Technical Information About the BLS Major Sector Productivity and Costs Measures

Background

Indexes of labor productivity and related measures for broad economic sectors, including manufacturing, are published by the Bureau of Labor Statistics. The traditional measure of labor productivity—output per hour—was first published in 1959, and represents the culmination of a long series of developments in productivity measurement in the Bureau.[1] Output (real output), measured net of price change and inter-industry transactions, is compared to labor input, measured as hours at work in the corresponding sector. Quarterly and annual measures of output per hour, together with comparable measures of compensation per hour and unit labor costs, are maintained for business and nonfarm business from 1947 to the present. Similar measures are also available for manufacturing (total, durable, and nondurable sectors) back to 1987 and for nonfinancial corporations back to 1958. The measures are updated and revised eight times a year.

Data Sources and Estimating Procedures

Output. Real gross domestic product in the business and nonfarm business sectors as published by the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce is the basis of the output components of the major sector labor productivity business measures. These output components are based on and are consistent with the National Income and Product Accounts (NIPA), including the gross domestic product (GDP) measure, also prepared by the BEA.[2] The output measures represent deliveries of

---

[1] *Trends in Output per Man-Hour in the Private Economy, 1909-58*, Bulletin 1249 (Bureau of Labor Statistics, 1959).

[2] A summary of the source data and methods used to estimate current-dollar Gross Domestic Product (GDP) and real GDP is provided by the Bureau of Economic Analysis in "Updated Summary of NIPA Methodologies," Survey of Current Business, November 2007, pp. 8-25. Also see "An Introduction to the National Income and Product Accounts" (Bureau of Economic Analysis, September 2007). The current chain-type annual-weighted quantity measures are discussed in J. Steven Landefeld and Robert P. Parker, "BEA's Chain Indexes, Time Series, and Measures of Long-Term Economic Growth," Survey of Current Business, May 1997, pp. 58-68. The official introduction of these measures into the National Accounts is discussed in J. Steven Landefeld and Robert P. Parker, "Preview of the Comprehensive Revision of the National Income and Product Accounts: BEA's New Featured Measures of Output and Prices," Survey of Current Business, July, 1995, pp. 31-38. These BEA articles may be found on their website (http://www.bea.gov) under the links for "Methodology Papers" and "Analytical and Presentational Articles

final goods and services by the sector to domestic households, investment, government and nonprofit institutions, and net exports to other countries. These measures are gross in the sense that neither capital consumption allowances nor purchases of capital goods are deducted, but they are net in the sense that inter-industry transactions in intermediate materials and services are excluded from output. These transactions are excluded to avoid double counting. For example, the output of the steel industry is excluded to the extent that it is incorporated in final products such as automobiles.

Real business sector output is an annual-weighted (Fisher-Ideal) index. It is constructed from the gross domestic product (GDP) excluding the following outputs: general government, nonprofit institutions, paid employees of private households, and the rental value of owner-occupied dwellings. These same exclusions are made when calculating current dollar output for the sector. The business sector thereby excludes many activities where it is difficult to draw inferences on productivity from NIPA output measures. Such inferences would be questionable mainly because the output measures are based largely on incomes of input factors. The farm sector, which is subject to unique external forces, also is excluded to yield the nonfarm business sector, the principal focus of many productivity studies. In addition to the exclusions made for the business measure, output for nonfinancial corporations also excludes the output of unincorporated businesses and those corporations classified as offices of bank holding companies, offices of other holding companies, or offices in the finance and insurance sector.

Annual manufacturing output indexes for the quarterly labor productivity measures are constructed by deflating the current-dollar industry value of production provided by the U.S. Census Bureau with deflators from the BLS. These deflators are constructed by combining data from the BLS producer price program and other sources. The industry shipments are aggregated using annual weights, and intrasector transactions are removed.[3] To derive quarterly estimates from the annual manufacturing indexes, a quarterly reference series is adjusted to the annual totals using a quadratic minimization formula devised by Frank Denton[4]. Monthly Indexes of Industrial Production, prepared by the Board of Governors of the Federal Reserve System (FRB), are used as the reference series. Due to a lag in the availability of the annual benchmark data, more recent quarterly and annual manufacturing output measures also are extrapolated based on the changes in the Indexes of Industrial Production.

