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TOTAL FACTOR PRODUCTIVITY – 2022

Total factor productivity (TFP) in the private nonfarm business sector decreased 1.2 percent in 2022, the U.S. Bureau of Labor Statistics reported today. (See chart 1, table A.) The 2022 decline in TFP reflects a 2.3-percent increase in output and a 3.6-percent increase in the combined inputs of capital and labor. Capital input grew by 2.9 percent and labor input–which is the combined effect of hours worked and labor composition–increased by 4.0 percent. This is the first time since 1993 that both capital and labor growth have outpaced output growth, leading to the decline in total factor productivity. Besides the COVID-19 pandemic year of 2020, this is the largest decline in productivity since 1982.

Chart 1. Total factor productivity, combined inputs, and output in the private nonfarm business sector, 2007-22

Annual percent change
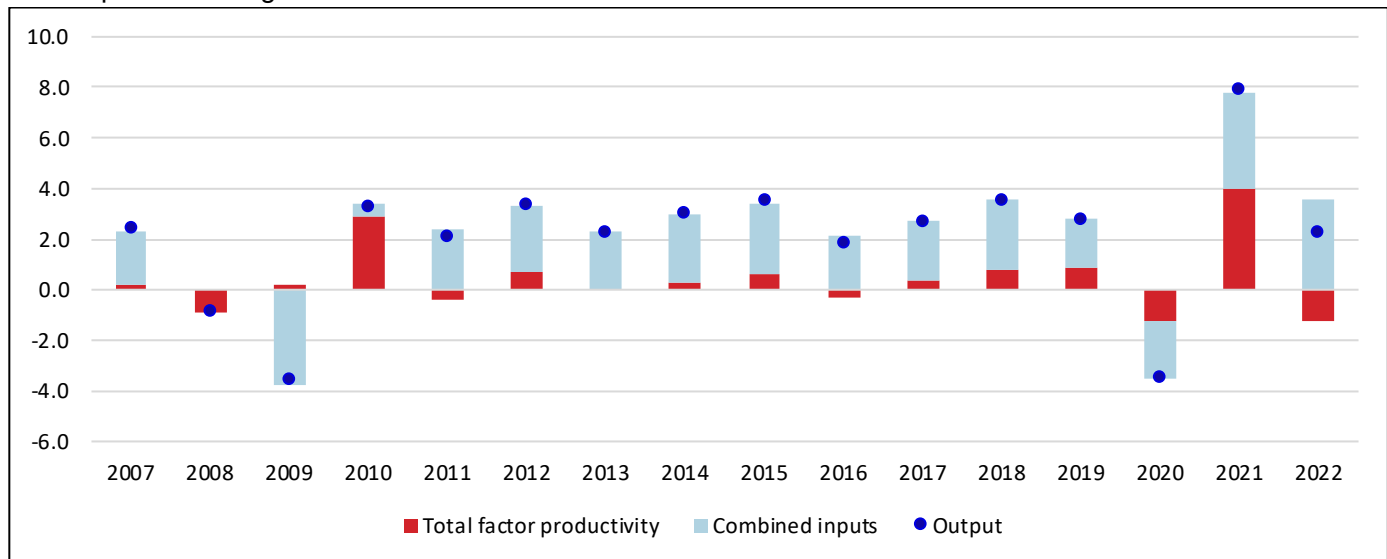
Methodology Change for Labor Composition Data

Starting with data released on November 18, 2022, the BLS Productivity program incorporated new methodology that uses a combination of the Census American Community Survey (ACS), BLS Current Population Survey (CPS), and the CPS Annual Demographic Supplement to estimate labor composition for all NAICS industries and Major Sectors.

Total factor productivity is calculated by dividing an index of real output by an index of combined units of labor input and capital input. Total factor productivity annual measures differ from BLS quarterly labor productivity (output per hour worked) measures because TFP includes the influences of capital input and shifts in the composition of workers. Measures for the most recent year of this release are preliminary estimates. See the Technical Notes for additional information.

Private business sector total factor productivity also decreased 1.2 percent in 2022, as output increased 2.2 percent and combined inputs increased 3.5 percent. (See table A.)

