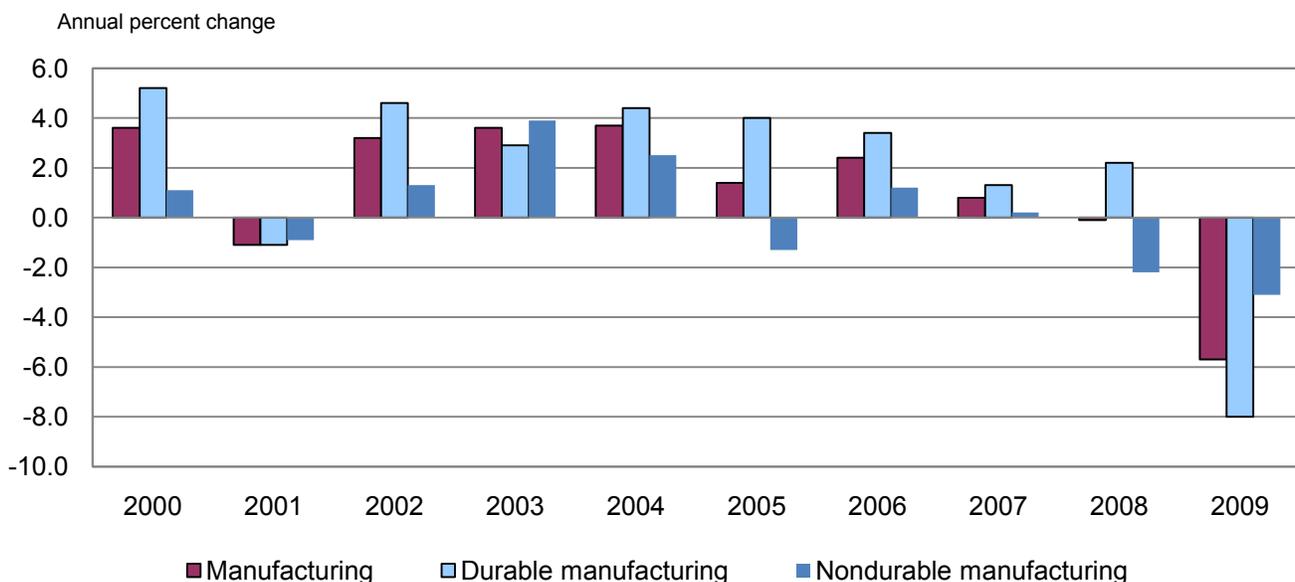# MULTIFACTOR PRODUCTIVITY TRENDS IN MANUFACTURING - 2009

Manufacturing sector multifactor productivity declined at a 5.7 percent annual rate in 2009, the U.S. Bureau of Labor Statistics reported today. (See chart 1.) This was the largest annual decline in multifactor productivity since the series started in 1987. (See table 1.) The multifactor productivity decline in 2009 reflected a 12.5 percent decrease in output and a 7.2 percent decrease in combined inputs.

Multifactor productivity measures the change in output per unit of combined inputs. Multifactor productivity is designed to measure the joint influences on economic growth of technological change, efficiency improvements, returns to scale, reallocation of resources, and other factors, allowing for the effects of capital, labor and, in the case of the manufacturing sector, also intermediate inputs (energy, materials, purchased business services). Multifactor productivity, therefore, differs from labor productivity (output per hour worked) measures that are published quarterly by BLS since it includes information on capital services and intermediate inputs that are not available on a quarterly basis.

Durable manufacturing sector multifactor productivity decreased 8.0 percent in 2009, after increasing 2.2 percent in 2008. **Nondurable manufacturing sector** multifactor productivity fell 3.1 percent in 2009, following a 2.2 percent decrease in 2008. In both sectors these were the sharpest declines in multifactor productivity since the series began in 1987.

