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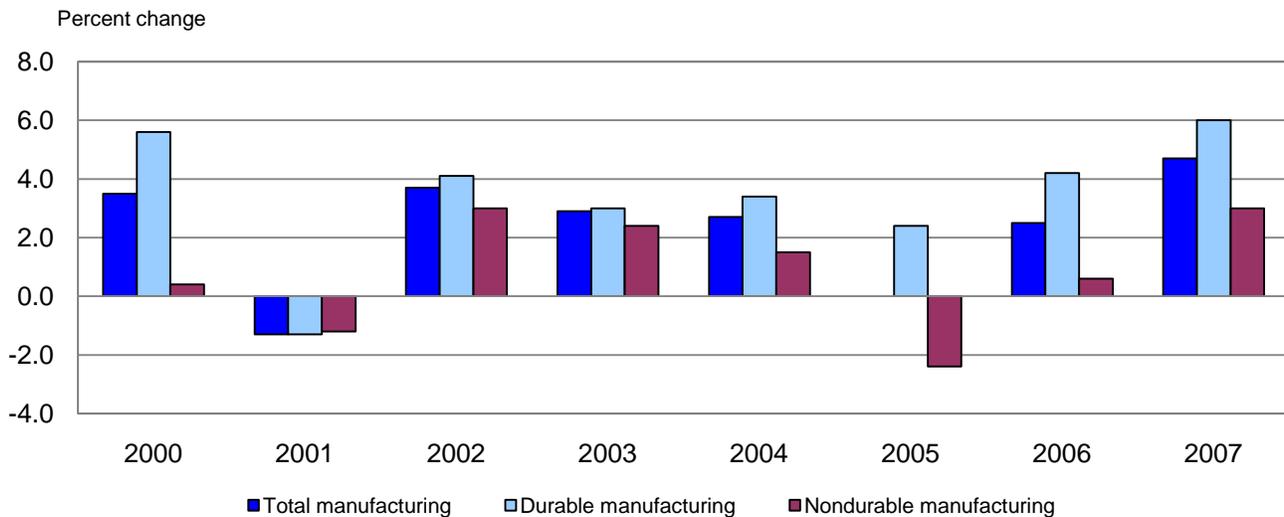
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## MULTIFACTOR PRODUCTIVITY TRENDS IN MANUFACTURING — 2007

**Manufacturing sector multifactor productivity** increased at a 4.7 percent annual rate in 2007, the U.S. Bureau of Labor Statistics reported today (chart 1). This was the largest gain in multifactor productivity in the series which began in 1987 (table 1). 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, 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 other data that are not available on a quarterly basis.

**Durable goods manufacturing sector multifactor productivity** grew 6.0 percent in 2007, accelerating from its 4.2 percent growth rate in 2006. **Nondurable goods manufacturing sector multifactor productivity** grew 3.0 percent in 2007, after a 0.6 percent increase in 2006.

Chart 1. Multifactor productivity for total, durable, and nondurable manufacturing, 2000-2007