Total Factor Productivity Trends

The 1.2-percent decline in TFP in private nonfarm business in 2022 resulted from combined inputs growth outpacing the growth of output. The 2.3-percent growth of output in 2022 represents a stabilization of private nonfarm business output after the COVID-19 pandemic, as this growth is in line with the previous business cycle (2007-19) growth of 2.0 percent. (See charts 2a and 2b.)

Combined inputs continued its recovery from the 2020 recession with 3.8 percent growth in 2021 and 3.6 percent growth in 2022. However, due to the large decline in this measure in 2020, combined inputs growth during the current business cycle (2019-22) is now in line with the 2007-19 growth.

Productivity growth is often viewed as a long run measure, especially when an economic shock like the COVID-19 pandemic happens. While total factor productivity growth has been volatile the last 3 years, 2019-22 shows similar growth to the previous business cycle.

Chart 2a. Total factor productivity, combined inputs, and output in the private nonfarm business sector, 2020-22
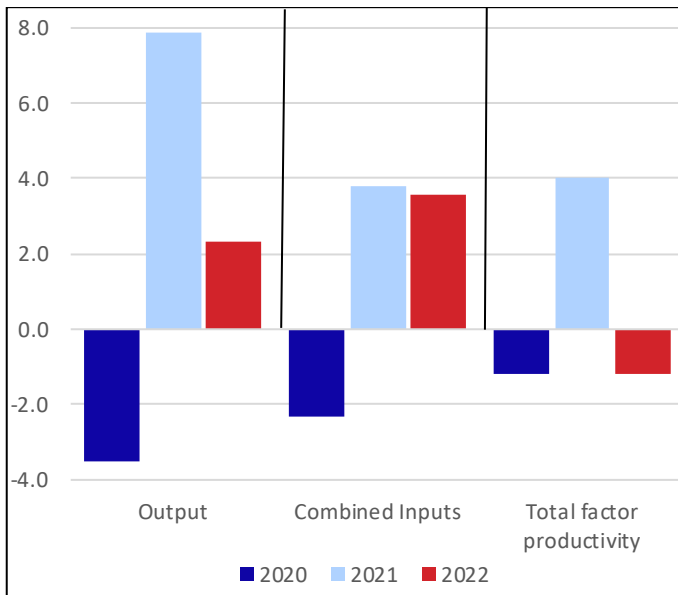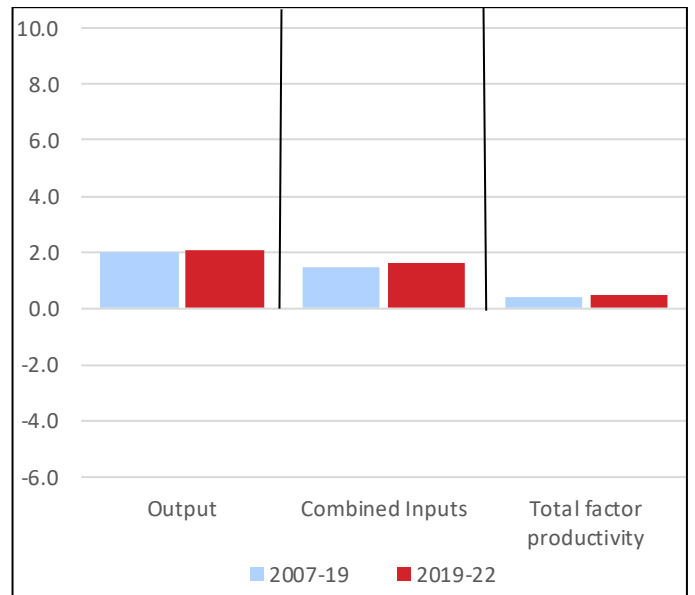
Annual percent change

Chart 2b. Total factor productivity, combined inputs, and output in the private nonfarm business sector, 2007-19 and 2019-22

Annual percent change

Combined input growth is made up of growth in three components: capital input, hours worked, and labor composition. The index of capital input has continued its pre-pandemic trend of positive growth and is now 8.0-percent higher in 2022 than in 2019. Hours worked grew 4.0 percent in 2022 and has now fully recovered from the historic decline in 2020, with the 2022 index 1.4-percent higher than in 2019. The index of labor composition experienced historically high growth in 2020 and has remained near this level over the last 2 years. (See chart 3.)