Chart 1. Multifactor productivity for the manufacturing, durable manufacturing, and nondurable manufacturing sectors, 2000-2009

Annual percent change

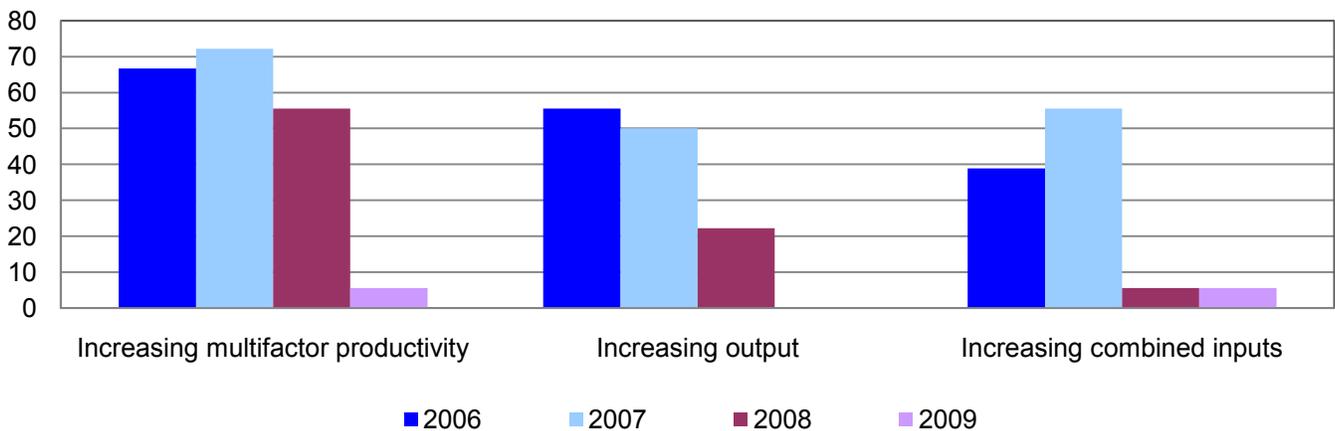■ Manufacturing   ■ Durable manufacturing   ■ Nondurable manufacturing

Historical trends in manufacturing

Multifactor productivity in manufacturing grew 1.1 percent annually between 1987 and 2009. Over the same period, sectoral output increased at a 1.5 percent annual rate and combined inputs grew 0.4 percent; output per hour (labor productivity) increased 3.3 percent. For the 2000-2007 period, multifactor productivity in manufacturing grew more rapidly than in previous periods, averaging 2.0 percent per year. In contrast, for the 2007-2009 period, multifactor productivity dropped 3.0 percent and output and all inputs except capital services experienced steep declines. (See table A.)

Of the 3.3 percent growth rate in labor productivity for the 1987-2009 period, 1.1 percent can be attributed to increases in multifactor productivity, 0.7 percent to the contribution of capital intensity, 0.1 percent to energy intensity, 0.9 percent to materials intensity, and 0.5 percent to purchased business services intensity. Multifactor productivity, the contribution of intermediate inputs, and the contribution of capital intensity may not sum to output per hour due to independent rounding. (See table B.)

In 2009, almost no manufacturing industries exhibited increases in multifactor productivity, output, or combined inputs. Of the 18 industries that comprise the manufacturing sector, only computer and electronic products experienced growth in multifactor productivity, and only food, beverage, and tobacco products exhibited growth in combined inputs. No industry had any increase in output. (See chart 2.)

Chart 2. Percent of manufacturing industries with increases in multifactor productivity, output, and combined inputs, 2006-2009

Revised measures

Previous and revised productivity measures and related data for 2007 and 2008 for the manufacturing, durable manufacturing, and nondurable manufacturing sectors are displayed in table C. In 2008, multifactor productivity growth was revised upward, showing a slight decline of 0.1 percent rather than the 0.7 percent decrease reported previously. After revision, multifactor productivity for the nondurable manufacturing sector fell 2.2 percent rather than falling 1.6 percent. In contrast, multifactor productivity in the durable manufacturing sector was revised upward to 2.2 percent from 0.3 percent. The revisions in both years were due to comprehensive revisions in source data in the revised National Income and Products (NIPA) released on May 25, 2010 and annual revisions of the NIPA industry accounts released on December 14, 2010.

The manufacturing industry measures have been revised to reflect an improved methodology for estimating the cost of materials. This revision is most notable in measures for apparel, leather, and allied products, and computer and electronic products.