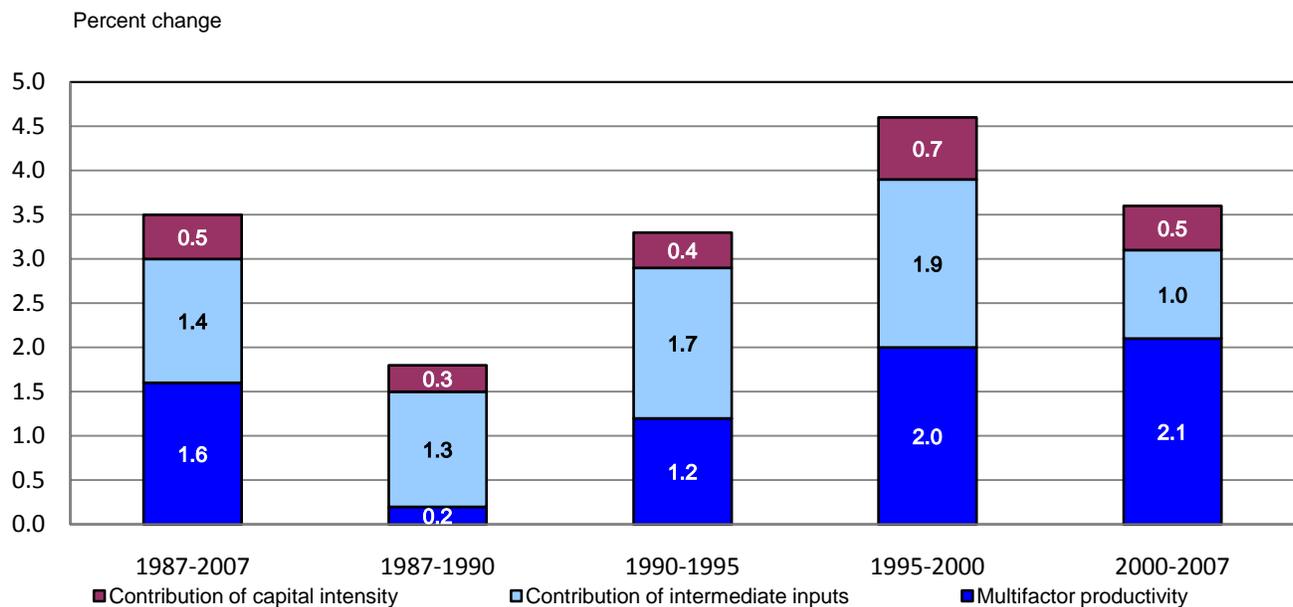
## Historical trends in manufacturing

Multifactor productivity in manufacturing grew 1.6 percent annually between 1987 (the starting point of the series) and 2007 (table A). Sectoral output increased at a 2.4 percent annual rate over the period and combined inputs rose an average of 0.8 percent per year. Output per hour (labor productivity) grew 3.6 percent. For the 2000-2007 period, multifactor productivity in manufacturing rose more rapidly than in previous periods, averaging 2.1 percent per year, slightly outpacing the 2.0 percent growth rate in the 1995-2000 period.

Historical trends in growth in output per hour can be attributed to multifactor productivity growth and the contributions of the intensities of capital and of intermediate inputs. The relationship between labor productivity growth and its components can be seen in table B and chart 2. Chart 2 shows how, relative to output per hour, contributions of multifactor productivity, capital intensity, and intermediate input intensity shifted upward in the latter half of the 1990's. These contributions have slowed somewhat during the 2000-2007 period.

Of the 3.6 percent growth rate in labor productivity in the 1987-2007 period, 1.6 percent can be attributed to increases in multifactor productivity, 0.5 percent to the contribution of capital intensity, 0.7 percent to changes in materials intensity, and 0.7 percent to changes in business services intensity (table B).

Chart 2. Percentage point contributions to growth in output per hour in the manufacturing sector, 1987-2007



The contribution of intermediate inputs includes energy, materials, and purchased business services. Multifactor productivity, the contribution of intermediate inputs, and the contribution of capital intensity may not sum to output per hour due to independent rounding (chart 2).

## Revised Measures

Previous and revised productivity and related data for 2005 and 2006 for the manufacturing, durable goods manufacturing, and nondurable goods manufacturing sectors are displayed in Table C. In 2006, productivity growth was revised upwards to 2.5 percent from 1.6 percent in the manufacturing sector, to 4.2 percent from 3.2 percent in the durable manufacturing sector, and to 0.6 percent from -0.2 percent in the nondurable manufacturing sector. Productivity growth was also revised downward for all three major sectors in 2005. The revisions in both years were due to large revisions in source data for energy, materials, and purchased services.

