Monetary Values over Time

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Overview

Real vs. nominal prices

- Consumer Price Index (CPI)
- Personal Consumption Expenditure (PCE) Index
- GDP Deflator
- Producer Price Index (PPI)

Growth rates

Real vs. Nominal Prices

Introductory Example

Time period 1

- Income = \$100
- Price of apples = \$5 and 4 apples are purchased
- Price of milk = \$10 and 8 gallons are purchased

Time period 2

- Income = \$120
- Price of apples = \$6 and 4 apples are purchased
- Price of milk = \$12 and 8 gallons are purchased

What about an income of \$110?

Index Numbers and Indices

Index number

- Single value assigned to several individual numbers in order to quantify trends

Index

- Series of index numbers used for tracking over time
- For economics: Important concept to differentiate nominal and real dollar values

Examples

- Consumer Price Index (CPI)
- Dow Jones or S&P 500

Consumer Price Index

Definition by the Bureau of Labor Statistics (BLS):

"*The Consumer Price Index (CPI) is a measure of the average change over time in the prices paid by urban consumers for a market basket of consumer goods and services.*"

Approximate weights in the market basket (about 80,000 items)

- Food and beverages (15%), housing (43%), apparel (4%), transportation (17%), medical care (6%), recreation (6%), education and communication (6%), and other goods and services (3%)

Tracking and reporting the price level

- Urban consumers represent about 87% of the U.S. population

Only real values matter!

Construction of the CPI

Constructing the CPI using a market basket (MB)

$$CPI_t = \frac{MB_t}{MB_b} \cdot 100$$

where MB_t and MB_b represent the market basket's cost in the year of interest t and the base year b, respectively. Example:

- $MB_t = \$71$ and $MB_b = \$68$ then $CPI = 71/68 \cdot 100 = 104.41$

Use of the CPI:

- Economic indicator and policy target
- Deflator of other economic series (i.e., translation from nominal to real prices)
- Means of adjusting dollar values (e.g., pensions)

CPI and Inflation

Problems with the CPI

- Substitution bias: consumers shift their purchases away from goods whose relative prices rise towards lower priced goods
- New technologies: when new, higher priced goods replace older goods
- Changes in Quality: failing to take into account of quality improvements that raise prices
- Growth in Discounting: with high prices, people switch to low-cost discount stores

The monthly inflation rate reported in the news is the percentage change in the price level over a 12 months period. The inflation rate can be calculated as follows:

$$\pi_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \cdot 100$$

Headline Inflation vs. Core Inflation

Food and energy prices are very volatile

- Bad weather and subsequent decline in crop yields
- Fluctuations in oil supply triggered by OPEC

Economists usually exclude those items which results in **core inflation**.

- The July 2023 figure of 3.3% represents **headline inflation** (i.e., including food and energy prices): CPI was 294.628 and 304.348 in July of 2022 and 2023, respectively
- Increase represents 3.3%

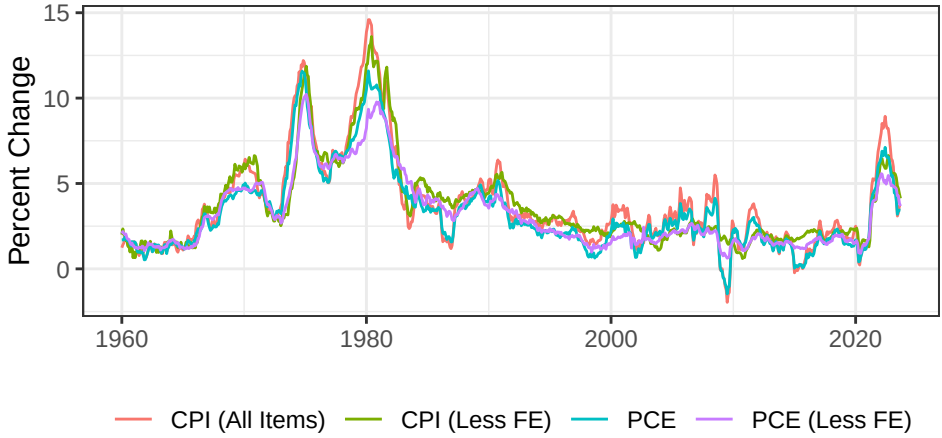
CPI source: Data

Personal Consumption Expenditure Index

Footnote of the Monetary Policy Report to the Congress (17 February 2000)

"The chain-type price index for PCE draws extensively on data from the consumer price index but, while not entirely free of measurement problems, has several advantages relative to the CPI. The PCE chain-type index is constructed from a formula that reflects the changing composition of spending and thereby avoids [. . .] fixed-weight nature of the CPI. In addition, the weights are based on a more comprehensive measure of expenditures. Finally, historical data used in the PCE price index can be revised to account for newly available information and for improvements in measurement techniques, including those that affect source data from the CPI; the result is a more consistent series over time."