Table A. Compound annual growth rates for productivity, sectoral output, and inputs in the manufacturing sector for selected periods, 1987-2009

In percent

	1987-2009	1987-1990	1990-1995	1995-2000	2000-2007	2007-2009	2008-2009
Productivity							
Multifactor productivity[1]	1.1	0.3	1.2	1.8	2.0	-3.0	-5.7
Output per hour of all persons	3.3	1.8	3.4	4.8	3.9	-0.2	0.1
Output per unit of capital services	-0.7	-0.1	0.7	0.7	-0.1	-10.4	-13.6
Sectoral Output	1.5	2.1	3.3	4.7	0.7	-8.6	-12.5
Inputs							
Combined inputs[2]	0.4	1.9	2.1	2.8	-1.3	-5.8	-7.2
Hours[3]	-1.8	0.4	-0.1	-0.1	-3.1	-8.4	-12.6
Capital services	2.2	2.3	2.6	4.0	0.8	2.0	1.2
Energy	0.4	1.9	1.7	5.9	-3.5	-4.1	-11.4
Non-energy materials	1.4	1.6	3.7	5.9	-1.2	-6.5	-8.0
Purchased business services	1.0	5.3	3.2	1.3	0.3	-8.7	-5.3

[1] Output per unit of combined hours, capital services, energy, materials, and purchased business services.

[2] The growth rate of each input is weighted by its share of current dollar costs.

[3] Hours at work of all persons.

Table B. Compound annual growth rates in output per hour of all persons and contributions of capital intensity, intermediate inputs intensity, and multifactor productivity in the manufacturing sector for selected periods, 1987-2009

In percent

	1987-2009	1987-1990	1990-1995	1995-2000	2000-2007	2007-2009	2008-2009
<u>Manufacturing</u>							
Output per hour of all persons	3.3	1.8	3.4	4.8	3.9	-0.2	0.1
Contribution of capital intensity[1]	0.7	0.3	0.4	0.7	0.7	2.1	2.9
Contribution of information processing equipment and software[2]	0.3	0.2	0.2	0.4	0.2	0.6	0.8
Contribution of all other capital services	0.4	0.2	0.2	0.3	0.5	1.5	2.1
Contribution of intermediate inputs[3]	1.5	1.2	1.8	2.2	1.2	0.8	3.2
Contribution of energy intensity[4]	0.1	0.0	0.0	0.2	0.0	0.2	0.0
Contribution of materials intensity[5]	0.9	0.4	1.1	1.8	0.6	0.7	1.7
Contribution of purchased business services intensity[6]	0.5	0.8	0.6	0.3	0.6	-0.1	1.4
Multifactor productivity[7]	1.1	0.3	1.2	1.8	2.0	-3.0	-5.7

[1] Capital services per hour multiplied by capital's share of current dollar costs.

[2] Information processing equipment and software per hour multiplied by its share of total current dollar costs.

[3] Intermediate inputs per hour multiplied by intermediate inputs share of current dollar costs.

[4] Energy per hour multiplied by energy's share of current dollar costs.

[5] Materials per hour multiplied by materials' share of current dollar costs.

[6] Purchased business services per hour multiplied by purchased business services' share of current dollar costs.

[7] Output per unit of combined hours, capital services, energy, materials, and purchased business services.

Table C. Previous and revised multifactor productivity and related measures for the 2007-2008 and 2006-2007 periods

