

# 2. Data and Empirics

Based on Mankiw, Chapter 2: *The Data of Macroeconomics*

**Attila Gyetvai** | University of Florida, Department of Economics

**Gross domestic product**

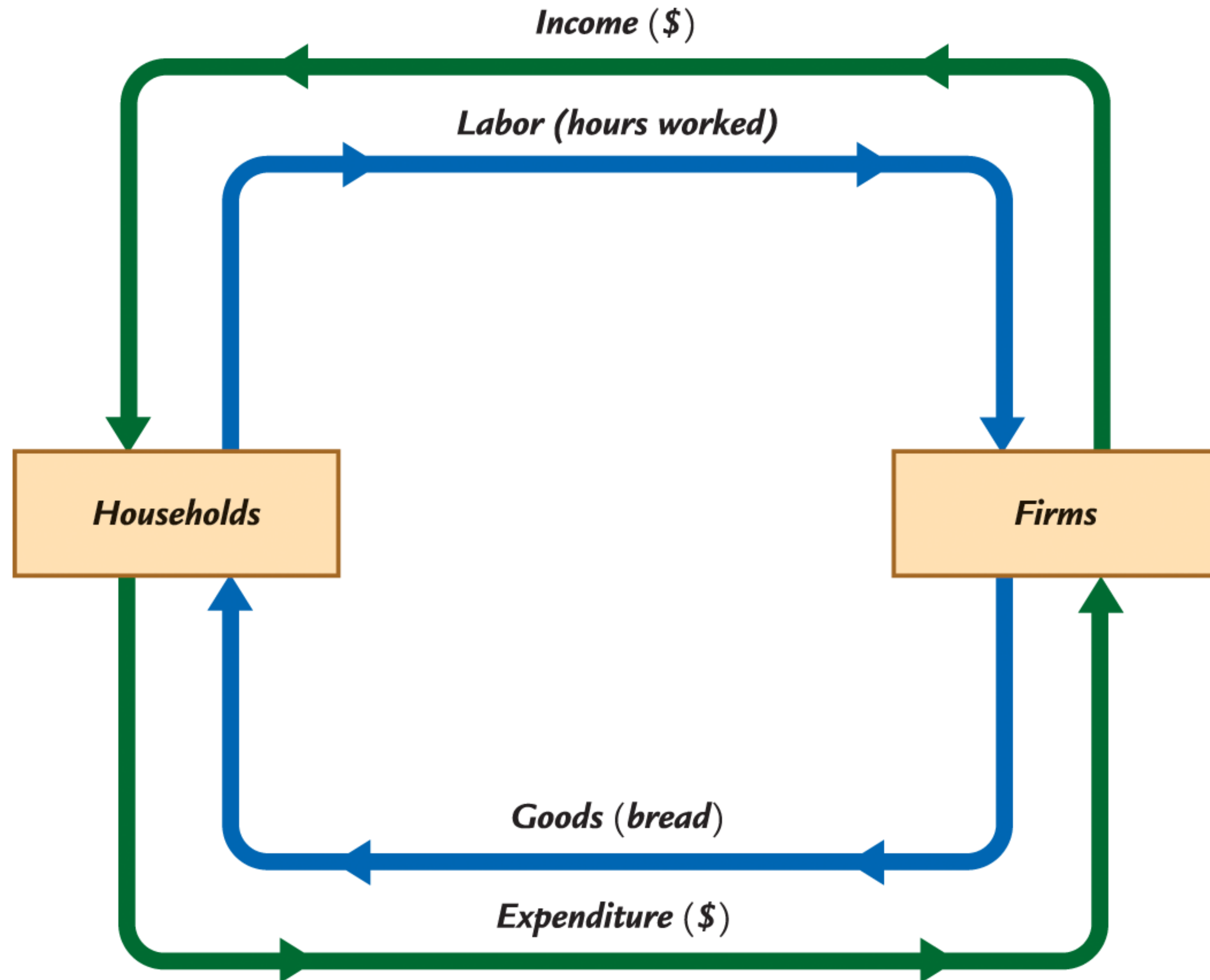
Inflation measures

Labor market statistics

# GDP: expenditure vs. income

- Two definitions:
  - Total expenditure on domestically produced final goods and services
  - Total income earned by domestically located factors of production
- Expenditure = income
  - Every dollar a buyer spends becomes income to the seller

# The circular flow



# Value added

- Value added = ...?

