Productivity in the carburetors, pistons, and valves industry

Growth in output per employee hour in the carburetors, pistons, and valves industry has been substantially below that for all manufacturing; the industry has felt the effects of weak demand

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Productivity in the carburetors, pistons, and valves industry, as measured by output per employee hour, declined slightly at an average annual rate of 0.4 percent from 1972 to 1986.[1] This was below the rate for all manufacturing, which grew at a rate of 2.4 percent per year during the same period. The decline in productivity reflected a small decrease in output of 0.1 percent per year and a rise in employee hours of 0.3 percent per year. Adversely affecting the industry were cyclical downturns in the economy, which resulted in sizable drops in production in several years and corresponding declines in productivity.

The productivity trends in the industry can be divided into two distinct periods. From 1972 to 1980, productivity declined at an average annual rate of 3.1 percent. Output fell 1.3 percent per year, while hours rose 1.9 percent per year. In the two recessions which occurred during this period, output dropped sharply. In the recession year of 1974, output fell 14.3 percent and hours decreased 4.7 percent. This resulted in a productivity falloff of 10.0 percent. In the recession year of 1980, a 17.1-percent decrease in output and a 13.2-percent decline in hours led to a 4.5-percent drop in industry productivity.

From 1980 to 1986, productivity rebounded, increasing at a rate of 4.5 percent per year. This was a result of output's having risen at an average annual rate of 4.2 percent while hours changed little, falling 0.3 percent per year. Productivity advanced in each year from 1980 to 1985; however, in 1986 output per hour declined.[2]

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Industry description

The carburetors, pistons, and valves industry includes establishments engaged primarily in the manufacture of all types of carburetors, pistons and piston rings, and valves for aircraft, motor vehicles, and engines. The breakdown of industry production in 1972 was 46 percent carburetors, 29 percent pistons and piston rings, and 25 percent valves. By 1986, the distribution had changed to 61 percent carburetors, 28 percent pistons and piston rings, and 11 percent valves. Michigan, New York, Kentucky, and Indiana are the leading States in employment in the industry, accounting for about 50 percent of the industry's employment in 1982 (the year of the most recent Census of Manufactures).

Establishments in the industry are large: The eight largest of the industry's 171 establishments accounted for more than one-half of the value of the industry's shipments in 1982. The average number of employees per establishment in 1982 was 182, compared to an average of 53 employees for all manufacturing.

Output and demand

The change in industry output over the entire period from 1972 to 1986 was negligible. However, annual output movements have varied significantly in certain years. (See table 1.) In 1973, the industry recorded its largest increase in output, 30.2 percent. The largest decrease—17.4 percent—occurred in 1975. Approximately three-fourths of the industry's output is purchased by motor vehicle manufacturers. Hence, the level of production in the motor vehicle industry is the primary determinant of industry output.[3]

From 1972 to 1980, output declined at an average annual rate of 1.3 percent, a reflection of a decline in output in the motor vehicle industry.[4] During this period the number of cars, trucks, and buses produced fell by 1.4 percent per year. The shift in automobile production in the United States from large cars to small and medium cars also adversely affected the industry. In 1972, the distribution of automobile production was 9 percent four cylinders, 11 percent six cylinders, and 80 percent eight cylinders. By 1980, the distribution had changed to 31 percent four cylinders, 37 percent six cylinders, and 32 percent eight cylinders.

By contrast, from 1980 to 1986, industry output grew at an average annual rate of 4.2 percent. This was primarily due to an 8.4-percent annual growth rate in motor vehicle production. However, other factors tempered the recovery of the carburetors, pistons, and valves industry. One of these was the continuing shift toward small-car production. By 1986, more than half of all automobiles produced in the United States had four-cylinder engines. Correlatively, the proportions of cars with six- and eight-cylinder engines both declined from 1980 levels, to 29 and 20 percent, respectively. Also tempering the growth rate of industry output was the increasing number of installations of electronic fuel injection systems in place of conventional carburetor systems in new cars. Before 1980, electronic fuel injection systems were virtually nonexistent in American-made automobiles. By 1986, nearly two-thirds of the automobiles produced in the United States were equipped with such systems.

Table 1. Productivity and related indexes for the carburetors, pistons, and valves industry, 1972–86

Year	Output per employee hour			Output	Employee hours		
	All employees	Production workers	Nonproduction workers		All employees	Production workers	Nonproduction workers
1972	113.6	113.8	112.9	94.3	83.0	82.9	83.5
1973	120.4	119.3	124.9	122.8	102.0	102.9	98.3
1974	108.3	108.8	106.3	105.3	97.2	96.8	99.1
1975	100.1	102.8	89.3	87.0	86.9	84.6	97.4
1976	107.3	108.4	102.0	102.9	95.9	94.9	100.9
1977	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1978	94.6	95.1	92.5	96.5	102.0	101.5	104.3
1979	94.6	94.2	96.4	105.7	111.7	112.2	109.6
1980	90.3	93.3	78.7	87.6	97.0	93.9	111.3
1981	91.7	93.1	85.6	90.1	98.3	96.8	105.2
1982	92.0	97.4	73.7	85.3	92.7	87.6	115.7
1983	99.6	102.9	86.3	91.6	92.0	89.0	106.1
1984	110.3	111.5	105.2	115.3	104.5	103.4	109.6
1985	114.0	116.8	102.8	110.8	97.2	94.9	107.8
1986	111.1	114.9	96.3	101.3	91.2	88.2	105.2
	Average annual rates of change (in percent)						
1972–86	−0.4	−0.1	−1.4	−0.1	0.3	0.0	1.3
1972–80	−3.1	−3.0	−3.9	−1.3	1.9	1.7	2.7
1980–86	4.5	4.4	4.9	4.2	−0.3	−0.2	−0.6