Sector	Multifactor productivity[1]	Sectoral output	Inputs					
			Combined inputs[2]	Hours[3]	Capital services	Energy	Materials	Purchased business services
Annual percent change, 2007-2008								
Manufacturing								
Previous	-0.7	-4.4	-3.7	-4.0	1.1	-2.6	-5.3	-5.4
Revised	-0.1	-4.4	-4.3	-4.0	2.8	3.9	-5.0	-11.9
Durable manufacturing								
Previous	0.3	-5.7	-6.0	-4.2	0.9	1.2	-12.4	-6.7
Revised	2.2	-5.7	-7.7	-4.2	1.7	0.4	-12.6	-14.3
Nondurable manufacturing								
Previous	-1.6	-3.3	-1.8	-3.7	1.2	-5.1	-1.5	-3.7
Revised	-2.2	-3.5	-1.3	-3.7	3.6	6.3	-0.9	-8.7
Annual percent change, 2006-2007								
Manufacturing								
Previous	5.1	2.4	-2.5	-1.7	1.2	6.0	-7.2	-0.8
Revised	0.8	2.2	1.4	-1.7	1.4	8.6	0.0	7.3
Durable manufacturing								
Previous	4.9	3.5	-1.3	-2.1	0.8	8.6	-4.8	2.2
Revised	1.3	3.2	1.9	-2.1	1.6	12.2	0.3	10.4
Nondurable manufacturing								
Previous	4.6	1.3	-3.2	-1.0	1.4	4.3	-6.4	-4.7
Revised	0.2	1.1	0.9	-1.0	1.3	6.2	0.2	3.3

[1] Output per unit of combined hours, capital services, energy, materials, and purchased business services.
[2] The growth rate of each input is weighted by its share of current dollar costs.
[3] Hours at work of all persons.

TECHNICAL NOTES

Capital Services: Capital services are the services derived from the stock of physical assets and software. There are 86 asset types for fixed business equipment and software, structures, inventories, and land. The aggregate capital services measures are obtained by Tornqvist aggregation of the capital stocks for each asset type within each of the eighteen manufacturing NAICS industry groupings using estimated rental prices for each asset type. Each rental price reflects the nominal rate of return to all assets within the industry and rates of economic depreciation and revaluation for the specific asset; rental prices are adjusted for the effects of taxes. Data on investments in physical assets and software are obtained from Bureau of Economic Analysis (BEA). Nonfarm industry detail for land is based on IRS book value data.

Labor Hours: The construction of the hours measures follows the methodology described in USDL 11-0435, *Multifactor Productivity Trends, 2009*, http://www.bls.gov/news.release/pdf/prod3.pdf. Hours in manufacturing are directly aggregated and do not include the effects of labor composition. Hours data for the manufacturing multifactor productivity measures include hours for all persons working in the manufacturing sector – wage and salary workers, the self-employed and unpaid family workers. The primary source of hours data is the BLS Current Employment Statistics (CES) survey. Hours paid of production workers are also obtained primarily from the CES survey. The hours of these employees are then converted to an at-work basis by using information from the Employment Cost Index (ECI) of the National Compensation Survey (NCS) and the BLS Hours at Work Survey. Hours at work for nonproduction workers are derived using data from the Current Population Survey (CPS), the CES, and the NCS. The hours at work of proprietors are derived from the CPS.

Hours at work data are based on underlying hours data published in the February 3, 2011, USDL-11-0128, *Productivity and Costs*, http://www.bls.gov/news.release/archives/prod2_02032011.pdf. Therefore, the data do not reflect the benchmark revisions to the CES and other revisions to hours released on February 4, 2011.

Intermediate Inputs: In manufacturing, intermediate inputs consist of energy, materials, and purchased business services, and represent a large share of production costs. Research has shown that substitution among inputs, including intermediate inputs, affects productivity change. Therefore, it is important to account for intermediate inputs in productivity measures at the level of manufacturing. In contrast, the more aggregate productivity measures compare "value-added" output with two classes of inputs, capital and labor. Because of these differences in concepts and methodology, productivity change in manufacturing cannot be directly compared with changes in private business or private nonfarm business.

Data on intermediate inputs are obtained from BEA based on BEA annual input-output tables. Tornqvist indexes of each of these three input classes are derived at the 3-digit NAICS level and then aggregated to total manufacturing. Materials inputs are adjusted to exclude transactions between establishments within the same sector.

Combined Inputs: The five input indexes (capital services, hours, energy, materials, and purchased business services) are combined using Tornqvist aggregation, employing weights that represent each component's share of total costs. Total costs are defined as the value of manufacturing sectoral output.

Capital Intensity: Capital intensity is the ratio of capital to hours worked in the production process. The higher the capital to hours ratio, the more capital intensive the production process is. Intermediate input intensities are also estimated and interpreted in a similar manner to capital intensity.