Labor input. The primary source of hours and employment data is the BLS Current Employment Statistics (CES) program, which provides monthly survey data on total employment, and employment and average weekly hours of production and

from the National Accounts". Derivation of business sector output is also discussed in Edwin R. Dean, Michael J. Harper, and Phyllis Flohr Otto, "Improvements to the Quarterly Productivity Measures", Monthly Labor Review, October 1995, pp. 27-32, available at
https://www.bls.gov/opub/mlr/1995/10/art4full.pdf .
[3] A discussion of manufacturing output measures is given in William Gullickson, "Measurement of productivity growth in U.S. manufacturing," *Monthly Labor Review*, July 1995, pp. 13-28.
[4] See Frank T. Denton, "Adjustment of Monthly and Quarterly Series to Annual Totals: An Approach Based on Quadratic Minimization," *Journal of the American Statistical Association*, March 1971, pp. 99-102.

nonsupervisory workers, in nonagricultural establishments. Jobs rather than persons are counted, so that multiple jobholders are counted more than once.

The CES data are based on payroll records from a sample of establishments in which the probability of sample selection is related to the establishment size. Data on employment and hours are collected monthly; the reference period for these data is the payroll period including the 12th of the month. The CES methods are described in chapter two of the BLS Handbook of Methods. Establishment data are published monthly in the BLS publication, *Employment & Earnings Online*, available at https://www.bls.gov/opub/ee/

The CES collects data on the paid hours of nonsupervisory workers, which include hours for which an employee is paid but is absent from a job. This includes paid holidays, sick leave and vacation time. Since this time is not available for the production of a good or performance of a service, the BLS believes it should be excluded when measuring productivity. Ratios of hours at work to hours-paid, developed from information on employer leave practices in the BLS National Compensation Survey (NCS), are used to remove these paid leave hours from the hours-paid data. The BLS Hours at Work Survey provided the ratios for years prior to 2000.[5] These ratios are applied to paid hours data for major industry groups to estimate hours at the workplace.

Although the CES has begun collecting information on the paid hours of all employees, it currently produces time-series of seasonally-adjusted average weekly hours information only for production and nonsupervisory workers. Information from the Current Population Survey (CPS), which collects information on the average weekly hours worked by all persons in the civilian noninstitutional population, is used to estimate the hours of supervisory and nonproduction workers. Using information on the industry and occupation of wage and salary workers, ratios are calculated of CPS supervisory worker average weekly hours to CPS nonsupervisory worker average weekly hours at the NAICS supersector level of detail.[6] For each sector, these ratios are multiplied by the adjusted nonsupervisory worker average weekly hours worked, as calculated above, to estimate average weekly hours of nonproduction and supervisory workers. The combination of information from the CES and the application of the two sets of ratios results in the estimates of hours at work for employees in the private nonfarm business sector.

Because CES data include only nonfarm wage and salary workers, data from the CPS are used for workers in the farm sector. In the nonfarm sector, the CPS is used for proprietors (the self-employed) and unpaid family workers. CPS data on employment and hours by primary and secondary job are processed separately and assigned to the appropriate class of worker for each job. Hours worked as proprietors and unpaid family workers in primary jobs are counted, but hours worked in a second job as a nonfarm employee by a proprietor (or other selected category of worker for whom our source is the CPS) are

---

[5] See brief description of the Bureau of Labor Statistics ratios of hours at work to hours paid and reasons for the discontinuation of the Hours at Work Survey in "Hours at work ratios derived from the Employment Cost Index, 2001-2003" at https://www.bls.gov/lpc/lprhws/lprhwhp.pdf

[6] See "Construction of average weekly hours for supervisory and nonproduction wage and salary workers in private nonfarm establishments," at https://www.bls.gov/lpc/lprswawhtech.pdf October 2004.

excluded to avoid double counting. Conversely, hours worked as a proprietor in a secondary job by a person who is primarily an employee are included. Hours worked rather than hours paid are collected by the household survey (CPS) so adjustment to hours worked is not needed for these workers.