Table A. Compound average annual growth rates for productivity, sectoral output, and inputs in the manufacturing sector for selected periods, 1987 to 2007

	1987- 2007	1987- 1990	1990- 1995	1995- 2000	2000- 2007	2006- 2007
<u>Productivity</u>						
Multifactor productivity <sup>1</sup>	1.6	0.2	1.2	2.0	2.1	4.7
Output per hour of all persons	3.6	1.8	3.4	4.6	3.7	3.4
Output per unit of capital services	0.3	-0.1	0.6	0.3	0.2	1.1
<u>Sectoral Output</u>						
	2.4	2.2	3.3	4.5	0.5	1.6
<u>Inputs</u>						
Combined inputs <sup>2</sup>	0.8	2.0	2.0	2.5	-1.6	-3.0
Hours <sup>3</sup>	-1.1	0.4	-0.1	-0.1	-3.1	-1.7
Capital services	2.2	2.3	2.7	4.2	0.4	0.5
Energy	-0.8	2.0	1.6	-2.5	-2.5	-2.7
Non-energy materials	1.4	1.6	3.6	4.9	-2.6	-8.1
Purchased business services	2.3	5.5	3.0	2.4	0.5	-0.3

<sup>1</sup>Output per unit of combined labor hours, capital, energy, materials, and business services inputs.

<sup>2</sup>The growth rate of each input is weighted by its share of nominal costs.

<sup>3</sup>Hours at work of all persons.

Table B. Compound average 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, 1987-2007

	1987-2007	1987-1990	1990-1995	1995-2000	2000-2007	2006-2007
<u>Manufacturing</u>						
Output per hour of all persons	3.6	1.8	3.4	4.6	3.7	3.4
Contribution of capital intensity <sup>1</sup>	0.5	0.3	0.4	0.7	0.5	0.4
Contribution of information processing equipment and software <sup>2</sup>	0.2	0.2	0.2	0.4	0.2	0.1
Contribution of all other capital services	0.3	0.1	0.2	0.3	0.4	0.2
Contribution of intermediate inputs <sup>3</sup>	1.4	1.3	1.7	1.9	1.0	-1.6
Contribution of energy intensity <sup>4</sup>	0.0	0.0	0.0	-0.1	0.0	0.0
Contribution of materials intensity <sup>5</sup>	0.7	0.4	1.0	1.4	0.1	-1.9
Contribution of purchased business services intensity <sup>6</sup>	0.7	0.9	0.6	0.6	0.9	0.3
Multifactor productivity <sup>7</sup>	1.6	0.2	1.2	2.0	2.1	4.7

<sup>1</sup>Growth rate in capital services per hour multiplied by capital's share of current dollar costs.

<sup>2</sup>Growth rate of information processing equipment and software per hour multiplied by its share of total current dollar costs.

<sup>3</sup>Growth rate in intermediate inputs per hour multiplied by intermediate inputs share of current dollar costs.

<sup>4</sup>Growth rate in energy services per hour multiplied by energy's share of current dollar costs.

<sup>5</sup>Growth rate in materials services per hour multiplied by materials' share of current dollar costs.

<sup>6</sup>Growth rate in business services per hour multiplied by business services' share of current dollar costs.

<sup>7</sup>Output per unit of combined labor hours, capital, energy, materials, and business services inputs.

Table C. Previous and revised productivity and related measures for the 2005-2006 and 2004-2005 periods

