



## Data Units in FRED<sup>®</sup>

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### GLOSSARY

**Employed:** People 16 years and older who have jobs.

**Gross domestic product (GDP):** The total market value, expressed in dollars, of all final goods and services produced in an economy in a given year.

**Index:** A number used to represent the change in value of a magnitude (frequently a price level) between a base date and a different date. An index typically has a value of 100 on the base date.

**Inflation:** A general, sustained upward movement of prices for goods and services in an economy.

**Inflation rate:** The percentage increase in the average price level of goods and services over a period of time.

**Nominal value:** A monetary value measured in current prices.

**Real gross domestic product (GDP):** The total market value of all final goods and services produced in an economy in a given year calculated by using a base year's price for goods and services; nominal gross domestic product (GDP) adjusted for inflation.

**Real value:** A measure of money that removes the effect of inflation.

### Compelling Question

What units should we use to present the data?

### Description

FRED<sup>®</sup> (Federal Reserve Economic Data) provides access to data on a wide range of topics. Depending on the topic, a specific type of data unit can help tell the story behind the numbers. This article describes the range of data units available in FRED<sup>®</sup> to new data users and can serve as a reference to advanced data users.

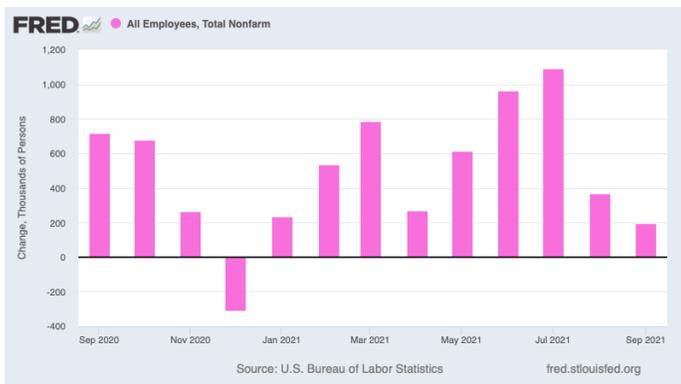
### Introduction

The data accessible through FRED<sup>®</sup> measures many different concepts—for example, the value of overall economic activity or the size of a country's population. FRED<sup>®</sup> presents the data produced by organizations and individuals “as is”—that is, exactly as provided by the source. This means that each data series is shown in the units reported by the source, whether it be millions of U.S. dollars or number of persons. However, FRED<sup>®</sup> users can select units for the data that help tell the story behind the numbers. This article provides a description of the choices of data units, their common use, and their interpretation. It also describes the steps for creating custom data transformations.

### Selecting Units

FRED<sup>®</sup> users can change the units of each data series from the default reported by the source.<sup>1</sup> By visiting [fred.stlouisfed.org](https://fred.stlouisfed.org) and navigating to any data series, users can click on “Edit Graph,” select “Edit Line 1,” and click on the “Units” drop-down menu to see the different options available. The FRED<sup>®</sup> website describes the formulas used to calculate each of those units in its Help webpages.<sup>2</sup> As the following examples illustrate, the story-telling purpose of a particular data visualization dictates the choice of units.

Figure 1  
Change in All Nonfarm Employees, Total

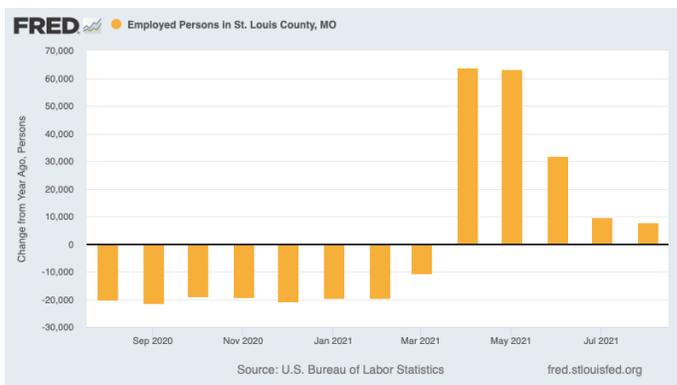


SOURCE: U.S. Bureau of Labor Statistics via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=lcxz>, accessed October 25, 2021.