Government enterprise hours are developed from the National Income and Product Accounts and CES estimates of employment and CPS data on average weekly hours. Hours of employees working in forestry, fishing, hunting and agricultural support industries are developed using employment counts from the Quarterly Census of Employment and Wages and the CES and combined with estimates of average weekly hours derived from the CES, the NCS and the CPS.

The labor input of employees of nonprofit corporations is estimated based on data from the Census Bureau and the Bureau of Economic Analysis and subtracted from the totals for each major sector. Hours of labor input are treated as homogeneous units; no distinction is made among workers with different skill levels or wages.

Compensation and labor costs. BEA develops employee compensation data as part of the national income accounts. These quarterly data include direct payments to labor—wage and salary accruals (including executive compensation), commissions, tips, bonuses, and payments in kind representing income to the recipients—and supplements to these direct payments. Supplements consist of employer contributions to funds for social insurance, private pension and health and welfare plans, compensation for injuries, etc.

The compensation measures taken from establishment payrolls refer exclusively to wage and salary workers. Labor cost would be seriously understated by this measure of employee compensation alone in sectors such as farm and retail trade, where hours at work by proprietors represent a substantial portion of total labor input. BLS, therefore, imputes a compensation cost for labor services of proprietors and includes the hours of unpaid family workers in the hours of all employees engaged in a sector. Labor compensation per hour for proprietors is assumed to be the same as that of the average employee in that sector for measures found in the BLS news release, "Productivity and Costs," at https://www.bls.gov/newsrelease/prod2.toc.htm.

Nonlabor payments are the excess of current-dollar output in an economic sector over corresponding labor compensation, and include nonlabor *costs* as well as corporate profits and the profit-type income of proprietors. *Nonlabor costs* include, consumption of fixed capital, taxes on production and imports less subsidies, net interest and miscellaneous payments, and business current transfer payments.

Analysis and Presentation

Labor productivity

Indexes of labor productivity show changes in the ratio of output to hours of labor input. However, these indexes should not be interpreted as presenting only the contribution of labor to production. Rather, changes over time in the output and labor input measures underlying these productivity indexes may reflect the influence of other factors including variations in the characteristics and efforts of the work force, changes in the managerial skill, changes in the organization of production, changes in the allocation of resources between sectors, the direct and indirect effects of R&D, and new technology.

In aggregate sectors, productivity changes through time reflect movements within the various component industries as well as shifts in the relative importance of each of the industries. For example, changes in labor productivity are influenced by the relative shift of inputs from low- to high-productivity industries and by productivity changes in the component subsectors[7].

Short-term movements in productivity and unit labor costs often result from cyclical variation in output, as noted below, and may also reflect unusual events such as drought. These short-term movements are sometimes substantially greater or smaller than long-term averages of productivity and cost movements. For example, productivity growth for 1 or 2 years can be substantially greater than the average for the business cycle that includes these years.

Compensation per hour

Indexes of compensation per hour for major sectors measure the compensation of employees and the self-employed divided by hours worked by all persons engaged in the sector. Hours of all persons include hours worked by employees, proprietors, and unpaid family workers. BLS imputes the compensation of proprietors based on the assumption that compensation per hour of proprietors is the same as that of the average employee in that sector. Measures of real compensation per hour reflect the adjustment of hourly compensation for changes in consumer prices. The price changes for recent quarters are based on the BLS Consumer Price Index for all urban consumers (CPI-U). For earlier periods consumer prices are based on the BLS Consumer Price Index research series (CPI-U-RS).

Unit labor and nonlabor costs

Unit labor costs relate hourly compensation of all persons to output per hour and are defined as compensation per unit of real output. Unit labor costs measure the cost of

---

[7] The farm-nonfarm shift that occurred during the twentieth century was examined in some detail by J.R. Norsworthy and L.J. Fulco in "Productivity and Costs in the Private Economy," *Monthly Labor Review*, June 1974, pp. 3-9.

labor input required to produce one unit of output and are derived by dividing compensation in current dollars by the output index. Unit nonlabor costs include the nonlabor components of gross product originating in a given sector—consumption of fixed capital, taxes on production and imports less subsidies, net interest and miscellaneous payments, business current transfer payments, rental income of persons, and the current surplus of government enterprises—divided by the output index.