Monthly CPI and PCE



Constant Dollar Calculations: Formula

Constant dollar calculation

$$CD_b = \frac{ND_t \cdot CPI_b}{CPI_t}$$

where

- CD_b: Constant dollar or real value
- ND_t: Nominal value in period t
- CPI_b: Consumer Price Index in the base period
- CPI_t: Consumer Price Index in period t

Constant Dollar Calculation: Example

Gasoline price in 1979 expressed in 2022 USD:

- May 1979: $ND_{1979} = 0.84$
- $CPI_{05/1979} = 71.4$ ($CPI = 100$ in 1982-1984)
- $CPI_{04/2022} = 288.663$
- $b = 04/2022$
- $t = 05/1979$

$$CD_{04/2022} = \frac{ND_{05/1979} \cdot CPI_{04/2022}}{CPI_{05/1979}} \Rightarrow \frac{0.84 \cdot 288.663}{71.4} = 3.40$$

BLS Calculator

Growth Rates

Decomposition of Growth Rates

Two components with respect to changes in dollar amounts:

- Real component: Change in the quantity of goods and services
- Inflation (price) component: Change in the prices of goods and services

Federal government national defense consumption expenditures and gross investment in nominal terms (FRED ID: FDEFX):

- 2010: \$827.971 billion
- 2019: \$847.830 billion
- 2020: \$882.443 billion

GDP Implicit Price Deflator (FRED ID: GDPDEF):

- 2010: 95.023
- 2019: 112.315
- 2020: 113.769

Price Increase

General percentage change formula:

$$\Delta\% = \frac{x_{t+1} - x_t}{x_t} \cdot 100 = \left(\frac{x_{t+1}}{x_t} - 1\right) \cdot 100$$

Let x_t and x_{t+1} be the deflator in 2019 and 2020, respectively. Thus, we have the following:

$$\Delta\% = \frac{x_{2020} - x_{2019}}{x_{2019}} \cdot 100 \Rightarrow \frac{113.769 - 112.315}{112.315} = 1.29\%$$

Nominal Spending Increase

Let x_t and x_{t+1} be the defense consumption expenditures and investments in 2010 and 2020, respectively. Thus, we have the following:

$$\Delta\% = \frac{x_{2020} - x_{2019}}{x_{2019}} \cdot 100 \Rightarrow \frac{882.443 - 847.830}{847.830} = 4.08\%$$

How much of 4.08% was real change and not inflation?

- Conversion of outlays into constant dollars

Real Spending Increase

Procedure ($ values in billion):

- 2020 outlays in 2020 dollars: $882.443
- 2019 outlays in 2020 dollars: $858.806

$$\frac{847.830 \cdot 113.769}{112.315} = 858.806$$

Real change of expenditures between 2019 and 2020:

$$\Delta\% = \frac{x_{2020} - x_{2019}}{x_{2019}} \cdot 100 \Rightarrow \frac{882.443 - 858.806}{858.806} = 2.75\%$$

For nominal growth (g), inflation (h), and real growth (m):

$$(1 + g) = (1 + h) \cdot (1 + m) \Rightarrow 1.0408 = 1.0275 \cdot 1.0129$$

Compound Growth Rates

National defense expenditures and investment between 2010 and 2020

- Nominal growth over entire period: 6.58%
- Real growth over entire period: -9.92%

Compound growth rate k (annual terms):

$$k = \left(\frac{x_1}{x_0}\right)^{1/N} - 1$$

where x_0 and x_1 represent the start and end value, respectively. N represents the number of periods.

$$\left[\frac{882.443}{827.971}^{1/10} - 1\right] \cdot 100 = 0.64\%$$