In a production process, profit maximizing/cost-minimizing firms adjust the factor proportions of capital and labor if the price of one factor is less than the other factor; there would be a tendency for the firms to substitute the less expensive factor for the more expensive one. In the short run, changes in hours worked are more variable than changes in capital services. Changes in hours worked in business cycles can result in volatility of the capital intensity ratio over short periods of time. In the long run an increase in wages relative to the price of capital will induce the firm to substitute capital for labor, resulting in an increase in capital intensity.

Rising labor costs are, in fact, an incentive for firms to introduce automated production processes. Industry estimates of capital to hours ratios can be obtained at http://www.bls.gov/mfp/mprdload.htm.

Sectoral Output: The output concept used for multifactor productivity in manufacturing is "sectoral output". Sectoral output equals gross output (sales, receipts, and other operating income, plus commodity taxes plus changes in inventories), excluding transactions between establishments within the same sector. In contrast, the output concept used for private business and nonfarm business is "real value added". Real value added output in private business equals gross domestic product in the economy less general government, government enterprises, private households (including the rental value of owner-occupied real estate), and non-profit institutions. Real value added output excludes intermediate transactions between businesses.

The output index for manufacturing is computed using a chained superlative index (Tornqvist) of three-digit NAICS industry outputs. Industry output is measured as sectoral output, the total value of goods and services leaving the industry. Wherever possible, the indexes of industry output are calculated with a Tornqvist formula. This formula aggregates the growth rates of the various industry outputs between two periods, using their relative shares in industry value of production averaged over the two periods as weights. Industry output measures for manufacturing industries are constructed using data from the economic censuses and annual surveys of the Bureau of the Census, U.S. Department of Commerce, together with information on price changes, primarily from BLS.

Multifactor Productivity: The manufacturing multifactor productivity measures describe the relationship between output in real terms and the inputs involved in its production. Manufacturing multifactor productivity measures exclude intermediate inputs between manufacturing establishments from both output and inputs. They do not measure the specific contributions of labor, capital, or intermediate inputs. Rather, they are designed to measure the joint influences on economic growth of technological change, efficiency improvements, returns to scale, reallocation of resources due to shifts in factor inputs across industries, and other factors. The multifactor productivity indexes are derived by dividing an output index by an index of the combined inputs of labor, capital services, energy, non-energy materials, and purchased business services.

Other information: Comprehensive tables containing more detailed data than that which is published in this press release are available upon request at 202-691-5606 or at http://www.bls.gov/mfp/mprdload.htm. More detailed information on methods, limitations, and data sources of capital and labor are provided in BLS Bulletin 2178 (September 1983), *Trends in Multifactor Productivity, 1948-81* and on the BLS Multifactor Productivity website under the title "Technical Information About the BLS Multifactor Productivity Measures" for Major Sectors and 18 NAICS 3-digit Manufacturing Industries at http://www.bls.gov/mfp/mprtech.pdf. Methods for measuring manufacturing multifactor productivity are discussed in "Measurement of productivity growth in U.S. manufacturing" in the July 1995 issue of the *Monthly Labor Review*. See http://www.bls.gov/mfp/mprgul95.pdf.

Table 1. Manufacturing sector: productivity and related measures for the 1987-2009 period

