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Technical information: (202) 691-5606 • Productivity@bls.gov • www.bls.gov/mfp

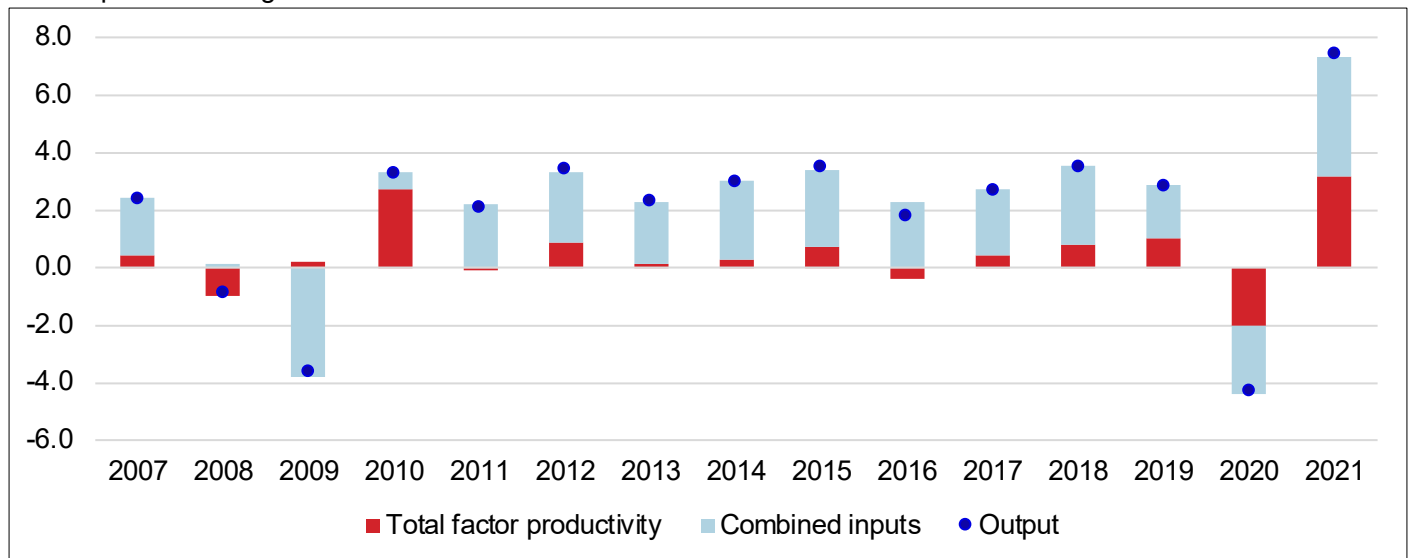
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TOTAL FACTOR PRODUCTIVITY – 2021

Private nonfarm business sector total factor productivity (TFP) increased 3.2 percent in 2021, the U.S. Bureau of Labor Statistics reported today. (See chart 1, table A.) The 2021 increase in TFP reflects a 7.4-percent increase in output and a 4.1-percent increase in the combined inputs of capital and labor. Capital input grew by 2.0 percent and labor input—which is the combined effect of hours worked and labor composition—increased by 5.3 percent.

Chart 1. Total factor productivity, combined inputs, and output in the private nonfarm business sector, 2007-21

Annual percent change



Total factor productivity (TFP) is calculated by dividing an index of real output by an index of combined inputs of labor and capital. Total factor productivity annual measures differ from BLS quarterly labor productivity (output per hour worked) measures because the former also 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.

Terminology Change for Multifactor Productivity Data

The BLS Productivity program replaced the term multifactor productivity (MFP) with total factor productivity (TFP) in November 2021. This was a change in terminology only and will not affect the data or methodology used in computing the measures. The use of the term “total factor productivity” will improve the visibility and accessibility of our data and was accompanied by changes to the BLS website and will be adopted in all future productivity news releases.