Availability of results

Indexes of output per hour, compensation per hour, and related cost data are published twice each quarter in the BLS news release, "Productivity and Costs," at https://www.bls.gov/news.release/prod2.toc.htm Historical indexes of these and related data are available on request. In addition, indexes of productivity and related cost data are available monthly in *Monthly Labor Review*, and can be accessed through the BLS home page at https://www.bls.gov

Calculation Procedures

Labor productivity, or output per hour, is computed as:

Labor productivity = (Output index) / (Hours of labor input)

or

$$P = O \,/\, H$$

The computation of labor compensation per hour parallels the computation of output per hour. Unit labor costs (ULC) are computed as labor compensation (C) per unit of output, but are often represented as:

$$ULC = (C \,/\, H) \,/\, (O \,/\, H)$$

This form highlights the relationships between unit labor costs, hourly compensation, and labor productivity.

Real compensation per hour (RC) is computed as hourly compensation deflated by an index of consumer prices (CPI):

$$RC = (C \,/\, H) \,/\, CPI$$

Unit nonlabor payments (UNLP) include the nonlabor components of gross product originating in a given sector—consumption of fixed capital, taxes on production and

imports less subsidies, net interest and miscellaneous payments, business current transfer payments, rental income of persons, and the current surplus of government enterprises as well as profits—whereas unit nonlabor costs (UNLC) exclude profits. These measures are computed as:

$$UNLP = (CU - C) / O$$

and

$$UNLC = (CU - C - PR) / O$$

where:

       CU is current-dollar output
       C is current-dollar compensation
       O is the output index
       PR is current-dollar profits.

Labor's share in current dollar output in a given sector is simply the ratio of labor compensation paid in that sector to current dollar output:

$$LS = C / CU$$

and, analogously, the nonlabor or capital share is defined as:

$$NLS = (CU - C) / CU = 1 - LS.$$

Most of the measures noted above are presented quarterly in index form. Indexes are computed from basic data or analytic ratios by dividing the series by its own base year annual value (presently 1992) and multiplying by 100. In addition, quarterly percent changes at a compound annual rate and percent changes from the same quarter in the previous year are computed:

$$Q_t = 100 \ (V_t / V_{t-1})^4 - 100$$

$$Y_t = 100 \ (V_t / V_{t-4}) - 100,$$

where:

t is a time subscript denoting the quarter,

V is a series described above,

Q_t is the quarterly percentage change in series V from quarter t-1 to quarter t, measured at a compound annual rate,

Y_t is the percentage change in series V from quarter t-4 (the same quarter 1 year before) to quarter t.

Indexes and percent changes are published to one decimal point but percent changes are calculated from index numbers to three decimal places. [8]

Uses and Limitations

Measures of output per hour (labor productivity) and related measures of costs are designed for use in economic analysis and public and private policy planning. The data are used in forecasting and analysis of prices, wages, and technological change.

The labor productivity and related cost measures are useful in investigating the relationships between productivity, wages, prices, profits, and costs of production. As noted before, gross domestic product represents the sum of all production costs: labor compensation, profits, consumption of fixed capital, interest, rent, indirect business taxes, and other minor items. Unit labor costs, or compensation per unit of output, represent a major portion of total unit costs and reflect the combined effect of changes in output per hour and compensation per hour; thus, an increase in compensation per hour tends to increase unit labor costs while an increase in output per hour tends to reduce them, other things being equal. Therefore, through its impact on unit labor costs, output per hour is an important element in the wage-price relationship because it is an indicator of the extent to which compensation gains can occur without putting pressure on prices or reducing payments to other input factors.

Certain characteristics of the productivity and related cost data should be recognized in order to apply them appropriately to specific situations. First, the data for aggregate sectors reflect changes within various constituent industries as well as shifts in the relative importance of these industries: a portion of labor productivity growth from 1947 to the mid-1960s is attributable to the shift of workers from farm to nonfarm occupations. Secondly, the relationships among variables are often difficult to identify over short time periods.

---

[8] The index numbers and rates of change reported by BLS for productivity and costs in its news release are rounded to one decimal place. All percent changes in the release are calculated using index numbers to three decimal places. These index numbers to three decimal places are available using data retrieval tools at https://www.bls.gov/data/home.htmor by contacting the BLS Division of Major Sector Productivity.