Sector	Multifactor productivity <sup>1</sup>	Sectoral output	Inputs					
			Combined inputs <sup>2</sup>	Hours <sup>3</sup>	Capital services	Energy	Materials	Purchased business services
Percent change, 2005-2006								
<u>Manufacturing</u>								
Previous	1.6	1.8	0.3	0.6	0.5	-5.5	-1.0	2.0
Revised	2.5	1.6	-0.9	0.7	0.5	-6.7	-2.5	-1.2
<u>Durable manufacturing</u>								
Previous	3.2	3.3	0.2	1.0	0.3	-6.5	-1.8	1.8
Revised	4.2	3.1	-1.0	1.1	0.4	-7.5	-4.0	-0.9
<u>Nondurable manufacturing</u>								
Previous	-0.2	0.3	0.5	0.1	0.7	-5.0	0.1	2.1
Revised	0.6	-0.1	-0.6	0.1	0.6	-6.3	-0.5	-1.5
Percent change, 2004-2005								
<u>Manufacturing</u>								
Previous	0.4	3.7	3.3	-1.1	0.0	9.1	5.9	7.8
Revised	0.0	3.6	3.5	-1.1	0.0	10.1	6.2	8.4
<u>Durable manufacturing</u>								
Previous	2.5	5.2	2.6	-0.1	-0.2	2.8	5.9	4.8
Revised	2.4	5.0	2.6	-0.1	-0.2	2.9	5.4	5.2
<u>Nondurable manufacturing</u>								
Previous	-1.8	2.0	3.9	-2.8	0.0	12.8	4.9	11.1
Revised	-2.4	2.0	4.5	-2.7	0.1	14.4	5.7	11.8

<sup>1</sup> Output per unit of combined labor hours, capital, energy, materials, and business services inputs.

<sup>2</sup> The growth rate of each input is weighted by its share of nominal costs.

<sup>3</sup> Hours at work of all persons.

## TECHNICAL NOTES

**Capital Input:** Capital input measures the services derived from the stock of physical assets and software. The assets included are fixed business equipment, structures, inventories, and land. Among equipment, BLS provides additional detail for information processing equipment and software (IPES). IPES is composed of four broad classes of assets: computers and related equipment, software, communications equipment, and other IPES equipment. Computers and related equipment includes mainframe computers, personal computers, printers, terminals, tape drives, storage devices, and integrated systems. Software is comprised of pre-packaged, custom, and own-account software. Communications equipment is not further differentiated. Other IPES includes medical equipment and related instruments, electromedical instruments, nonmedical instruments, photocopying and related equipment, and office and accounting machinery.

The aggregate capital input 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. Current-dollar gross product originating (GPO) data, obtained from BEA, are used in estimating capital rental prices.

**Labor Hours:** Hours paid of production workers are obtained primarily from the Current Employment Statistics (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 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. The construction of hours at work follows the methods used in the private business sector described in USDL 09-0480, *Multifactor Productivity Trends, 2008*, <http://www.bls.gov/news.release/pdf/prod3.pdf>, except that hours in manufacturing are directly aggregated and do not include the effects of changing labor composition.

Hours at work data reflect Productivity and Costs data as of the March 5, 2009, news release. Therefore it reflects the benchmark revisions to the CES and other revisions to hours released on February 6, 2009. Data in this release do not reflect the comprehensive revision to the National Income and Product Accounts (NIPA) released by the Bureau of Economic Analysis of the U.S. Department of Commerce on July 31, 2009.

**Intermediate Inputs:** In manufacturing, intermediate inputs are the largest input in terms of costs. Furthermore, research has shown that substitution among inputs, including intermediate inputs, affects productivity change. Therefore, it is important to include 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.

Intermediate inputs (energy, materials, and purchased business services) 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. The index uses changing weights; the share in each year is averaged with the preceding year's share.

**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), but excludes transactions between establishments within the same sector. In contrast, the output concept used for private business and nonfarm business is "gross product originating" and is similar to "real value added". Gross product originating 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. Gross product originating 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.

**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. Multifactor productivity does not measure the specific contributions of labor, capital, or any other factor of production. Rather, multifactor productivity is 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 business service inputs.

**Other information:** Comprehensive tables containing additional data beyond the scope of this press release are available upon request at 202-691-5606 or at <http://www.bls.gov/mfp/mprdownload.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*. 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>. More detailed data can be obtained from our web site at <http://www.bls.gov/mfp> or by request at 202-691-5606.