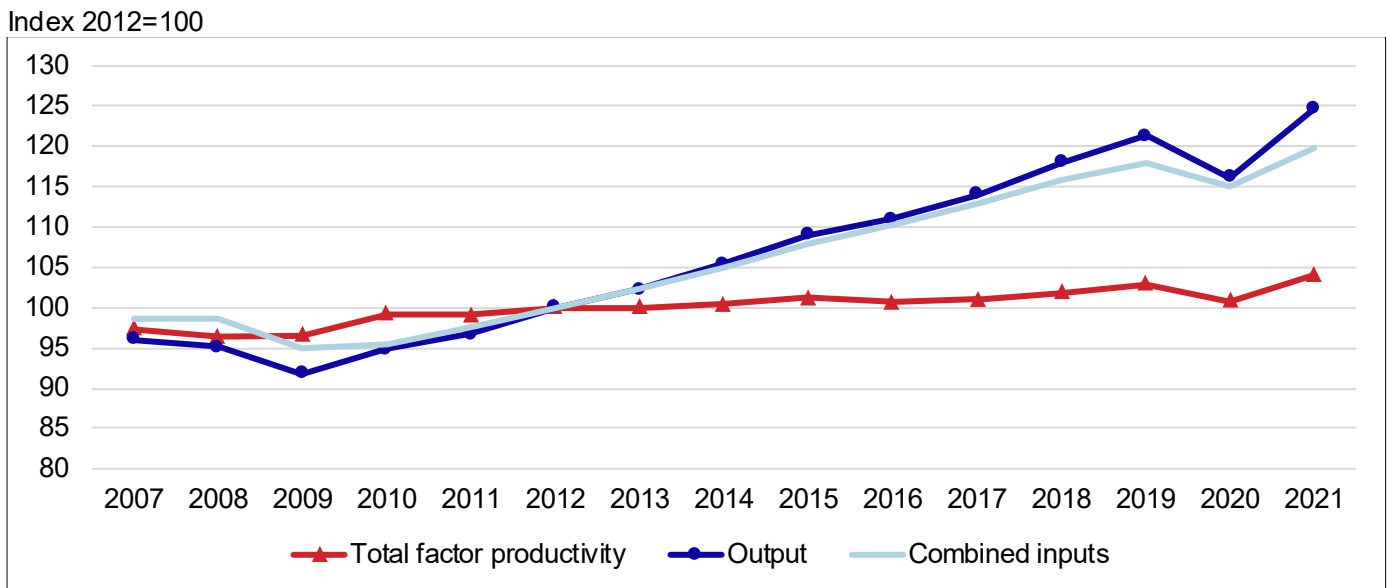
Private business sector total factor productivity also increased 3.2 percent in 2021, as output increased 7.2 percent and combined inputs increased 4.0 percent. (See table A.)

Total Factor Productivity Trends

The 3.2-percent growth in private nonfarm business TFP in 2021 was the largest growth since 1983 and resulted from strong output growth outpacing growth of combined inputs. The 7.4-percent growth of output in 2021 was the largest output growth since 1984, while the combined inputs growth of 4.1 percent was the largest growth for the series since 1997.

In 2021, both output and combined inputs were at higher levels than their pre-pandemic levels of 2019. The level of output is 2.7 percent higher than 2019, while the level of combined inputs is 1.6 percent higher. The quick recovery of these measures from the 2020 COVID-19 recession is in sharp contrast to the recovery seen in the previous 2007-09 Great Recession, when it took output 4 years to recover to the 2007 levels and 5 years for combined inputs to recover. (See chart 2.)

