

GDP, Price Indexes, Inflation, and Real Output

This handout follows the complete classroom sequence: define the production boundary, account for expenditure and value added, construct a price index, and convert nominal output to real output.

Opening comparison

Year	Cheeseburger	Median hourly wage	Burgers per hour
1960	\$0.19	\$2.00	10.53
2024	\$2.49	\$28.47	11.43

Year	Home size	Median hourly wage	Years of work
1960	1,289 sq ft	\$2.00	2.87
2024	1,289 sq ft	\$28.47	5.04

Original Chapter 22 examples. House calculation uses median price per square foot and 2,080 paid hours per year. Each comparison is narrow and is not a complete cost-of-living index.

1 What GDP measures

GDP is the market value of final goods and services produced within a country's territory during a specified period.

- Current production, not the resale of an existing asset.
- Domestic territory, not ownership or citizenship.
- Final output; intermediate inputs are embodied in final value.
- Includes nonmarket government output and standard imputations.
- Unreported current production belongs conceptually but may be missed in measurement.

GDP measures production, not welfare.

2 Transaction boundary practice

Five boundary cases

Case	Treatment
New final bicycle	Current final production in C
Steel used by appliance maker	Intermediate; counted indirectly
Used car plus dealer margin	Car excluded; current margin counted
Existing stock plus broker commission	Asset excluded; current service counted
Current unreported landscaping	Conceptually included; may be omitted or estimated in measured GDP

3 Expenditure GDP and imports

$$Y = C + I + G + (X - M)$$

Expenditure components

Component	Meaning
C	Household consumption
I	New capital, residential construction, and inventory investment
G	Government purchases of goods and services, not transfers
X	Exports
M	Imports, subtracted to remove foreign production already included in C, I, or G

Practice 1

C = \$620, I = \$140, G = \$210, X = \$85, M = \$105 billion.

NX = _____ GDP = _____

4 Three views of the same production

Expenditure, income, and value added are three meters on the same flow. Statistical discrepancies arise because agencies assemble estimates from different source data.

Value-added example

Stage	Sales	Intermediate	Value added
Farmer	\$45	\$0	\$45
Grain Mill	\$110	\$45	\$65
Bakery	\$200	\$110	\$90
Total			\$200

5 Nominal, real, and revisions

Nominal GDP mixes price and quantity changes. Real GDP isolates quantity change using chain-type measures. BEA publishes three current quarterly vintages: advance near the end of month 1 after the quarter, second near the end of month 2, and third near the end of month 3.

GDP release sequence

Advance	Second	Third
About 1 month after quarter end	About 2 months after quarter end	About 3 months after quarter end

BEA GDP release—additional information; sequence verified September 13, 2026.

6 Price index and inflation

$$\text{Price index} = \frac{\text{current basket cost}}{\text{base basket cost}} \times 100$$

$$\text{Inflation rate} = \left(\frac{\text{new index}}{\text{old index}} - 1 \right) \times 100$$

A fixed basket is an introductory model, not the definition of every price index.

Default calculator example

Base cost	Current cost	Earlier index	Current index	Inflation
\$60	\$72	110	120	9.09%

- **Inflation:** price level rises.
- **Disinflation:** price level rises more slowly.
- **Deflation:** price level falls.

U.S. CPI-U, 2019 to the latest observation

Period	Index	Inflation calculation
2019	255.657	$(255.657 \div 251.107 - 1) \times 100 = 1.8\%$ 2018 annual average to 2019 annual average
2020	258.811	$(258.811 \div 255.657 - 1) \times 100 = 1.2\%$ annual average to annual average
2021	270.970	$(270.970 \div 258.811 - 1) \times 100 = 4.7\%$ annual average to annual average
2022	292.655	$(292.655 \div 270.970 - 1) \times 100 = 8.0\%$ annual average to annual average
2023	304.702	$(304.702 \div 292.655 - 1) \times 100 = 4.1\%$ annual average to annual average
2024	313.689	$(313.689 \div 304.702 - 1) \times 100 = 2.9\%$ annual average to annual average
2025	321.943	$(321.943 \div 313.689 - 1) \times 100 = 2.6\%$ annual average to annual average
August 2026	334.980	$(334.980 \div 323.976 - 1) \times 100 = 3.4\%$ August 2025 to August 2026

Rows through 2025 compare annual averages; August 2026 is the 12-month change from August 2025.

BLS CPI-U annual averages through 2025 and August 2026 release; calculations verified September 13, 2026.

7 Rule of 70

The Rule of 70 is a quick approximation: divide 70 by an annual growth rate (in percent) to estimate the years required for a quantity to double.