Table 1. Manufacturing sector: Productivity and related measures, 1988-2007

Percent change from previous year

Year	Productivity			Sectoral Output	Inputs					
	Output per hour of all persons	Output per unit of capital	Multifactor Productivity <sup>1</sup>		Hours <sup>2</sup>	Capital Services	Energy	Materials	Purchased business services	Combined units of all Inputs <sup>3</sup>
1988	2.1	3.4	1.7	5.2	3.0	1.8	4.0	1.4	8.9	3.4
1989	1.0	-0.7	-0.6	1.7	0.6	2.3	-0.2	2.0	6.0	2.2
1990	2.2	-3.0	-0.7	-0.3	-2.5	2.7	2.1	1.5	1.8	0.4
1991	2.6	-4.0	-0.3	-1.7	-4.2	2.4	-0.3	-0.6	-0.7	-1.4
1992	3.8	0.9	-0.6	3.3	-0.5	2.4	-1.0	8.6	7.1	3.9
1993	2.6	1.3	2.7	3.9	1.3	2.5	3.2	0.9	0.2	1.2
1994	3.5	3.2	2.7	6.0	2.3	2.7	3.1	3.9	3.7	3.1
1995	4.6	1.6	1.8	5.3	0.7	3.6	3.0	5.3	4.9	3.4
1996	3.6	-0.6	0.5	3.4	-0.2	4.1	-2.9	9.0	-0.4	2.9
1997	5.5	2.7	2.8	7.4	1.8	4.6	-1.9	8.0	4.1	4.4
1998	5.4	0.2	2.3	5.2	-0.3	5.0	-2.6	5.3	3.2	2.9
1999	4.5	-0.3	0.8	3.8	-0.7	4.1	0.1	5.1	5.3	3.0
2000	4.1	-0.4	3.5	2.7	-1.3	3.1	-5.2	-2.6	0.0	-0.7
2001	1.6	-6.5	-1.3	-5.1	-6.5	1.5	-9.4	-6.7	0.7	-3.8
2002	6.9	-1.2	3.7	-0.7	-7.1	0.6	-1.5	-5.3	-2.5	-4.3
2003	6.3	1.0	2.9	1.1	-4.9	0.0	-5.5	-0.8	0.9	-1.8
2004	2.3	2.3	2.7	1.8	-0.5	-0.6	-0.5	-0.5	-2.1	-0.9
2005	4.7	3.6	0.0	3.6	-1.1	0.0	10.1	6.2	8.4	3.5
2006	0.8	1.1	2.5	1.6	0.7	0.5	-6.7	-2.5	-1.2	-0.9
2007	3.4	1.1	4.7	1.6	-1.7	0.5	-2.7	-8.1	-0.3	-3.0

<sup>1</sup>Output per unit of combined labor hours, capital, energy, materials, and business services inputs.<sup>2</sup>Hours at work of all persons.<sup>3</sup>Combined units of capital services, hours, energy, non-energy materials, and purchased business services, superlative chained 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. See also Technical Notes in this release.

Table 2. Manufacturing sector: Productivity and related measures, 1987-2007

Indexes  
(2000=100)