Chart 3. Components of combined inputs: capital input, hours worked, and labor composition, 2012-22

Index 2012=100
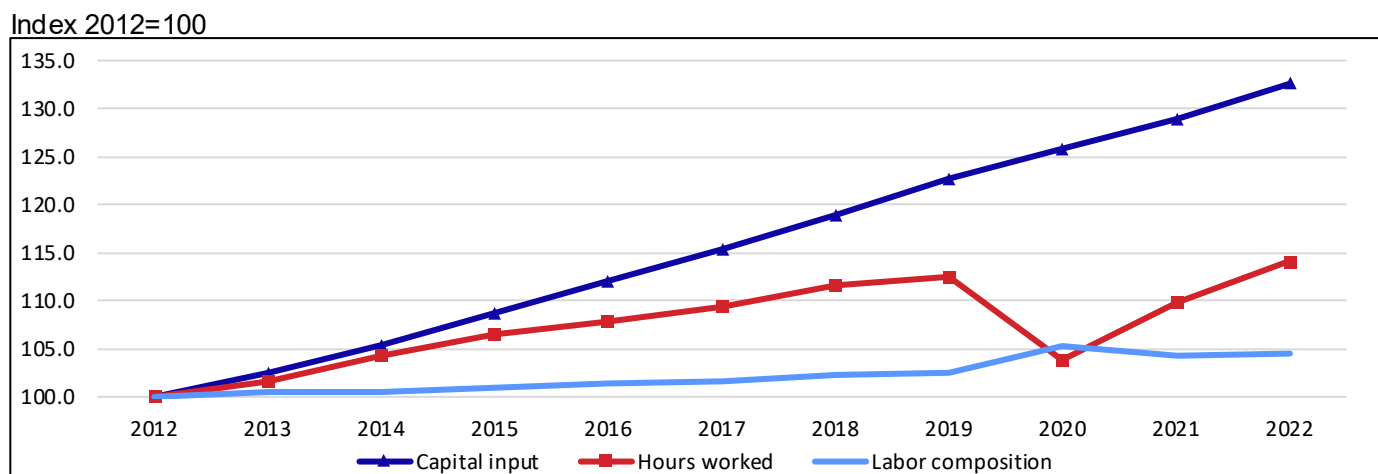
Labor Productivity Trends

Labor productivity growth is the approximate sum of three components: total factor productivity growth, the contribution of capital intensity, and the contribution of shifts in the composition of labor. In 2022, private nonfarm business labor productivity decreased 1.7 percent, the largest decline since the series began in 1948. (See chart 4 and table B.)

The 2022 private nonfarm business sector decline in labor productivity was a result of the 1.2-percent decline in total factor productivity, and a 0.4-percent decline in the contribution of capital intensity to labor productivity growth. Capital intensity is the ratio of capital input growth to labor hours growth. The 2022 decline in capital intensity was driven by the increase in hours worked of 4.0 percent relative to the slower capital input growth of 2.9 percent. (See tables A and B.)

The contribution of labor composition to labor productivity for private nonfarm business was unchanged in 2022. Labor composition estimates the effect of shifts in the age, education, and gender composition of the workforce on hours worked. The historic contribution of labor composition to labor productivity growth in 2020 was followed by a decline in 2021, the first time this measure declined since 1977. Over the 2019-22 business cycle, the contribution to labor productivity growth from labor composition was 0.4 percent. (See chart 4.)

Chart 4. Contributions to labor productivity growth, private nonfarm business sector, selected time periods