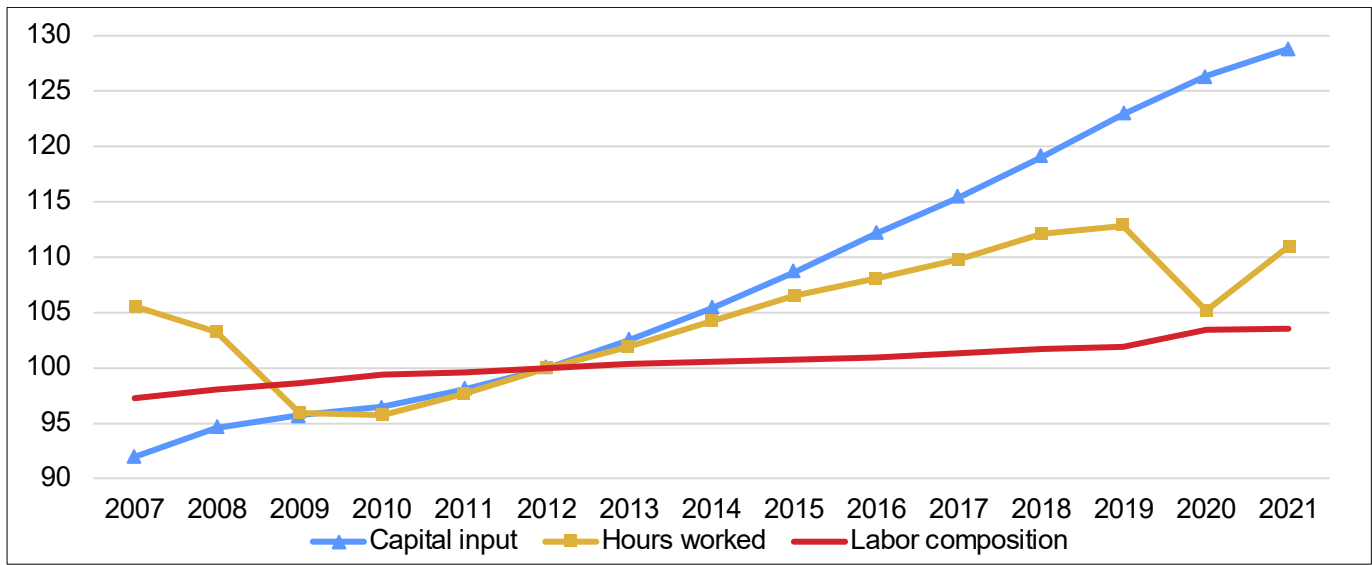
Chart 2. Total factor productivity, output, and combined input indexes in the private nonfarm business sector, 2007-21



While combined inputs have recovered from the effects of the pandemic, not all of the input components have returned to pre-pandemic levels. Combined input growth is made up of growth in three components: capital input, hours worked, and labor composition. Capital input growth has slowed from the pre-pandemic growth of 3.3 percent in 2019 to 2.0 percent in 2021. Hours worked grew 5.4 percent in 2021, the largest growth in the series since 1984, however hours worked levels remain 1.7 percent below the 2019 level. Labor composition experienced historic growth in 2020 (1.5 percent) but 2021 grew much more slowly (0.1 percent) even below the average growth experienced over the past 20 years (0.4 percent). (See chart 3).

Chart 3. Components of combined inputs: capital input, hours worked, and labor composition, 2007-21