**Change** is calculated as the value of the data in the current period minus their value in the previous period. When the U.S. Bureau of Labor Statistics (BLS) releases its monthly figures on the thousands of persons estimated to be employees on payrolls, news media outlets frequently highlight their change in value to describe their evolution. In the Figure 1 FRED® graph, the source-reported data units of “Thousands of Persons, Seasonally Adjusted” are displayed as “Change, Thousands of Persons.”<sup>3</sup>

Note that “Seasonally Adjusted” and its counterpart “Not Seasonally Adjusted” are types of data units calculated by the data source. Seasonal adjustment of data involves accounting for the predictable changes in their value brought about by the calendar year. For example, employment figures regularly peak during the last quarter of the year due to high retail sales activity.<sup>4</sup> The procedure to affect that seasonal adjustment is beyond the scope of this article.

Figure 2  
Change in Employed Persons from Year Ago in St. Louis County, MO

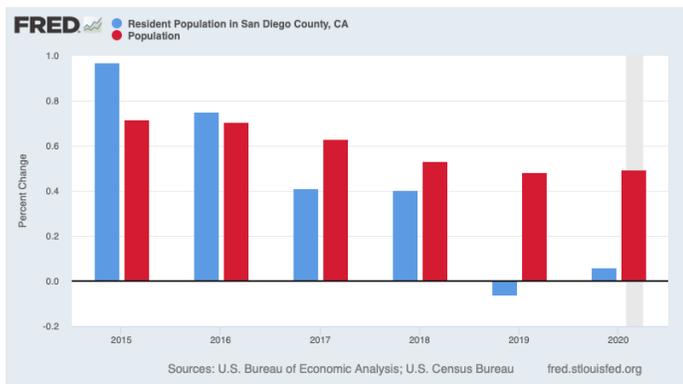


SOURCE: U.S. Bureau of Labor Statistics via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=lcxM>, accessed October 25, 2021.

**Change from Year Ago** is calculated as the value of the data in the current period minus their value from a past period, which could be 1 year, 4 quarters, 12 months, 52 weeks, or 365 days ago, depending on the frequency of the data. Because the BLS does not currently adjust its county-level employment figures for seasonal effects, their change from month to month will reflect seasonal patterns and can easily yield a distorted interpretation of the data. A more robust description of monthly changes in county-level employment can be achieved by changing the units to year-over-year values. In the Figure 2 FRED® graph, the source-reported data units of “Persons, Not Seasonally Adjusted” are displayed as “Change from Year Ago, Persons.”<sup>5</sup>

Notice that when calculating the change in the value of a series, from either the preceding period or a year ago, the value is not scaled by the magnitude of the series. That scaling, frequently presented in percent form, provides a helpful reference point for purposes of storytelling. We will discuss that unit choice next.

Figure 3  
Percent Change in San Diego County, CA, and U.S. Population



SOURCE: U.S. Bureau of Economic Analysis and U.S. Census Bureau via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=Gfyw>, accessed August 20, 2021.

**Percent Change** is calculated as the growth rate of the data between the current period and the previous period. It is expressed in hundredths and frequently followed by the symbol “%.” Because it is a rate, this unit type allows users to compare changes in data of different magnitudes. For example, we use percent changes to compare the ups and downs in the San Diego County, CA, population (which was 3.3 million people in 2020) with changes in the U.S. population (which was 330.1 million people that same year). In the Figure 3 FRED® graph, the source-reported data units of “Thousands of Persons, Not Seasonally Adjusted” are displayed as “Percent Change.”<sup>6</sup>

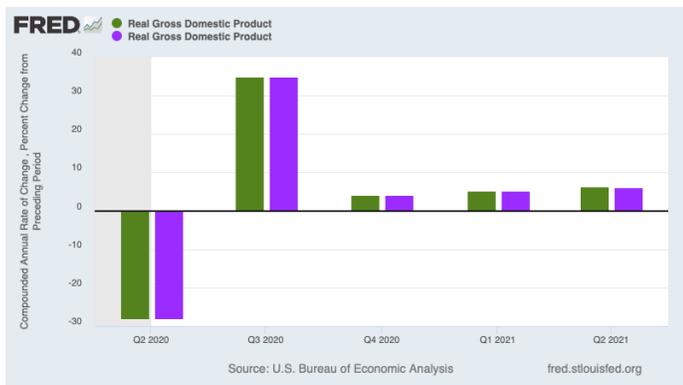
Figure 4  
Percent Change from Year Ago in Monthly Consumer Price Index: All Items in U.S. City Average



SOURCE: U.S. Bureau of Labor Statistics via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=lcxh>, accessed October 25, 2021.