# Value added

- Value added = value of output — value of the intermediate goods
- It represents the increase in the value of a product at each production stage
- It measures the contribution of a specific activity to the overall economy
- VAT?

## NOW YOU TRY

- A farmer grows a bushel of wheat and sells it to a miller for \$1
- The miller turns the wheat into flour and sells it to a baker for \$3
- The baker uses the flour to bake bread and sells it to an engineer for \$6
- The engineer eats the bread
- Compute the value added at each stage of production and GDP

# Final goods, value added, and GDP

- GDP = value of final goods produced
- GDP = sum of value added at all stages of production
- Value of final goods  $\supset$  value of intermediate goods
  - Including intermediate and final goods in GDP would be double counting



# The expenditure components of GDP

- $C$ : consumption
- $I$ : investment
- $G$ : government spending
- $NX$ : net exports
- An important identity:

$$\underbrace{Y}_{\text{value of total output}} = \underbrace{C + I + G + NX}_{\text{aggregate expenditure}}$$

# Consumption, $C$

- The value of all goods and services bought by households
  - *Durable goods*: last a long time
    - E.g., cars, home appliances
  - *Nondurable goods*: last a short time
    - E.g., food, clothing
  - *Services*: intangible/non-physical items or activities
    - E.g., dry cleaning, air travel, concerts

# U.S. consumption, 2024

	Total (billions of dollars)	Per person (dollars)	Percent of GDP
Gross Domestic Product	29,179	85,795	100
Consumption	19,826	58,295	68
<i>Nondurable goods</i>	4,077	11,988	14
<i>Durable goods</i>	2,168	6,375	7
<i>Services</i>	13,582	39,935	47

# Investment, $I$

- Spending on capital, a physical asset used in future production
  - *Business fixed investment*: spending on plants and equipment
  - *Residential fixed investment*: spending on housing units
  - *Inventory investment*: the change in the value of all firms' inventories

# U.S. investment, 2024

	Total (billions of dollars)	Per person (dollars)	Percent of GDP
Gross Domestic Product	29,179	85,795	100
Investment	5,273	15,504	18
<i>Nonresidential fixed investment</i>	4,037	11,870	14
<i>Residential fixed investment</i>	1,186	3,487	4
<i>Inventory investment</i>	51	1,500	0

# Government spending, $G$

- Includes all government spending on goods and services, e.g.:
  - national defense
  - purchases of trains and installation of subway rail
  - services provided by park rangers to visitors of national parks
- Excludes transfer payments, e.g., unemployment insurance payments
  - Why? They do not represent spending on goods and services!

# U.S. government spending, 2024

	Total (billions of dollars)	Per person (dollars)	Percent of GDP
Gross Domestic Product	29,179	85,795	100
Gov. expenditures & investment	4,989	14,669	17
<i>Federal</i>	1,867	5,490	6
Defense	1,070	3,146	4
Nondefense	797	2,343	3
<i>State and local</i>	3,122	9,180	11

# Net exports, $NX$

- $NX = \text{exports} - \text{imports}$ 
  - Exports: the value of goods and services (g&s) sold to other countries
  - Imports: the value of g&s purchased from other countries
- Hence,  $NX$  equals net spending from abroad on our g&s
- Notice: the trade deficit ( $NX < 0$ ) does not reduce GDP
  - Instead, imports are subtracted to remove them from domestic spending



# U.S. net exports, 2024

	Total (billions of dollars)	Per person (dollars)	Percent of GDP
Gross Domestic Product	29,179	85,795	100
Net exports	−909	−2,673	−3
Exports	3,179	9,347	11
Imports	4,088	12,020	14

## NOW YOU TRY

- Suppose a firm produces \$10M worth of final goods today and puts all 10 million in inventory
- Then, tomorrow sells only \$9M worth
- Does this violate the expenditure = output identity?