Average annual percent growth
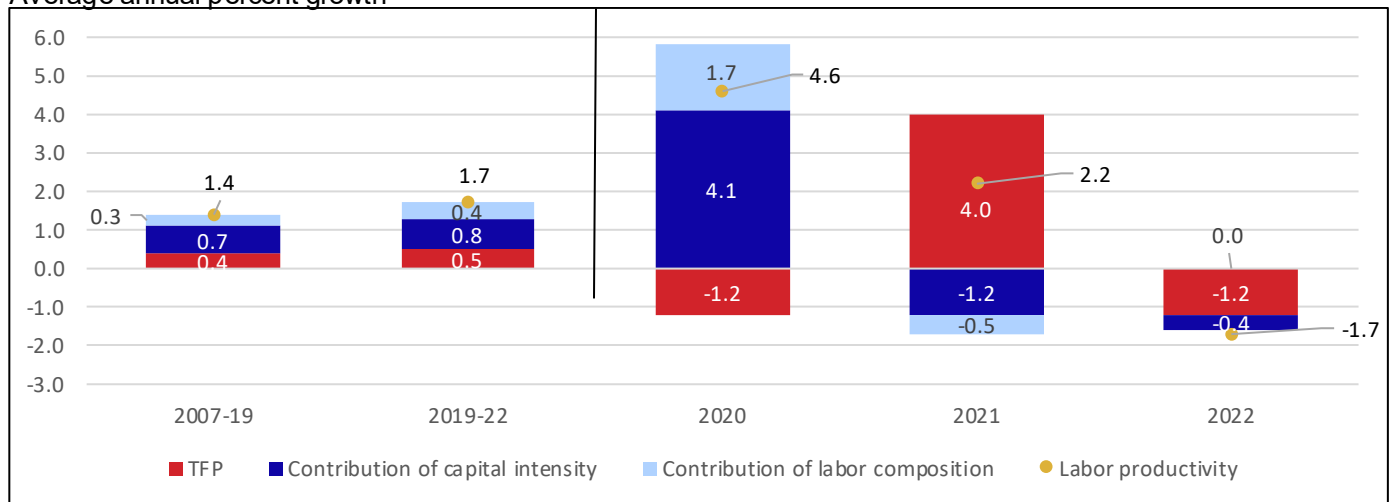
Note: The sum of long-term rates of change of total factor productivity, contribution of capital intensity, and contribution of labor composition may differ from the long-term rate of change in labor productivity.

Detailed Capital Input Trends 2021

Capital input in the private nonfarm business sector increased at an average annual rate of 2.3 percent in 2021, the latest year of available detailed capital data. The 2021 capital input growth declined 0.3 percentage point (see table C) from the 2020 annual rate of 2.6 percent and continues the deceleration of capital growth from the 2019 annual rate of 3.2 percent. This is the first 2-year consecutive decline in capital growth since the Great Recession of 2007-09.

Capital input is made up of different types of capital assets, including equipment, structures, and intellectual property products. In the 2000-07 business cycle, equipment and intellectual property products, which consist of software, research and development, and artistic originals assets, accounted for 2.9 percentage points of the private nonfarm business capital input growth of 3.5 percent. However, in the following business cycle of 2007-19, the contribution of equipment decreased by almost half, leading to capital input growth of only 2.4 percent. (See chart 5.)

The decline in the contribution of equipment continued into the current 2019-21 business cycle as equipment now accounts for 0.5 percentage point of capital input growth. However, capital input growth was unchanged at the previous rate of 2.4 percent due to the increased contribution of intellectual property products. Intellectual property products increased from a 1.0 percentage point contribution in 2007-19 to a 1.5 percentage point contribution in 2019-21, and now accounts for over half of private nonfarm business capital input growth.

Chart 5. Asset type contributions to capital input growth in the private nonfarm business sector for selected time periods