Year	Productivity			Sectoral Output	Inputs					
	Output per hour of all persons	Output per unit of capital	Multifactor Productivity <sup>1</sup>		Hours <sup>2</sup>	Capital Services	Energy	Materials	Purchased business services	Combined units of all Inputs <sup>3</sup>
1987	64.0	96.1	84.9	64.0	100.1	66.6	99.1	63.0	65.2	75.4
1988	65.3	99.4	86.4	67.4	103.1	67.8	103.1	63.9	71.0	78.0
1989	66.0	98.7	85.9	68.5	103.8	69.4	102.9	65.2	75.2	79.7
1990	67.5	95.8	85.3	68.2	101.2	71.3	105.0	66.1	76.6	80.0
1991	69.2	92.0	85.0	67.1	96.9	72.9	104.7	65.7	76.0	78.9
1992	71.8	92.8	84.5	69.3	96.4	74.7	103.7	71.4	81.4	82.0
1993	73.7	94.0	86.7	72.0	97.7	76.6	107.0	72.0	81.6	83.0
1994	76.3	97.0	89.1	76.3	100.0	78.6	110.4	74.8	84.6	85.6
1995	79.8	98.5	90.7	80.3	100.7	81.5	113.7	78.8	88.8	88.5
1996	82.7	97.9	91.2	83.0	100.4	84.8	110.4	85.9	88.4	91.1
1997	87.2	100.5	93.8	89.2	102.3	88.7	108.2	92.8	92.0	95.1
1998	91.9	100.7	95.9	93.8	102.0	93.2	105.4	97.7	95.0	97.8
1999	96.1	100.4	96.6	97.3	101.3	97.0	105.5	102.6	100.0	100.7
2000	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2001	101.6	93.5	98.7	94.9	93.5	101.5	90.6	93.3	100.7	96.2
2002	108.6	92.4	102.4	94.3	86.8	102.1	89.3	88.4	98.3	92.1
2003	115.4	93.3	105.3	95.3	82.6	102.1	84.4	87.7	99.1	90.5
2004	118.0	95.5	108.1	97.0	82.2	101.6	84.0	87.3	97.0	89.7
2005	123.6	98.9	108.1	100.4	81.3	101.5	92.5	92.7	105.2	92.9
2006	124.6	100.0	110.8	102.0	81.9	102.0	86.3	90.4	103.9	92.0
2007	128.8	101.1	116.0	103.6	80.4	102.5	84.0	83.1	103.5	89.3

<sup>1</sup> Output per unit of combined labor hours, capital, energy, materials, and business services inputs.<sup>2</sup> Hours at work of all persons.<sup>3</sup> Combined units of capital services, hours, energy, non-energy materials, and purchased business services, superlative chained 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. See also Technical Notes in this release.

Table 3. Multifactor productivity measures for manufacturing industries in selected periods, 1987-2007

Compound average annual growth rates

Industry	1987-2007	1987-1990	1990-1995	1995-2000	2000-2007	2006-2007
<b>Manufacturing</b>	<b>1.6</b>	<b>0.2</b>	<b>1.2</b>	<b>2.0</b>	<b>2.1</b>	<b>4.7</b>
<b><u>Nondurable manufacturing</u></b>	<b>0.3</b>	<b>-0.6</b>	<b>0.7</b>	<b>-0.3</b>	<b>1.0</b>	<b>3.0</b>
Food, beverage, and tobacco products	-0.1	-1.7	1.5	-1.9	0.7	3.5
Textile mills and textile product mills	0.9	1.0	0.7	1.2	0.7	-2.7
Apparel, leather, and allied products	0.2	0.1	2.8	0.7	-1.9	-17.1
Paper products	0.4	-0.4	-0.1	0.1	1.3	-0.2
Printing and related support activities	0.6	0.7	-0.3	0.3	1.4	1.8
Petroleum and coal products	-0.3	-0.1	0.6	0.2	-1.5	-4.0
Chemical products	0.7	-1.0	-0.8	-0.1	3.1	12.0
Plastics and rubber products	0.6	0.7	0.6	1.2	0.1	1.7
<b><u>Durable manufacturing</u></b>	<b>2.5</b>	<b>0.8</b>	<b>1.6</b>	<b>3.6</b>	<b>3.1</b>	<b>6.0</b>
Wood products	0.2	1.0	-1.2	0.1	1.1	4.5
Nonmetallic mineral products	0.8	0.3	1.0	0.8	0.9	3.3
Primary metals	1.0	1.1	0.1	0.5	1.9	5.6
Fabricated metal products	0.7	-0.1	1.0	0.1	1.3	4.8
Machinery	0.1	1.0	-1.7	-0.7	1.7	3.1
Computer and electronic products	9.8	5.6	9.6	15.9	7.4	9.2
Electrical equipment, appliances, and components	-0.4	-2.2	-2.0	-1.1	2.1	1.4
Transportation equipment	0.6	-1.7	-0.3	0.3	2.6	6.5
Furniture and related products	0.6	-0.8	0.7	0.5	1.4	1.8
Miscellaneous manufacturing	1.4	2.4	0.3	1.7	1.5	-0.1

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.