Machine Bolts and Hexagon Nuts*, Report No. 47 (Bureau of Labor Statistics, October 1953).

[19] Until the early 1970's, most boltforming machinery was based on designs of the 1920's and 1930's. When newly designed machines were introduced in the early 1970's, the majority of customers were foreign rather than domestic manufacturers. By the 1980's, however, most orders for these machines were being placed by domestic firms. See Bergstrom, "Sundown on U.S. Boltmaking," p. 38.

[20] Ronald Henkoff, "The Ultimate Nuts & Bolts Co.," *Fortune*, July 6, 1990, pp. 70–73.

[21] Karl Schultz, "Robot Revitalizes Retrofitted Screw Machine," *Automation*, May 1988, pp. 76–78.

[22] "SPC Used to Tighten Fastener QC," *Quality*, October 1990, p. 85.

In the nuts and bolts industry, machine operators traditionally set up a machine and then ran off samples that were inspected by separate quality control inspectors. After the setup was approved (with the machine being idle in the interim), production began. Following a production run, samples were again taken and measured to determine whether the products complied with standards; if too many failed to meet the standards, the whole production run was reworked.

By contrast, using statistical process-control methods, machine operators themselves continuously test and measure the products during all stages of setup and actual production, reducing both machine downtime and the need for frequent rework of production runs.

[23] Robert Eade, "Screw Machining: An Industry with Nine Lives," *Manufacturing Engineering*, June 1988, pp. 73–82.

[24] Henkoff, "The Ultimate Nuts & Bolts Co."

[25] For a description of how changes in work rules have affected productivity in one facility, see John Merwin, "People, Attitudes and Equipment," *Forbes*, February 8, 1988, pp. 68–69.

[26] Average production worker hourly earnings, however, do vary by size of establishment. Over the 1958–87 period, earnings of workers in small-sized establishments gradually fell behind earnings of their counterparts in large-sized facilities. In 1958, average hourly earnings for production workers in small-sized establishments were about the same as those for workers employed in large-sized facilities—$2.62 versus $2.58. By 1972, workers in large plants were averaging about 12 percent more than workers in small establishments ($4.93 versus $4.39), and by 1987, the gap had widened to about 25 percent ($13.97 versus $11.10).

[27] *Bolts, Nuts, and Large Screws of Iron or Steel*, p. A–22.

[28] Data are from *American Machinist*'s periodic inventories of metalworking equipment, various issues.

Data represent totals of metalforming machinery for SIC 345, screw machine products. According to industry sources, SIC 3451, screw machine products, accounts for the vast majority of metalcutting equipment within SIC 345. SIC 3452, bolts, nuts, rivets, and washers, accounts for the vast majority of metalforming machinery within SIC 345.

[29] Capital equipment expenditures are made either to increase capacity or to replace existing machinery.

In 1972, 1977, 1982, and 1987, capital expenditures for used equipment typically accounted for about 16 percent of total annual equipment expenditures.

[30] Capital expenditures for new equipment were developed using the Producer Price Index for forging machinery, the prevalent type of production machinery used in the industry.

APPENDIX: Measurement techniques and limitations

Indexes of output per employee hour measure changes in the relationship between the output of an industry and the employee hours expended on that output. The indexes do not measure the specific contributions of labor, capital, or any other single factor. Rather, they reflect the joint effect of factors such as changes in technology, capital investment, capacity utilization, plant design and layout, skill and effort of the work force, managerial ability, and labor-management relations. An index of output per employee hour is derived by dividing an index of output by an index of industry employee hours.

Output indexes measure change in industry output over time. The output indexes for the bolts, nuts, screws, rivets, and washers industry were constructed using a price-deflated value technique that removes the price change from the current-dollar value of the industry's production. The bolts, nuts, screws, rivets, and washers industry consists of one four-digit industry, SIC 3452, which contains five five-digit product classes: SIC 34524, externally threaded fasteners; SIC 34525, internally threaded fasteners; SIC 34526, nonthreaded fasteners, except aerospace; SIC 34527, aerospace fasteners; and SIC 34528, other formed fasteners. The values of shipments for each of these product classes, obtained from the Bureau of the Census, are respectively deflated with the following BLS Producer Price Indexes: 34524, externally threaded fasteners; 34525, internally threaded fasteners, except aircraft; 34526, nonthreaded fasteners, except aircraft; 34527, aerospace fasteners; and 34528, other formed fasteners.

The deflated value-of-shipments indexes are then combined with employee hour weights to derive the industry quantity-of-shipments index. This index is adjusted for net changes in inventory and for coverage to bring the establishment-coded product class shipments data up to the level of total industry shipments.

The annual industry output series is adjusted (by linear interpolation) to the index levels of the benchmark output series. This quinquennial benchmark series incorporates more comprehensive, but less frequently collected, economic census data.

Employment and employee hour indexes measure the change in the aggregate number of employees and employee hours, respectively, over a period of time. Employment and employee hours are each considered homogeneous and additive. Hence, changes in employment, such as in the skills, education, and experience of persons constituting the aggregate, are not reflected in the employee hour indexes. The employee hour data relate to the total time expended by the employees in establishments that are classified in the industry and include hours spent on the production of primary and secondary products.

The indexes of total employment and hours, production workers, production worker hours, nonproduction workers, and nonproduction worker hours developed for the bolts, nuts, screws, rivets, and washers industry are based on data published by the Bureau of Labor Statistics. The index of employee hours is derived from production worker hours, the number of nonproduction workers, and an estimate of average weekly hours paid for nonproduction workers. Estimates of nonproduction worker average weekly hours were prepared by the Bureau of Labor Statistics for SIC 34, fabricated metal products, except machinery and transportation equipment, and were derived primarily from studies undertaken by the Department of Labor.

Average hours for nonproduction workers are multiplied by the number of nonproduction workers to obtain total nonproduction worker hours. These are then added to production worker hours to derive total employee hours.

Average annual rates of change in output per employee hour or per employee at the overall industry level are based on aggregated data of value of shipments, employment, and employee hours. As such, they are averages; some individual establishments will, of course, have experienced higher or lower rates of productivity change over various periods of time.