Average annual percent change
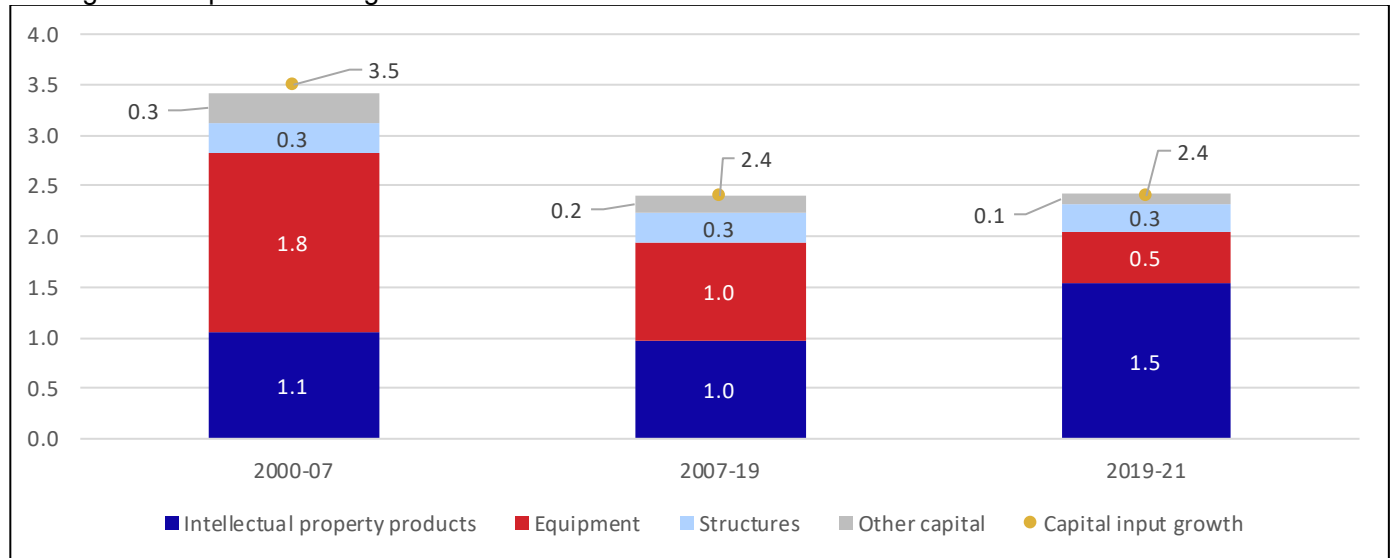
Note: The sum of contributions of the rates of change of the asset types may differ from the rate of change in capital growth. Other capital consists of inventories, land and residential structures.

Technical Notes

Capital Input

Capital input is the services derived from the stock of physical assets and intellectual property assets. There are 90 asset types for fixed business equipment, structures, inventories, land, and intellectual property products. Data on investment for fixed assets are obtained from the Bureau of Economic Analysis (BEA). Data on inventories are estimated using information from BEA and the Internal Revenue Service (IRS) Corporation Income Returns. Data for land in the farm sector are obtained from the U.S. Department of Agriculture (USDA). Nonfarm industry detail for land is based on IRS book value data. Current-dollar value-added data, obtained from BEA, are used in estimating capital rental prices.

Additional detail on information processing equipment and intellectual property products are available in table C. Information processing equipment is composed of three broad classes of assets: computers and related equipment, communications equipment, and other information processing equipment. Computers and related equipment include mainframe computers, personal computers, printers, terminals, tape drives, storage devices, and integrated systems. Communications equipment is not further differentiated. Other information processing equipment includes medical equipment and related instruments, electromedical instruments, nonmedical instruments, photocopying and related equipment, and office and accounting machinery. Intellectual property products are composed of three broad classes of assets: software, research and development, and artistic originals. Software is comprised of pre-packaged and custom. Research and development is creative work undertaken to increase the stock of knowledge for the purpose of discovering or developing new products or improving existing ones. Research and Development also includes own-account R&D for software which had previously been classified in software. Artistic originals include theatrical movies, long-lived television programs, books, music, and other forms of entertainment. Structures include nonresidential structures and residential capital that are rented out by profit-making firms or persons.

Financial assets are excluded from capital input measures, as are owner-occupied residential structures. The aggregate capital input measures are obtained by Tornqvist aggregation of the capital stocks for each asset type within each of 61 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. Current-dollar capital costs can be defined as each asset's rental price multiplied by its constant-dollar stock, adjusting for capital composition effects.

Capital input measures constructed for the most recent year are preliminary and are based on less detail than the rest of the series. These measures consist of 6 asset types as opposed to the 90 asset types for fixed business equipment, structures, inventories, land, and intellectual property products included in estimates for all previous years. The assets included in the most recent year are structures, fixed business equipment, intellectual property products, inventories, rental residences, and land. Investments, depreciation, and capital income are estimated for each of these six aggregates. Capital input is calculated by a chained superlative Tornqvist index combining stocks of the six asset categories, weighted by capital income shares. See the June 2005 Monthly Labor Review article, "Preliminary estimates of multifactor productivity growth" located at www.bls.gov/opub/mlr/2005/06/art3full.pdf.