Index 2012=100



Labor Productivity Trends

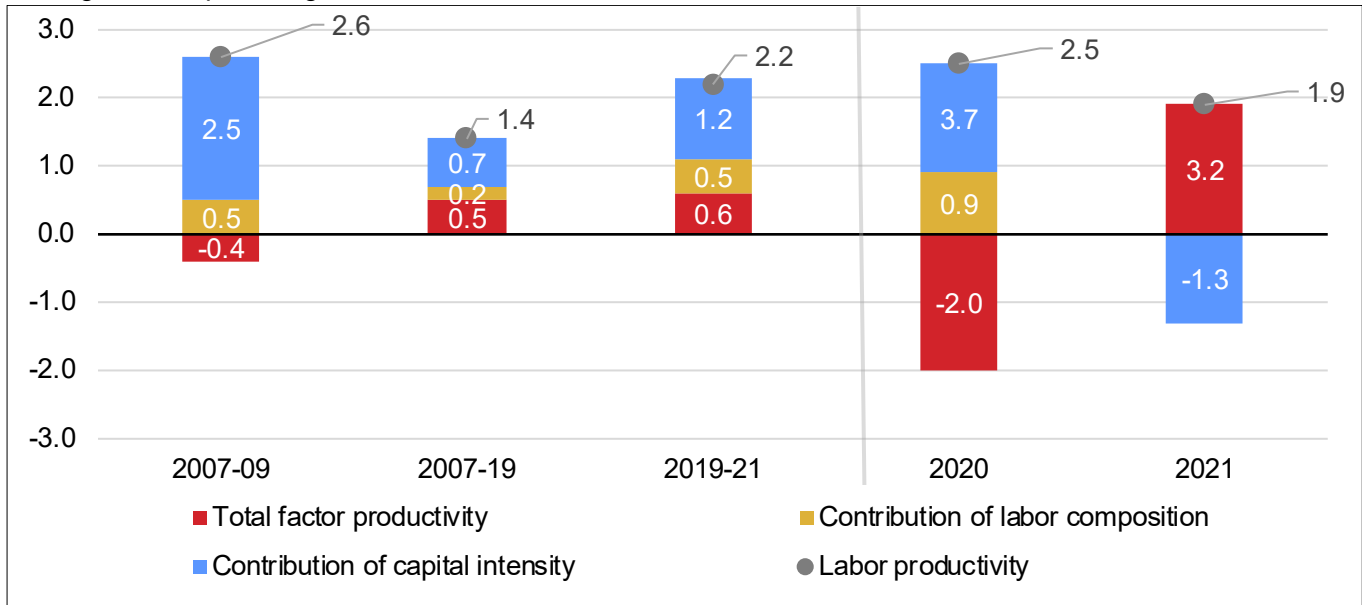
Labor productivity growth is the approximate sum of three components: total factor productivity growth, the contribution of capital intensity, and the contribution of shifts in the composition of labor. In 2021, private nonfarm business labor productivity increased 1.9 percent. (See chart 4 and table B.)

The contribution of capital intensity to labor productivity growth declined 1.3 percent in the private nonfarm business sector in 2021. This was the largest annual decline since the series began in 1948. Capital intensity is the ratio of capital input growth to labor hours growth. The 2021 decline is a result of choices toward hiring labor and working more hours rather than investing in more capital. The 2021 decrease in this measure was driven by the increase in hours worked of 5.4 percent relative to the slower capital input growth of 2.0 percent in 2021.

The contribution of labor composition to labor productivity for private nonfarm business had no growth in 2021 due to minimal labor composition growth. This follows record growth in the contribution of labor composition in 2020 of 0.9 percent. (See chart 4.) Labor composition estimates the effect of shifts in the age, education, and gender composition of the workforce on hours worked. The deceleration in the labor composition growth from 1.5 percent in 2020 to 0.1 percent in 2021 is primarily due to lower paid workers reentering the labor market in 2021 following employment declines during the COVID-19 pandemic. (See table A).

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.