Approximate years to double

Annual growth rate	Years to double
1%	70.0 years
3%	23.3 years
5%	14.0 years
7%	10.0 years

Approximation: years to double $\approx 70 \div$ annual growth rate (percent).

8 Deflation and living standards

$$\text{Real GDP} = \frac{\text{nominal GDP}}{\text{price index} \div 100}$$

$$\text{Real GDP per capita} = \frac{\text{real GDP}}{\text{population}}$$

Real GDP is a flow measured in reference-year dollars. A quantity index is an index; real GDP is not reclassified as an index merely because chain-type methods underlie it.

Practice 2

Nominal GDP = \$30.40T, price index = 125.0, population = 342 million.

Real GDP = _____ Real GDP per capita = _____

Chained-dollar components generally do not add exactly because their weights change from period to period. The current-dollar identity remains exact.

9 Exit check

1. A used car is sold through a dealer earning a \$1,500 margin. What enters current GDP?
2. Distinguish a price-index level from inflation.
3. Why is nominal GDP growth not necessarily real growth?

Appendix - supplementary information

This material is outside the 75-minute lecture route.

Price indexes in the news

Index	What it measures
CPI-U	Prices paid by urban consumers
Core CPI	CPI-U excluding food and energy
PCE	Broader personal-consumption prices; headline PCE is the Federal Reserve's target index
Core PCE	PCE excluding food and energy
PPI	Selling prices received by domestic producers

Annualized values and rates

$$\begin{aligned}\text{Annualized value} &= V \times n \\ \text{Annualized rate} &= (1 + r)^n - 1\end{aligned}$$

Annualization examples

Period observation	Annualized result
\$7.5 trillion during one quarter	$\$7.5\text{T} \times 4 = \$30.0\text{T}$ annualized value
\$1.8 trillion during one month	$\$1.8\text{T} \times 12 = \$21.6\text{T}$ annualized value
0.5% quarterly growth	$(1.005^4 - 1) \times 100 = 2.02\%$ annualized rate
1.0% quarterly growth	$(1.01^4 - 1) \times 100 = 4.06\%$ annualized rate

Data and release claims verified September 13, 2026. Recheck BEA material after September 30, 2026 and CPI material after October 14, 2026.

Practice problems

All numerical values in this section are hypothetical.

1 Price index

In the base year, a market basket costs \$80. This year, the identical basket costs \$92. Calculate this year's price index, using the base year = 100.

Price index = _____

2 Inflation from the PCE price index

PCE price-index values

Year	PCE price index
2024	124.0
2025	127.1

Calculate the inflation rate from 2024 to 2025.

Inflation rate = _____

3 Real GDP

Nominal GDP is \$31.50 trillion and the price index is 126.0. Calculate real GDP in reference-year dollars.

Real GDP = _____

4 Annualized value

Production during one quarter is \$6.80 trillion. Calculate the annualized value.

Annualized value = _____

5 Annualized rate

Real GDP grows 0.75% in one quarter. Calculate the annualized growth rate.

Annualized growth rate = _____

6 Rule of 70

If real GDP grows 1.5% per year, approximately how many years will it take to double?

Years to double = _____

7 GDP transaction boundary

For each transaction, state whether it is included in current GDP and give one reason.

Transaction classification practice

Transaction	Included in current GDP? Why?
An investor buys existing shares of stock from another investor.	_____
A household takes out a loan from a bank.	_____
A barber provides a haircut this year.	_____
A household buys a newly produced refrigerator.	_____
A dealer resells a used car and earns a current service margin.	_____

Data for this lecture

Use FRED for a convenient chart and download interface. For GDP material, also consult the original BEA National Income and Product Accounts (NIPA) tables; FRED republishes, but does not replace, those source estimates.

GDP and real-output data

Measurement	FRED series	Original data
Nominal GDP	GDP	BEA NIPA Table 1.1.5, Gross Domestic Product
Real GDP	GDPC1	BEA NIPA Table 1.1.6, Real Gross Domestic Product
GDP price deflator	GDPDEF	BEA NIPA Table 1.1.9, Implicit Price Deflators for GDP
Real GDP per capita	A939RX0Q048SBEA	BEA NIPA Table 7.1, Selected Per Capita Product and Income Series

Price, wage, and housing data

Measurement	FRED series	Original data
CPI-U	CPIAUCSL	BLS CPI-U
PCE price index	PCEPI	BEA NIPA Table 2.3.4, Price Indexes for PCE
Manufacturing hourly earnings	CES3000000008	BLS Current Employment Statistics
House-price index	USSTHPI	FHFA House Price Index

Data links corrected September 19, 2026; classroom values retain their original vintage. Check units, seasonal adjustment, reference year, and release vintage before comparing series.