Labor Input

Labor input in private business and private nonfarm business is obtained by a chained superlative Tornqvist aggregation of the hours worked, classified by age, education, and gender with weights determined by each

group's share of the total wage bill. Hours worked data for the measures this news release include hours worked for all persons working in the 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) program, which provides monthly survey data on the number of jobs held by and hours paid to wage and salary workers in nonfarm establishments, counting a person who is employed by two or more establishments at each place of employment. Hours of paid time off are excluded from hours paid using data from the National Compensation Survey (NCS) for 1996 forward and data from the BLS Hours at Work survey, conducted for this purpose, prior to 1990. Between 1990 and 1995, hours of paid time off are excluded using a combination of NCS and Hours at Work survey data. Off-the-clock hours are added, yielding hours worked, using data from the Current Population Survey (CPS). To estimate the hours of farm labor, nonfarm proprietors, and nonfarm unpaid family workers the CPS data are used. The hours worked of proprietors, unpaid family workers, and farm employees are derived from the CPS. Hours worked data reflect estimates in the March 2, 2023 "Productivity and Costs" news release (www.bls.gov/news.release/archives/prod2_03022023.pdf) and a new methodology for estimating hours worked. More information on the methodology change can be found at www.bls.gov/productivity/technical-notes/labor-productivity-hours-worked-method-using-ces-all-employee-hours-nov-2022.htm.

The estimates of 2022 hours worked for the private nonfarm business and private business sectors are extrapolated from the hours worked reported in the nonfarm business and business sectors, respectively, in the March 2, 2023 "Productivity and Costs" news release (www.bls.gov/news.release/archives/prod2_03022023.pdf). The growth rate of labor composition is defined as the difference between the growth rate of weighted labor input and the growth rate of the hours of all persons. The index of hours worked of all persons including employees, proprietors, and unpaid family workers, classified by age, education, and gender are weighted together using median wages to compute the labor composition estimates reflecting the different skillset of the work force. These cell estimates are smoothed using a three-year moving average to address missing observations and reduce volatility.

Combined Inputs

Labor input and capital input are combined using chained superlative Tornqvist aggregation, applying weights that represent each component's average share of total costs. The chained superlative Tornqvist index uses changing weights; the share in each year is averaged with the preceding year's share. Total costs are defined as the value of output less a portion of taxes on production and imports. Most taxes on production and imports, such as excise taxes, are excluded from costs; however, property and motor vehicle taxes remain in total costs.

Capital Intensity

Capital intensity is the ratio of capital input to hours worked in the production process. The higher the capital to hours ratio, the more capital intensive the production process becomes.

In a production process, profit-maximizing/cost-minimizing firms adjust the factor proportions of capital and labor when the price of one factor is less than the other factor; there is 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 input. 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 www.bls.gov/productivity/tables/.

Value-Added Output

Private business sector output is a chain-type, current-weighted index constructed after excluding from gross domestic product (GDP) the following outputs: general government, nonprofit institutions, private households (including owner-occupied housing), and government enterprises. This release presents data for the private business and private nonfarm business sectors. Additionally, the private nonfarm business sector excludes farms from the private business sector but includes agricultural services. Total factor productivity measures exclude government enterprises, while the BLS quarterly Productivity and Costs series include them.

The output measures are based on the National Income and Product Accounts (NIPA) data released by BEA on February 23, 2023. The estimates of 2022 output for the private nonfarm business and private business sectors are extrapolated from the output reported in the nonfarm business and business sectors, respectively, in the March 2, 2023 "Productivity and Costs" news release (www.bls.gov/news.release/archives/prod2_03022023.pdf).

Total Factor Productivity

Total factor productivity measures describe the relationship between output in real terms and the inputs involved in its production. They do not measure the specific contributions of labor or capital, or any other factor of production. Rather, total factor productivity is designed to measure the joint influences of technological change, efficiency improvements, returns to scale, reallocation of resources, and other factors on economic growth, allowing for the effects of capital and labor.

The total factor productivity indexes for private business and private nonfarm business are derived by dividing an output index by an index of combined inputs of capital input and labor input. The output indexes are computed as chained superlative indexes (Fisher Ideal indexes) of components of real output.

Research and Development

The stock of research and development in private nonfarm business is derived by aggregating different vintages of constant dollar measures of research and development expenditures and allowing for depreciation. Current dollar expenditures for privately financed research and development are obtained from annual issues of Research and Development in Industry published by the National Science Foundation. BLS develops price deflators and estimates of the rate of depreciation.