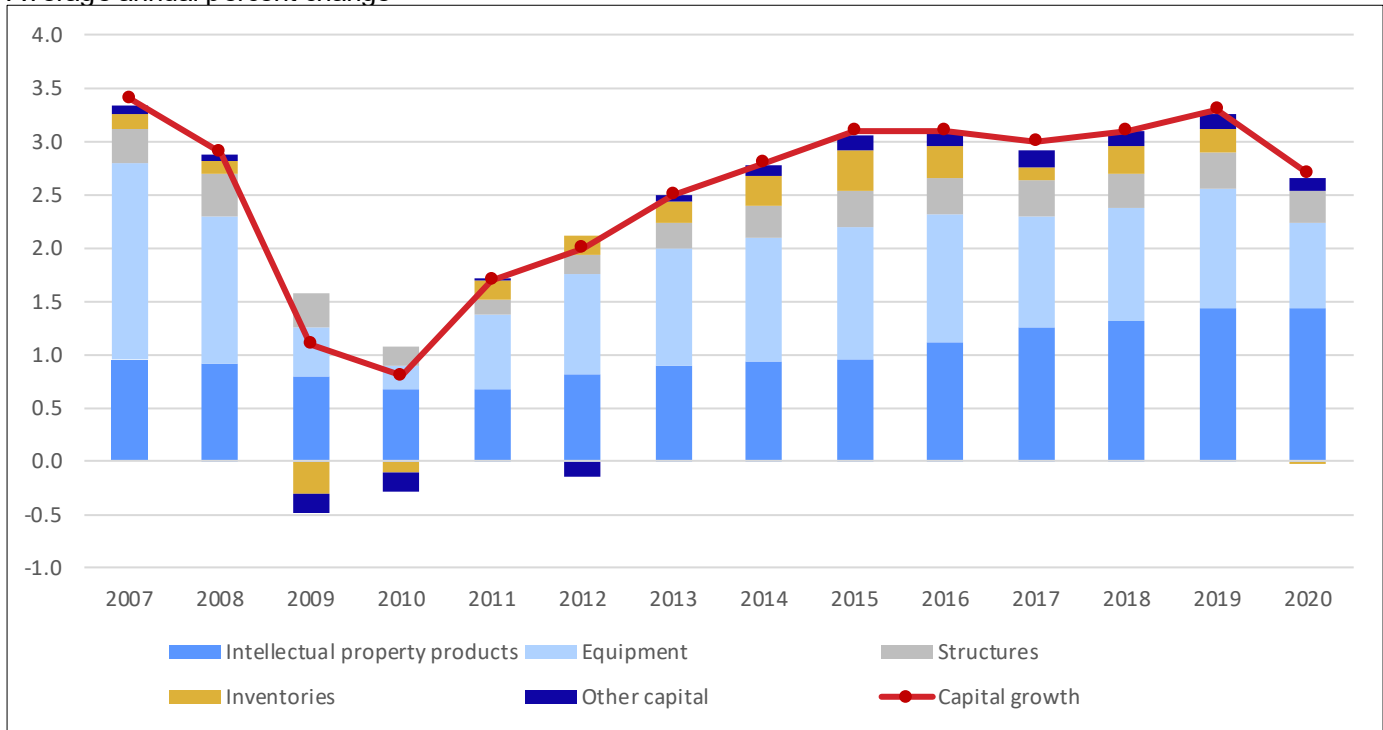
Detailed Capital Input Trends

Capital input in the private nonfarm business sector increased at an average annual rate of 2.7 percent in 2020, the latest year of available detailed capital data. The growth of capital input in 2020 was 0.6 percentage point slower than the 3.3 percent growth in the previous year, the largest slowdown in capital growth since the Great Recession year of 2009, as the COVID-19 pandemic slowed production. (See table C.)

Chart 5 shows the contribution of asset types to capital input growth. As in all years, intellectual property products and equipment are the largest contributors to capital input growth. In the pandemic recession year of 2020, the 0.6-percentage point slowdown in growth was primarily due to the equipment and inventories assets, as their contributions to capital input growth decelerated by 0.3 percentage point and 0.2 percentage point, respectively. The Great Recession years of 2008 and 2009 saw a similar trend, when capital input growth also slowed significantly in the equipment and inventories assets, but at a much larger magnitude. In 2009, the contribution of equipment assets slowed a full percentage point from 1.4 percentage points to 0.4 percentage point, while the contribution of inventories was a drag on capital growth, declining 0.4 percentage point.

Chart 5. Asset type contributions to capital input growth in the private nonfarm business sector, 2007-20

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.