**Percent Change from Year Ago** is calculated as the growth rate of the data between the current period and their value from a past period, which could be 1 year, 4 quarters, 12 months, 52 weeks, or 365 days ago, depending on the frequency of the data. When the BLS releases its monthly consumer price **index** (CPI) figures, news media outlets report their percent change in value from a year ago to describe the evolution of the **inflation rate**. In the Figure 4 FRED® graph, the source-reported data units of “Index 1982-1984=100, Seasonally Adjusted” are displayed as “Percent Change from Year Ago.” This type of unit also helps to describe the growth rate of data that are not seasonally adjusted: Because it represents their year-over-year percent change, it won’t reflect seasonal patterns likely to distort the interpretation of the data.<sup>7</sup>

Figure 5  
**Compounded Annual Rate of Change and Percent Change from Preceding Period in Gross Domestic Product**



SOURCE: U.S. Bureau of Economic Analysis via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=1cEjz>, accessed December 12, 2023.

**Compounded Annual Rate of Change** is calculated as an exponential growth rate, whether the interval period is 1 year, 4 quarters, 12 months, 52 weeks, or 365 days, depending on the frequency of the data. A compounded annual rate of change would make a figure grow from its beginning value to its ending value in a finite number of steps. This type of unit helps to describe data experiencing regular but unforeseeable fluctuations in value, and it facilitates comparison with other data reported with different frequencies.

For example, the U.S. Bureau of Economic Analysis (BEA) reports the value of **real gross domestic product (GDP)** four times, or quarterly, every year. It adjusts the value of real GDP to account for seasonal variations, but because some types of economic activity either peak or only take place during specific times of the year (e.g., purchases of school supplies in August or eggnog in December), the BEA also presents an annualized figure—that is, the value of real GDP that would be reached a year from now if overall economic activity were to keep its current pace for three more quarters.

However, describing the year-over-year growth rate of annualized real GDP figures by calculating a simple percent growth rate between quarters is misleading. Instead, a compounded annual rate of change accounts for the cumulative change in economic activity over time, allowing us to compare real GDP growth figures throughout the year. In the Figure 5 FRED® graph, the source-reported real GDP data units of “Billions of Chained 2017 Dollars,

Figure 6  
**Consumer Price Index and Personal Consumption Expenditures Price Index**



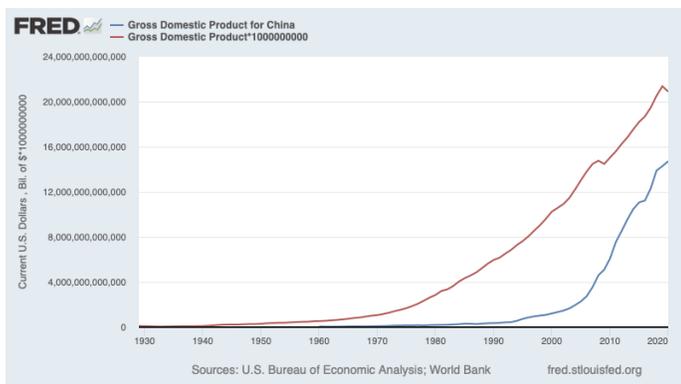
SOURCE: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=Gfzy>, accessed October 25, 2021.

Seasonally Adjusted Annual Rate” (in green) are presented as “Compounded Annual Rate of Change.” Next to it (in purple) is the source-reported “Percent Change from Preceding Period, Seasonally Adjusted Annual Rate” of real GDP. Both are effectively identical.