The research and development data in the private nonfarm business sector presented here show the effect of spillovers from economic units that conduct research and development. BEA publishes measures of research and development investments in each industry that include estimates of the direct returns to firms conducting such research and development activities. By combining the direct returns to firms conducting research and development with the spillover effect of other firms, a picture of the total overall effects of research and development can be drawn.

Further description of these data and methods can be found in BLS Bulletin 2331 (September 1989), "The Impact of Research and Development on Productivity Growth" at www.bls.gov/productivity/technical-notes/impact-of-research-and-development-on-productivity-growth-1989.pdf.

BLS measures of year-to-year contributions of research and development to the private nonfarm business sector and measures of the stock of research and development are available at www.bls.gov/productivity/highlights/research-and-development-contribution-to-total-factor-productivity.htm.

Other Information

Detailed information on methods used in this release can be found in the BLS Handbook of Methods. Productivity Measures: Business Sector and Major Sector section at www.bls.gov/opub/hom/msp/home.htm.

Comprehensive tables containing more detailed data than that which is published in this news release are available upon request at 202-691-5606 or at www.bls.gov/productivity/tables.

Industry specific contributions to output are available at www.bls.gov/productivity/highlights/contributions-of-total-factor-productivity-major-industry-to-output.htm.

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Table A. Productivity, output, and inputs in the private nonfarm business and private business sectors for selected periods, 1987-2022

Average annual growth rates

	1987-2022	1990-2000	2000-07	2007-19	2019-22	2020-21	2021-22
Private nonfarm business							
Productivity							
Total factor productivity	0.7	0.9	1.3	0.4	0.5	4.0	-1.2
Labor productivity	1.9	2.2	2.7	1.4	1.7	2.2	-1.7
Output per unit of capital input	-0.6	-0.7	-0.6	-0.5	-0.5	5.5	-0.6
Output	2.8	4.0	2.8	2.0	2.1	7.9	2.3
Combined inputs	2.1	3.1	1.5	1.5	1.6	3.8	3.6
Labor input	1.4	2.2	0.6	1.0	1.1	4.7	4.0
Hours	0.9	1.7	0.1	0.5	0.5	5.6	4.0
Labor composition	0.5	0.5	0.4	0.5	0.6	-0.9	0.1
Capital input	3.4	4.8	3.5	2.4	2.6	2.3	2.9
Analytic ratio							
Capital intensity	2.5	3.0	3.3	1.9	2.1	-3.1	-1.1
Private business							
Productivity							
Total factor productivity	0.8	1.0	1.3	0.5	0.4	3.9	-1.2
Labor productivity	2.0	2.3	2.7	1.4	1.6	2.2	-1.6
Output per unit of capital input	-0.5	-0.5	-0.6	-0.4	-0.6	5.3	-0.8
Output	2.8	4.0	2.8	2.0	2.1	7.7	2.2
Combined inputs	2.0	3.0	1.5	1.5	1.6	3.7	3.5
Labor input	1.3	2.2	0.5	1.0	1.0	4.5	3.9
Hours	0.9	1.7	0.1	0.5	0.4	5.5	3.9
Labor composition	0.5	0.5	0.4	0.5	0.6	-0.9	0.1
Capital input	3.3	4.6	3.4	2.4	2.6	2.3	3.0
Analytic ratio							
Capital intensity	2.5	2.8	3.3	1.8	2.2	-3.0	-0.8

Table B. Labor productivity growth and the contributions of capital intensity, labor composition, and total factor productivity to labor productivity growth, private nonfarm business and private business sectors