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 paid of employees are largely obtained from the Current Employment Statistics (CES) program. Weekly paid hours are adjusted to hours worked 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, weekly paid hours are adjusted to hours at work using a combination of NCS and Hours at Work survey data. Hours worked for nonproduction and supervisory workers are derived using data from the Current Population Survey (CPS), CES, and NCS. The hours worked of proprietors, unpaid family workers, and farm employees are derived from the CPS. Hours worked data reflect estimates in the March 3, 2022 "Productivity and Costs" news release (www.bls.gov/news.release/archives/prod2_03032022.htm).

The estimates of 2021 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 3, 2022 "Productivity and Costs" news release (www.bls.gov/news.release/archives/prod2_03032022.htm). 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.

Additional information concerning data sources and methods of measuring labor composition can be found in "Changes in the Composition of Labor for BLS Multifactor Productivity Measures, 2014" (www.bls.gov/mfp/mprlabor.pdf).

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/mfp/mprdload.htm.

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 24, 2022. The estimates of 2021 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 3, 2022 “Productivity and Costs” news release (www.bls.gov/news.release/archives/prod2_03032022.htm).

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/mfp/mfparchive.htm. 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/mfp/rdtable.pdf.

Other Information

Comprehensive tables containing additional data beyond the scope of this press release are available at www.bls.gov/mfp/mprdload.htm or upon request through <https://data.bls.gov/forms/mfp.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” (www.bls.gov/mfp/mfparchive.htm) 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” (www.bls.gov/mfp/mprtech.pdf). General information is available on the BLS website at www.bls.gov/mfp/mprover.htm. Additional data not contained in the release can be obtained at www.bls.gov/mfp. Comprehensive tables for the private business and private nonfarm business sector can be downloaded at www.bls.gov/mfp/mprdload.htm, including data that links 1948-87 SIC data to NAICS data from 1987 forward.

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Table A. Productivity, output, and inputs in the private nonfarm business and private business sectors for selected periods, 1987-2021

Average annual growth rates

	1987-2021	1990-2000	2000-07	2007-19	2019-20	2020-21
<u>Private nonfarm business</u>						
Productivity						
Total factor productivity	0.8	0.9	1.3	0.5	-2.0	3.2
Labor productivity	2.0	2.2	2.7	1.4	2.5	1.9
Output per unit of capital input	-0.6	-0.7	-0.6	-0.5	-6.8	5.3
Output	2.8	4.0	2.8	2.0	-4.3	7.4
Combined inputs	2.0	3.0	1.5	1.5	-2.4	4.1
Labor input	1.3	2.2	0.5	1.0	-5.3	5.3
Hours	0.8	1.7	0.1	0.6	-6.7	5.4
Labor composition	0.4	0.5	0.4	0.4	1.5	0.1
Capital input	3.5	4.7	3.5	2.5	2.7	2.0
Analytic ratio						
Capital intensity	2.6	3.0	3.3	1.9	10.1	-3.2
<u>Private business</u>						
Productivity						
Total factor productivity	0.8	1.0	1.3	0.5	-1.9	3.2
Labor productivity	2.0	2.3	2.7	1.4	2.6	1.9
Output per unit of capital input	-0.5	-0.5	-0.6	-0.4	-6.6	5.0
Output	2.8	4.0	2.8	2.0	-4.2	7.2
Combined inputs	2.0	3.0	1.4	1.5	-2.3	4.0
Labor input	1.2	2.2	0.4	1.0	-5.3	5.2
Hours	0.8	1.7	0.1	0.6	-6.6	5.3
Labor composition	0.4	0.5	0.4	0.4	1.4	0.1
Capital input	3.4	4.6	3.4	2.4	2.6	2.1
Analytic ratio						
Capital intensity	2.5	2.8	3.3	1.8	9.9	-3.0