**Continuously Compounded Rate of Change** and **Continuously Compounded Annual Rate of Change** unit types are calculated as growth rates of an amount that compounds at a continuous rate, rather than at a step-by-step rate. The interest earned on a savings account balance is calculated using a compound formula, which also is the basis of the present-value calculation. Although FRED® allows users to present data in those units, applications of their use are beyond the scope of this article.

**Index (Scale value to 100 for chosen date)** is calculated by using the value of the data on a chosen date (also known as the base date) to rescale all data points in a series. On the base date, the index has a value of 100. This unit type allows users to compare the rates of change in data series of different magnitudes. For example, we use a custom index to compare the changes in two headline figures of consumer price **inflation**: the CPI and the personal consumption expenditures price index. Because the BLS uses 1982-1984 as the base date for the former and the BEA uses 2012 as the base date for the latter, it is easier to compare the change in their values by choosing a common base date. In the Figure 6 FRED® graph, the source-reported data units for both data series are displayed as “Index” with the same base date of February 2020.<sup>8</sup>

Figure 7  
Gross Domestic Product for China and the United States



SOURCE: U.S. Bureau of Economic Analysis and World Bank via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=G4Cj>, accessed August 12, 2021.

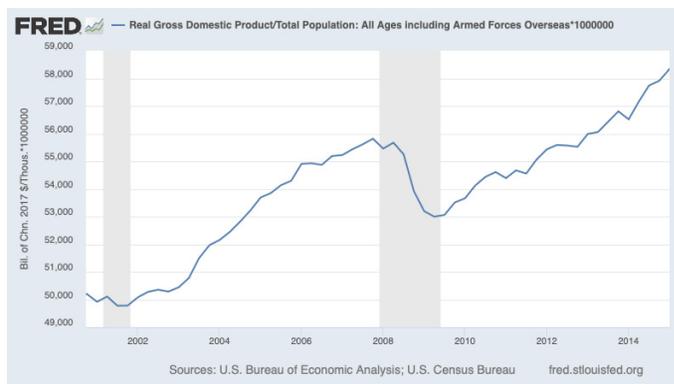
### Customizing Units

FRED® users can customize the units of data by applying formulas. This FRED® feature allows users to transform the data and create a new visualization.<sup>9</sup> The FRED® website describes the steps of that process in its Help webpages.<sup>10</sup>

For example, to change the order of magnitude of a data series, FRED® users can create a custom data transformation by applying a formula to a single series in a line. To transform billions of U.S. dollars into millions, click on “Edit Graph,” select “Edit Line,” type the formula “a\*10000,” and click on “Apply.”

In the Figure 7 FRED® graph, the World Bank reports China’s **gross domestic product (GDP)** in U.S. dollars, and the BEA reports U.S. GDP in billions of the same currency. You can easily see both series in the same graph by multiplying the data for the United States by 1,000,000,000. You can achieve the same end by dividing the data for China by 1,000,000,000.<sup>11</sup>

Figure 8  
Real U.S. Gross Domestic Product per Person

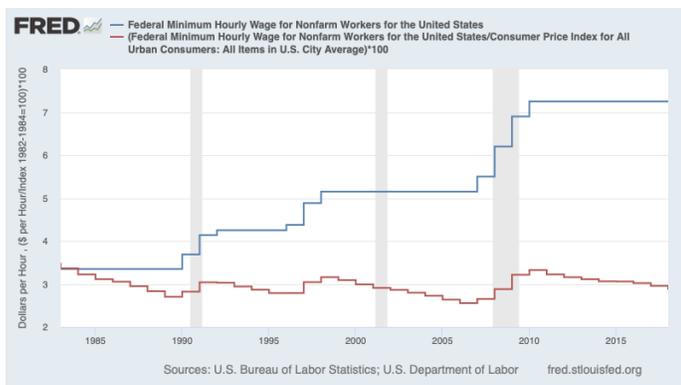


SOURCE: U.S. Bureau of Economic Analysis and U.S. Census Bureau via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=1cEkx>, accessed December 12, 2023.