Annual percent change from previous year

Year	Productivity			Sectoral Output	Inputs					
	Output per hour of all persons	Output per unit of capital services	Multifactor Productivity[1]		Hours[2]	Capital Services	Energy	Materials	Purchased business services	Combined units of all Inputs[3]
1988	2.1	3.3	2.0	5.2	3.0	1.8	4.1	1.0	8.7	3.1
1989	1.0	-0.7	-0.5	1.6	0.6	2.4	-0.3	2.1	5.8	2.1
1990	2.2	-3.0	-0.7	-0.3	-2.5	2.7	1.9	1.7	1.5	0.4
1991	2.6	-3.9	-0.4	-1.7	-4.2	2.3	-0.3	-0.5	-0.8	-1.3
1992	3.8	1.0	-0.6	3.3	-0.5	2.2	-1.0	8.6	7.5	4.0
1993	2.6	1.5	2.6	3.9	1.3	2.4	3.4	0.8	0.8	1.3
1994	3.5	3.3	2.6	5.9	2.3	2.5	3.6	4.3	3.9	3.3
1995	4.5	1.7	1.8	5.2	0.7	3.5	2.9	5.4	4.9	3.4
1996	3.6	-0.6	0.3	3.4	-0.2	4.1	-2.7	9.0	-0.3	3.1
1997	5.4	2.8	2.7	7.3	1.8	4.5	-2.0	8.0	4.1	4.5
1998	5.6	0.7	1.3	5.3	-0.3	4.6	3.8	8.4	3.4	4.0
1999	4.9	0.4	1.2	4.2	-0.7	3.8	23.3	6.2	0.9	3.0
2000	4.4	0.2	3.6	3.1	-1.3	2.9	9.1	-1.9	-1.3	-0.5
2001	1.9	-6.2	-1.1	-4.8	-6.5	1.6	9.3	-6.3	-1.7	-3.7
2002	7.3	-1.3	3.2	-0.3	-7.1	1.0	-22.6	1.0	-3.2	-3.4
2003	6.2	0.6	3.6	1.0	-4.9	0.4	-10.7	-1.7	-0.6	-2.4
2004	2.3	2.1	3.7	1.7	-0.5	-0.3	-6.3	-0.8	-6.4	-1.9
2005	4.7	3.0	1.4	3.6	-1.1	0.6	10.1	1.5	8.9	2.1
2006	0.9	0.8	2.4	1.6	0.7	0.8	-7.8	-1.8	-1.6	-0.8
2007	3.9	0.7	0.8	2.2	-1.7	1.4	8.6	0.0	7.3	1.4
2008	-0.4	-7.0	-0.1	-4.4	-4.0	2.8	3.9	-5.0	-11.9	-4.3
2009	0.1	-13.6	-5.7	-12.5	-12.6	1.2	-11.4	-8.0	-5.3	-7.2

[1] Output per unit of combined hours, capital services, energy, materials, and purchased business services.

[2] Hours at work of all persons.

[3] Combined units of hours, capital services, energy, materials, and purchased business services, chained superlative index.

Source: Output data are from the Bureau of the Census, U.S. Department of Commerce, and modified by the Bureau of Labor Statistics, U.S. Department of Labor. Compensation and hours data are from the Bureau of Labor Statistics. Capital measures are based on data supplied by the Bureau of Economic Analysis, U.S. Department of Commerce. See also Technical Notes in this release.

Table 2. Manufacturing sector: indexes of productivity and related measures, 1987-2009

Indexes 2005=100

Year	Productivity			Sectoral Output	Inputs					
	Output per hour of all persons	Output per unit of capital services	Multifactor Productivity[1]		Hours[2]	Capital Services	Energy	Materials	Purchased business services	Combined units of all Inputs[3]
1987	51.0	95.9	76.9	62.9	123.2	65.6	83.8	63.8	71.0	81.7
1988	52.1	99.1	78.5	66.1	126.9	66.8	87.3	64.4	77.2	84.2
1989	52.6	98.4	78.1	67.2	127.7	68.3	87.0	65.8	81.7	86.0
1990	53.8	95.4	77.5	67.0	124.5	70.2	88.6	66.9	82.9	86.4
1991	55.2	91.7	77.2	65.8	119.3	71.8	88.4	66.6	82.3	85.2
1992	57.3	92.7	76.8	68.0	118.7	73.4	87.5	72.3	88.4	88.6
1993	58.8	94.1	78.7	70.7	120.3	75.1	90.4	72.9	89.1	89.7
1994	60.8	97.2	80.8	74.9	123.1	77.0	93.7	76.0	92.6	92.7
1995	63.6	98.8	82.2	78.8	123.9	79.7	96.4	80.2	97.1	95.8
1996	65.9	98.2	82.4	81.5	123.6	83.0	93.8	87.4	96.8	98.8
1997	69.5	100.9	84.7	87.4	125.8	86.7	91.9	94.4	100.8	103.3
1998	73.4	101.6	85.8	92.1	125.5	90.7	95.4	102.4	104.2	107.3
1999	77.0	102.0	86.8	95.9	124.7	94.1	117.7	108.7	105.2	110.5
2000	80.4	102.1	89.9	98.9	123.1	96.8	128.4	106.7	103.8	110.0
2001	81.9	95.7	88.9	94.2	115.0	98.4	140.3	100.0	102.0	105.9
2002	87.9	94.5	91.8	93.9	106.9	99.3	108.6	101.0	98.7	102.3
2003	93.3	95.1	95.1	94.9	101.6	99.7	97.0	99.3	98.1	99.8
2004	95.5	97.1	98.6	96.5	101.1	99.4	90.8	98.5	91.8	97.9
2005	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2006	100.9	100.8	102.4	101.6	100.7	100.8	92.2	98.2	98.4	99.2
2007	104.9	101.6	103.2	103.8	99.0	102.2	100.1	98.3	105.6	100.6
2008	104.5	94.5	103.1	99.2	95.0	105.1	104.0	93.4	93.0	96.3
2009	104.5	81.6	97.2	86.8	83.0	106.4	92.2	85.9	88.1	89.3