Average annual growth rates/percentage point contributions

	1987-2021	1987-2022	1990-2000	2000-07	2007-19	2019-22	2020-21	2021-22
Private nonfarm business								
Labor productivity growth	2.0	1.9	2.2	2.7	1.4	1.7	2.2	-1.7
Contribution of capital intensity	0.9	0.9	1.0	1.1	0.7	0.8	-1.2	-0.4
Contribution of information processing equipment (IPE)	0.3	-	0.4	0.4	0.2	-	0.0	-
Contribution of research and development (R&D)	0.1	-	0.1	0.1	0.1	-	0.0	-
Contribution of intellectual property products (IPP) excluding R&D	0.2	-	0.2	0.2	0.2	-	0.1	-
Contribution of capital input excluding IPP & IPE	0.2	-	0.2	0.4	0.2	-	-1.3	-
Contribution of labor composition	0.3	0.3	0.3	0.3	0.3	0.4	-0.5	0.0
Total factor productivity growth	0.8	0.7	0.9	1.3	0.4	0.5	4.0	-1.2
Contribution of R&D to total factor productivity	0.2		0.2	0.2	0.1		0.2	
Private business								
Labor productivity growth	2.1	2.0	2.3	2.7	1.4	1.6	2.2	-1.6
Contribution of capital intensity	0.9	0.9	0.9	1.1	0.7	0.8	-1.2	-0.4
Contribution of information processing equipment (IPE)	0.3	-	0.4	0.4	0.2	-	0.0	-
Contribution of research and development (R&D)	0.1	-	0.1	0.1	0.1	-	0.0	-
Contribution of intellectual property products (IPP) excluding R&D	0.2	-	0.2	0.2	0.2	-	0.1	-
Contribution of capital input excluding IPE & IPP	0.2	-	0.2	0.4	0.2	-	-1.3	-
Contribution of labor composition	0.3	0.3	0.3	0.3	0.3	0.4	-0.5	0.0
Total factor productivity growth	0.8	0.8	1.0	1.3	0.5	0.4	3.9	-1.2

*- Data for the most recent year not available

Note: Total factor productivity plus contribution of capital intensity and labor composition may not sum to labor productivity due to independent rounding. Contributions of the components of capital intensity may not sum to the total contribution of capital intensity due to independent rounding.

Table C. Real capital input growth by asset type, private nonfarm business and private business sectors
Average annual growth rates

	1987-2021	1990-2000	2000-07	2007-19	2019-21	2020-21
Private nonfarm business						
All assets	3.5	4.8	3.5	2.4	2.4	2.3
Equipment	4.5	6.6	4.9	3.2	1.8	1.3
Information processing equipment (IPE)	9.2	13.0	9.5	6.8	5.9	6.0
Computers & related equipment	15.1	28.1	14.4	6.1	6.8	7.3
Communication equipment	9.1	8.0	9.7	10.5	8.1	7.9
Other IPE	3.0	3.3	3.2	2.8	2.8	2.7
All other equipment	2.4	3.5	2.9	1.7	0.3	-0.3
Structures	1.5	2.1	1.3	1.0	1.0	0.8
Intellectual property products (IPP)	6.1	7.5	5.4	4.7	6.5	6.7
Research and development	4.5	5.5	4.1	3.6	5.1	5.2
Software	10.3	14.0	8.1	7.2	9.9	10.2
Artistic originals	3.0	3.7	3.6	2.1	1.3	0.9
Rental residential capital	1.2	1.4	2.2	0.1	0.8	0.9
Inventories	2.6	3.5	2.1	2.5	-0.3	-0.5
Land	0.8	1.2	0.5	0.3	0.9	0.7
Private business						
All assets	3.4	4.6	3.4	2.4	2.4	2.3
Equipment	4.4	6.5	4.9	3.2	1.8	1.3
Information processing equipment (IPE)	9.2	13.0	9.5	6.8	5.9	6.0
Computers & related equipment	15.1	28.1	14.4	6.1	6.8	7.3
Communication equipment	9.1	8.0	9.7	10.5	8.1	7.9
Other IPE	3.1	3.4	3.4	3.0	2.8	2.7
All other equipment	2.3	3.4	2.8	1.7	0.3	-0.3
Structures	1.5	2.0	1.2	1.0	1.0	0.8
Intellectual property products (IPP)	6.1	7.5	5.4	4.7	6.5	6.7
Research and development	4.5	5.5	4.1	3.6	5.1	5.2
Software	10.3	14.0	8.1	7.2	9.9	10.2
Artistic originals	3.0	3.7	3.6	2.1	1.3	0.9
Rental residential capital	1.2	1.4	2.2	0.1	0.8	0.9
Inventories	2.5	3.4	2.1	2.3	-0.4	-0.6
Land	0.7	0.7	0.5	0.1	1.3	1.5

Note: Real capital input by asset type is not available for the most recent reference year. For a brief discussion of methods used in preparing these data see the Technical Notes in this release.