Technical References

Bureau of Labor Statistics

"Construction of Employment and Hours for Self-employed and other Nonfarm workers and for all Farm workers, using Current Population Survey data for primary and secondary jobs." (**https://www.bls.gov/lpc/lprjobsnote.pdf**, March 2006.

"Construction of average weekly hours for supervisory and nonproduction wage and salary workers in private nonfarm establishments" (**https://www.bls.gov/lpc/lprswawhtech.pdf**, October 2004.

Eldridge, Lucy P.; Manser, Marilyn; and Otto, Phyllis Flohr, "Alternative measures of supervisory employee hours and productivity growth" (**https://www.bls.gov/opub/mlr/2004/04/art2full.pdf**, *Monthly Labor Review*, April 2004.
An evaluation of new estimates of nonproduction and supervisory employee hours finds that the procedure currently used by BLS to estimate nonproduction and supervisory employee hours for the major sector productivity statistics does not misstate past productivity trends, but does undercount the number of hours worked.

Dean, Edwin R. and Harper, Michael J.; "The BLS Productivity Measurement Program," (**https://www.bls.gov/lpc/lprdh98.pdf**, Discussion Paper presented at the Conference on Research in Income and Wealth: New Directions in Productivity Research, March 20-21, 1998.

Dean, Edwin; Harper, Michael; and Otto, Phyllis Flohr, "Improvements to the quarterly productivity measures," (**https://www.bls.gov/opub/mlr/1995/10/art4full.pdf**, *Monthly Labor Review*, October 1995.
Summarizes the impact of switching from fixed-weighted to annual-weighted output on the labor productivity measures.

Gullickson, William, "Measurement of productivity growth in U.S. manufacturing," (https://www.bls.gov/opub/mlr/1995/07/art2full.pdf), *Monthly Labor Review*, July 1995.
Updates multifactor (KLEMS) productivity measures for each 2-digit SIC. Contains a discussion of alternative manufacturing output measures and their use in productivity measurement.

Jablonski, Mary; Kunze, Kent; and Otto, Phyllis Flohr, "Hours at Work: A New Base for BLS Productivity Statistics," (http://www.bls.gov/opub/mlr/1990/02/art2full.pdf), *Monthly Labor Review*, February 1990.
A description of the methodology used to develop measures of the ratio of hours at work to hours paid for the period 1948 to the present by linking the Hours at Work survey to early periodic surveys and unpublished data sources.

Mark, Jerome A. "Problems Encountered in Measuring Single-Factor and Multifactor Productivity," (https://www.bls.gov/opub/mlr/1986/12/art1full.pdf), *Monthly Labor Review*, December 1986.
Development of new data sources, better use of existing sources, and broader coverage are some of the ways in which BLS has improved its productivity measures; progress has been made, but inadequacies remain.

Kunze, Kent. "A New BLS Survey Measures the Ratio of Hours Worked to Hours Paid," (https://www.bls.gov/opub/mlr/1984/06/art1full.pdf), *Monthly Labor Review*, June 1984.
Hours at work accounted for about 93 percent of hours paid for production and nonsupervisory workers in 1982, according to an annual survey which includes only the time required to be on the job site, thereby excluding paid holidays, sick leave, and vacations.

Other publications

Baily, Martin Neil and Gordon, Robert J. "Measurement Issues, the Productivity Slowdown, and the Explosion of Computer Power," *Brookings Papers on Economic Activity*. Washington, DC, The Brookings Institution, 1989.

Jorgenson, Dale; Gollop, Frank; and Fraumeni, Barbara. *Productivity and U.S. Economic Growth*, Cambridge, MA, The Harvard University Press, 1987.

Denison, Edward F. *Trends in American Economic Growth, 1929-1982*. The Brookings Institution, Washington, DC, 1985.

Caves, Douglas W.; Christensen, Laurits R.; and Diewert, W. Erwin. "The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity," *Econometrica*, Vol. 50, No. 6, 1983, pp. 1393-1414.

Kendrick, John W. and Vaccara, Beatrice N., editors. *New Developments in Productivity Measurement and Analysis*. Chicago, The University of Chicago Press, 1980.