[1] Output per unit of combined hours, capital services, energy, materials, and purchased business services.

[2] Hours at work of all persons.

[3] Combined units of hours, capital services, energy, materials, and purchased business services, chained superlative index.

Source: Output data are from the Bureau of the Census, U.S. Department of Commerce, and modified by the Bureau of Labor Statistics, U.S. Department of Labor. Compensation and hours data are from the Bureau of Labor Statistics. Capital measures are based on data supplied by the Bureau of Economic Analysis, U.S. Department of Commerce. See also Technical Notes in this release

Table 3. Multifactor productivity measures for manufacturing industries in selected periods, 1987-2009

Compound annual growth rates

	1987-2009	1987-1990	1990-1995	1995-2000	2000-2007	2007-2009	2008-2009
Manufacturing	**1.1**	**0.3**	**1.2**	**1.8**	**2.0**	**-3.0**	**-5.7**
Nondurable manufacturing	**0.1**	**-0.5**	**0.7**	**-0.2**	**1.0**	**-2.7**	**-3.1**
Food, beverage, and tobacco products	-0.2	-1.6	1.4	-1.7	0.8	-2.2	-1.4
Textile mills and textile product mills	1.0	1.1	0.7	1.5	1.7	-2.3	-8.7
Apparel, leather, and allied products	2.1	0.0	2.9	0.6	4.4	-0.8	-8.7
Paper products	0.1	-0.2	-0.1	0.5	0.7	-2.2	-1.3
Printing and related support activities	0.3	1.0	-0.2	-0.5	1.3	-1.3	-4.1
Petroleum and coal products	0.8	0.8	0.8	1.1	0.3	2.0	-1.7
Chemical products	-0.4	-0.9	-0.7	-0.5	1.9	-6.4	-4.6
Plastics and rubber products	0.3	0.8	0.5	1.2	0.5	-4.3	-3.6
Durable manufacturing	**1.8**	**0.9**	**1.5**	**3.3**	**2.8**	**-3.0**	**-8.0**
Wood products	-0.5	1.0	-1.3	-0.3	0.9	-6.1	-12.8
Nonmetallic mineral products	-0.2	0.2	0.8	0.1	-0.7	-2.5	-4.5
Primary metals	0.0	1.0	0.0	0.3	-0.4	-1.3	-3.7
Fabricated metal products	-0.4	-0.1	1.0	-0.2	0.6	-8.4	-15.6
Machinery	-0.3	1.0	-1.9	-1.2	1.2	-1.6	-2.9
Computer and electronic products	9.7	5.5	9.3	14.4	9.8	5.1	2.4
Electrical equipment, appliances, and components	-0.9	-2.4	-2.4	-2.6	1.4	1.4	-1.0
Transportation equipment	-0.2	-1.6	-0.5	0.5	1.7	-5.0	-11.6
Furniture and related products	-0.4	-0.7	0.6	0.6	1.1	-9.7	-12.2
Miscellaneous manufacturing	1.6	2.6	-0.1	2.4	2.2	0.4	-0.9

Note: Multifactor productivity measures by industry do not sum up to aggregate manufacturing measures because industry measures exclude transactions only within the specific industry while the aggregate manufacturing measures also exclude transactions between all manufacturing industries.