Also, to change the units provided by the source of the data to per person or to inflation-adjusted units, FRED® users can create a custom data transformation by applying a formula to two series in a line. Those unit customizations require adding a new series (*series b*) to combine with an existing series (*series a*) and then applying a formula such as “a/b.”

In the Figure 8 FRED® graph, data on the **real value** of GDP reported by the BEA (*series a*) is divided by the population data reported by the U.S. Census Bureau (*series b*). This is called per person, or *per capita*, GDP. Because the Census Bureau reports population figures in thousands of persons and the BEA reports real GDP in billions of U.S. dollars, we use the formula “a/b\*1000000.”<sup>12</sup>

Figure 9  
**Nominal and Inflation-Adjusted Federal Minimum Hourly Wage for Nonfarm Workers for the United States**



SOURCE: U.S. Bureau of Labor Statistics and U.S. Department of Labor via FRED®, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/graph/?g=G4On>, accessed August 12, 2021.

Similarly, in the Figure 9 FRED® graph, data on the **nominal value** of the federal minimum hourly wage for nonfarm workers reported by the U.S. Department of Labor (in blue) is plotted along its real value (in red). To calculate the inflation-adjusted value of the minimum wage, its nominal value (*series a*) is divided by the CPI for all urban consumers (all items in a U.S. city average), reported by the U.S. Census Bureau (*series b*). Because the CPI is an index with a value of 100 on the base date, we use the formula “(a/b)\*100.”<sup>13</sup>

## Summary

Different data units can help tell the story behind the numbers in a data series. FRED® offers a range of data units to choose from and outlines the steps for creating customized data transformations. ■

## Additional Resources

Mendez-Carbajo, Diego. “Visualizing Data and the Online FRED Database.” *Journal of Economic Education*, 2015, 46(4), pp. 420-429; <https://doi.org/10.1080/00220485.2015.1071222>.

Perkis, David. “Data Literacy: Adjusting for Population.” Federal Reserve Bank of St. Louis, 2019; <https://www.stlouisfed.org/education/adjusting-for-population>.

## Notes

<sup>1</sup> See this short video for a brief introduction: <https://www.youtube.com/watch?v=1pPZhDZ1IpE>.

<sup>2</sup> See <https://fredhelp.stlouisfed.org/fred/data/understanding-the-data/formulas-calculate-growth-rates/>.

<sup>3</sup> For another example of Change data units, see <https://fredblog.stlouisfed.org/2020/07/when-initial-claims-unemployment-and-payroll-employment-clash/>.

<sup>4</sup> For a discussion of seasonal patterns in fruit prices related to harvest times, see <https://fredblog.stlouisfed.org/2020/08/seasonality-in-food-prices-a-bountiful-harvest-of-fred-data/>.

<sup>5</sup> For another example of Change from Year Ago data units, see <https://fredblog.stlouisfed.org/2019/04/a-closer-look-at-labor-in-the-u-s/>.

<sup>6</sup> For another example of Percent Change data units, see <https://fredblog.stlouisfed.org/2020/05/the-largest-changes-in-payroll-employment/>.

<sup>7</sup> For another example of Percent Change from Year Ago data units, see <https://fredblog.stlouisfed.org/2020/10/employment-losses-are-largest-for-the-least-educated/>.

<sup>8</sup> For another example of Index data units, see <https://fredblog.stlouisfed.org/2021/06/a-v-shaped-recovery/>.

<sup>9</sup> See this short video for a brief demonstration: <https://youtu.be/Fmml49xdU-U>.

<sup>10</sup> See <https://fredhelp.stlouisfed.org/uncategorized/data-transformation-add-series-to-existing-line/>.

<sup>11</sup> For another example of customized scale-adjusted data, see <https://fredblog.stlouisfed.org/2020/10/how-much-commuting-time-are-we-saving-by-working-from-home/>.

<sup>12</sup> For another example of customized population-adjusted data, see <https://fredblog.stlouisfed.org/2021/05/the-distribution-of-patents-across-u-s-states/>.

<sup>13</sup> For another example of customized inflation-adjusted data, see <https://fredblog.stlouisfed.org/2020/04/eating-out-or-staying-in-fred-says-bon-appetit/>.

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