Employment and hours

Industry employment grew at an average annual rate of 0.2 percent from 1972 to 1986. Employment increased from 26,700 in 1972 to a high of 36,200 in 1979 and fell to 28,800 in 1986. Total employee hours grew at a slightly faster pace of 0.3 percent per year. The number of production workers rose slightly from 21,600 in 1972 to 22,300 in 1986. Nonproduction worker employment grew at a faster rate of 1.4 percent per year as the number of nonproduction workers increased from 5,100 in 1972 to 6,500 in 1986. The proportion of production workers to total employment fell from 80.9 percent in 1972 to 77.4 percent in 1986.

Average hourly earnings of production workers were significantly higher in the industry than in all manufacturing industries. In 1972, industry average hourly earnings were $4.65, compared with $3.82 in all manufacturing industries. By 1986 the gap had widened, and industry average hourly earnings were $12.66 compared with $9.73 in all manufacturing.

Capital spending

Measured in constant dollars,[5] industry capital expenditures increased at an average annual rate of 6.6 percent from 1972 to 1986, as capital spending per employee was brought up to the level for all manufacturing industries. Strained production capacity, which peaked in the late 1970's, was the main reason for the high levels of capital spending. During the same years, capital expenditures by all manufacturing industries rose 2.5 percent per year.

From 1972 to 1980, investments in plant and equipment by companies in the industry rose 10.6 percent per year while all manufacturing industries increased their capital expenditures 5.2 percent per year. At the beginning of this period, the level of capital spending per employee in the industry was about one-half the level of all manufacturing industries. By the late 1970's, the industry was investing in plant and equipment at a level comparable to that of all manufacturing.

Following this period of high capital spending, industry productivity benefited from 1980 to 1986, growing 4.5 percent annually. The lag between capital expenditures and productivity is due in part to the lapse of time that occurs before the new facilities made possible by the capital expenditures, which incorporate technological advances, become fully operational.

Between 1980 and 1986, capital spending slowed slightly throughout the manufacturing segment of the economy, declining by 0.1 percent per year. In contrast, investment in plant and equipment in the carburetors, pistons, and valves industry increased 9.3 percent per year. Much of the capital spending by the industry was on the conversion to the production of electronic fuel injection systems.[6]

Technology

Although productivity has been dampened by decreasing demand, the industry has introduced some new technology into its production processes. Changes in technology have centered on improvements in metalworking machinery, as well as automatic movement and positioning of work.

In carburetor manufacturing, new technology has centered on improvements in assembly line production.[7] In the earliest years of the study period, loading and transferring the workpiece were manual operations. Soon, establishments increasingly installed automatic transfer lines. As a result, many metalworking operations (for example, milling, grinding, drilling, and reaming) became automated. In the newer system, workers perform the initial tool setup, monitor performance, and provide maintenance. Testing and inspection may or may not be automated. For the installation and continued use of such machinery to be economical, the volume of production must be very high.

In recent years the volume of production of carburetors has declined sharply, as more new cars are equipped with electronic fuel injection systems. Major manufacturers who once produced thousands of carburetors daily now produce only hundreds daily. The reduced volume of production has resulted in a shift away from the newer assembly line production technique toward cell manufacturing and job-order production. In cell manufacturing, the workpiece is assembled at one location, and jigs and fixtures are provided as operator aids. Convenient parts bins and state-of-the-art tools are also provided to minimize labor and increase production. Direct labor requirements are higher in cell manufacturing than in assembly line production.

In piston manufacturing, new technology has centered on improvements in metalworking and transfer machines. Traditionally, pistons were manufactured on a succession of lathes and grinders, requiring much manpower to transport and position the work in process. Some establishments in the industry have now installed automatic-dial transfer machines.[8] These machines perform all the operations of the lathes and grinders at a faster rate than the machines they replaced. The machine cycle consists of two trips around the seven-station dial with the pistons automatically positioned. Two pistons are always in place at each work station—one in a vertical position for the first series of machine operations and one in a horizontal position for the second series. At the first station an operator loads a casting that is indexed for the second station into the load-assist, which places the casting in a three-jaw compensating lathe. At the second station, a horizontal feed unit with a boring spindle drills the wrist-pin hole and counterbores, faces, and chamfers (grooves) the piston skirt. At the third station, the near and far sides of the wrist-pin hole are recessed to hold a snap ring. The wrist-pin hole is bored further at the fourth station, and polishing takes place at the fifth station. At the sixth station a tool peens the surface of the piston, hardening the bore to the desired depth. At the final station in its first trip around the seven-station dial, the wrist-pin bore is gaged. The part is then automatically unloaded from the vertical position and reloaded in the horizontal position.