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

	1987-2020	1987-2021	1990-2000	2000-07	2007-19	2019-20	2020-21
<u>Private nonfarm business</u>							
Labor productivity growth	2.0	2.0	2.2	2.7	1.4	2.5	1.9
Contribution of capital intensity	0.9	0.9	1.0	1.1	0.7	3.7	-1.3
Contribution of information processing equipment (IPE)	0.3	-	0.4	0.4	0.2	0.4	-
Contribution of research and development (R&D)	0.1	-	0.1	0.1	0.1	0.5	-
Contribution of intellectual property products (IPP) excluding R&D	0.2	-	0.2	0.2	0.2	0.6	-
Contribution of capital input excluding IPP & IPE	0.3	-	0.2	0.4	0.2	2.0	-
Contribution of labor composition	0.3	0.3	0.3	0.3	0.2	0.9	0.0
Total factor productivity growth	0.7	0.8	0.9	1.3	0.5	-2.0	3.2
Contribution of R&D to total factor productivity	0.2	-	0.2	0.2	0.1	0.2	-
<u>Private business</u>							
Labor productivity growth	2.0	2.0	2.3	2.7	1.4	2.6	1.9
Contribution of capital intensity	0.9	0.9	0.9	1.1	0.7	3.6	-1.2
Contribution of information processing equipment (IPE)	0.3	-	0.4	0.4	0.2	0.4	-
Contribution of research and development (R&D)	0.1	-	0.1	0.1	0.1	0.5	-
Contribution of intellectual property products (IPP) excluding R&D	0.2	-	0.2	0.2	0.2	0.6	-
Contribution of capital input excluding IPE & IPP	0.3	-	0.2	0.4	0.2	2.0	-
Contribution of labor composition	0.3	0.3	0.3	0.2	0.2	0.9	0.0
Total factor productivity growth	0.8	0.8	1.0	1.3	0.5	-1.9	3.2

*- 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

	1987-2020	1990-2000	2000-07	2007-19	2019-20
<u>Private nonfarm business</u>					
All assets	3.5	4.7	3.5	2.5	2.7
Equipment	4.6	6.6	4.9	3.2	2.7
Information processing equipment (IPE)	9.4	13.0	9.5	6.8	6.8
Computers & related equipment	15.3	28.1	14.4	6.1	6.4
Communication equipment	9.2	8.0	9.7	10.6	9.8
Other IPE	3.0	3.3	3.2	2.8	3.6
All other equipment	2.5	3.5	2.9	1.7	1.2
Structures	1.6	2.1	1.3	1.0	1.1
Intellectual property products (IPP)	6.0	7.5	5.4	4.7	6.2
Research and development	4.5	5.5	4.1	3.6	4.7
Software	10.4	14.0	8.1	7.2	9.4
Artistic originals	3.0	3.7	3.6	2.1	1.8
Rental residential capital	1.2	1.4	2.2	0.1	0.6
Inventories	2.7	3.5	2.1	2.6	-0.2
Land	0.8	1.2	0.5	0.3	1.2
<u>Private business</u>					
All assets	3.4	4.6	3.4	2.4	2.6
Equipment	4.5	6.4	4.9	3.2	2.6
Information processing equipment (IPE)	9.4	13.0	9.5	6.8	6.7
Computers & related equipment	15.3	28.1	14.4	6.1	6.4
Communication equipment	9.2	8.0	9.7	10.6	9.8
Other IPE	3.1	3.4	3.3	3.0	3.6
All other equipment	2.4	3.4	2.8	1.7	1.2
Structures	1.5	2.0	1.2	1.0	1.1
Intellectual property products (IPP)	6.0	7.5	5.4	4.7	6.2
Research and development	4.5	5.5	4.1	3.6	4.7
Software	10.4	14.0	8.1	7.2	9.4
Artistic originals	3.0	3.7	3.6	2.1	1.8
Rental residential capital	1.2	1.4	2.2	0.1	0.6
Inventories	2.6	3.4	2.1	2.4	-0.3
Land	0.7	0.9	0.5	0.1	1.1

Note: Real capital input by asset type are 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.