The second cycle begins at station 2, where the outside diameter of the piston is rough-turned. At the third station, the piston dome is rough-cut and finish-cut. A horizontal positioning unit with a grooving spindle then cuts the ring groove at the fourth station. At the fifth station, the outside diameter is finish-turned to the desired roundness tolerance. At the sixth station, the outside diameter is gaged. Finally, at the seventh station, the dial indexes the piston to its original position and automatically unloads it into a chute. Pistons produced on the automatic-dial transfer machine are of consistently higher quality than those produced on a succession of lathes and grinders. Also, labor requirements are significantly lower due to the reduced material handling and reworking of pistons.

Outlook

The carburetor segment of the carburetors, pistons, and valves industry is expected to decline sharply. In 1987, the proportion of new American-made cars with electronic fuel injection systems rose to 77 percent. Industry sources predict that carburetors will cease to exist as original equipment on new American cars by 1991. However, manufacturers will continue to produce carburetors for replacements in older cars and for nonautomotive use. The low level of demand will probably be responsible for the failure to adopt, on a widespread basis, new technologies such as automatic transfer lines.

The outlook for the remaining segments of the industry appears better. Diffusion of the more efficient metalworking and transfer machinery is far from complete. In addition, establishments in the industry may adopt computer-integrated manufacturing, a system in which engineers use computers to design products. Computers can also guide workpieces among machines and direct machine tools.

The major reason for the lack of diffusion of the newer technologies throughout the industry is weak and volatile demand. Contributing to the weakness in demand is strong foreign competition. For example, in 1972 imports of piston rings were virtually nonexistent. Today, one industry source estimates that imports account for 20 percent of the piston ring market. The volatility in demand is a byproduct of the cyclical patterns in motor vehicle production. □

—*FOOTNOTES*—

[1]The carburetors, pistons, and valves industry is designated by the Office of Management and Budget as SIC 3592 in the *Standard Industrial Classification Manual, 1987.* This industry comprises establishments engaged primarily in the manufacture of carburetors, pistons, piston rings, and engine intake and exhaust valves.

Average annual rates mentioned in the text and tables are based on the linear least squares trend of the logarithms of the index numbers. The indexes for productivity and related variables are updated annually and published in *Productivity Measures for Selected Industries and Government Services,* Bulletin 2296 (Bureau of Labor Statistics, November 1987).

[2]By definition, the least squares rate of change is the rate resulting from the best fit of the trend line. The overall rate is not necessarily the average of the year-to-year rates of change. In this case, the overall rate of change is not an average of the two subperiod rates of change.

[3]*Census of Manufactures* (U.S. Department of Commerce, 1972, 1977, 1982), table 6a.

[4]All motor vehicle data in this article come from *Facts and Figures '86* (Motor Vehicles Manufacturers Association of the United States, Inc., 1987); or *Ward's Automotive Yearbook* (Ward's Communications, Inc., 1987).

[5]Capital expenditures were deflated by the implicit price deflator for producers' durable equipment; see *The Economic Report to the President,* transmitted to the Congress January 1988, table B3.

[6]Industry sources. It should be noted that production of electronic fuel injection systems is done primarily in the motor vehicle parts and accessories industry (SIC 3714). Conversion to electronic fuel injection systems will lead to a reduction in the size of the carburetors, pistons, and valves industry as presently defined in the *Standard Industrial Classification Manual.*

[7]*Ibid.*

[8]"Transfer Machine for Mini Pistons," *American Machinist,* March 1981, pp. 112–14; and "Machine of the Month: Hardinge Piston Turning Machine," *Manufacturing Engineering,* March 1979, p. 43.

APPENDIX: Measurement techniques and limitations

Indexes of output per employee hour measure changes in the relation between the output of an industry and employee hours expended on that output. An index of output per employee hour is derived by dividing an index of output by an index of industry employee hours.

The preferred output index of manufacturing industries would be obtained from data on quantities of the various goods produced by the industry, each weighted (multiplied) by the employee hours required to produce one unit of each good in some specified base period. Thus, those goods which require more labor for production are given more importance in the index.

In the absence of adequate data on quantities produced, the output index for the carburetors, pistons, and valves industry was constructed by a deflated-value technique. The values of shipments of the various product classes were adjusted for price changes by appropriate producer price indexes and industry sector price indexes to derive real output measures. These, in turn, were combined with employee hour weights to derive the overall output measure. The result is a final output index that is conceptually close to the preferred output measure.

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

The indexes of output per employee hour relate total output to one input—labor. The indexes do not measure the specific contribution of labor, capital, or any other single factor. Rather, they reflect the joint effects 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.

The average annual rates of change presented in the text are based on the linear least squares trend of the logarithms of the index numbers. Extensions of the indexes will appear annually in the BLS bulletin, *Productivity Measures for Selected Industries and Government Services.* A technical note describing the methods used to develop the indexes is available from the Bureau's Office of Productivity and Technology, Division of Industry Productivity and Technology Studies.