# Why output = expenditure

- Unsold output goes into inventory and is counted as “inventory investment”
  - ... whether or not the inventory buildup was intentional
- In effect, we assume that firms purchase their unsold output

# An important and versatile concept

- We have now seen that GDP measures:
  - total income
  - total output
  - total expenditure
  - the sum of value added at all stages in the production of final goods

# GNP vs. GDP

- *Gross national product (GNP):*
  - total income earned by the nation's factors of production, regardless of where located
- *Gross domestic product (GDP):*
  - total income earned by domestically located factors of production, regardless of nationality
- $\text{GNP} - \text{GDP} = \text{factor payments from abroad} - \text{factor payments to abroad}$
- Examples of factor payments:
  - wages, rent
  - profits
  - interest and dividends on assets

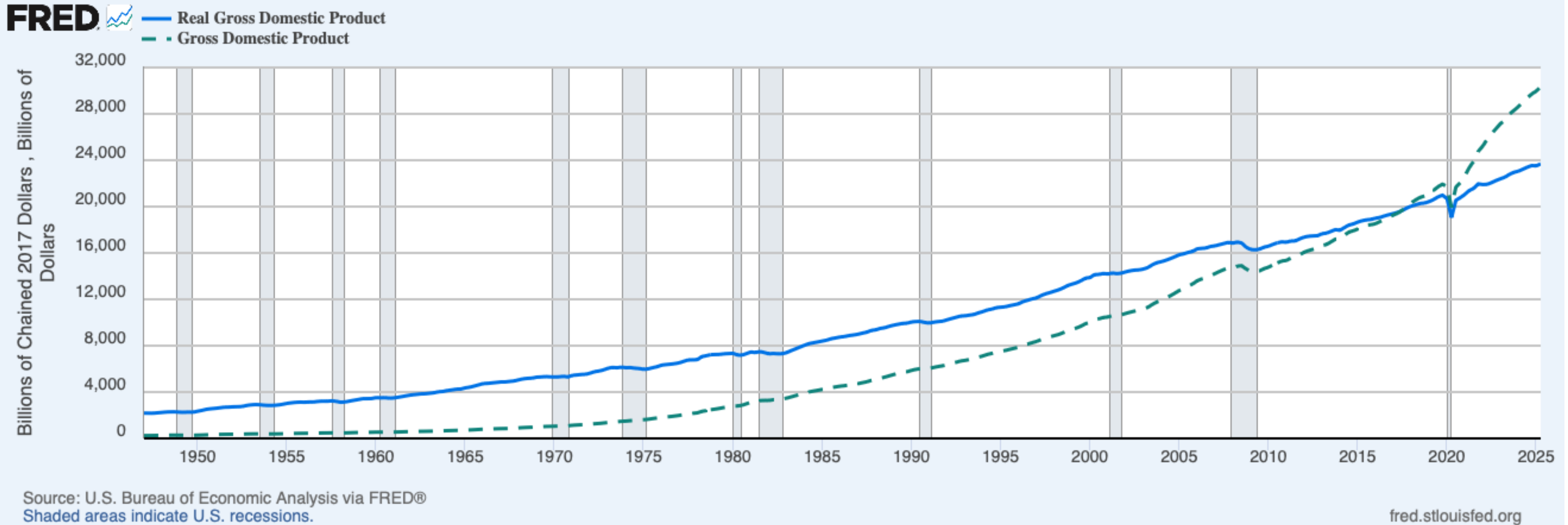
# Real vs. nominal GDP

- GDP is the value of all final goods and services produced
- Nominal GDP measures these values using current prices
- Real GDP measures these values using the prices of a base year

# Real GDP controls for inflation

- Changes in nominal GDP can be due to:
  - changes in prices
  - changes in quantities of output produced
- Changes in real GDP can only be due to changes in quantities
  - Why? Real GDP is constructed using constant base-year prices

# U.S. nominal and real GDP





Gross domestic product  
**Inflation measures**  
Labor market statistics

# GDP deflator

- Inflation rate: the percentage increase in the overall level of prices
- One measure of the price level: GDP deflator
- Definition:

$$\text{GDP deflator} = 100 \times \frac{\text{nominal GDP}}{\text{real GDP}}$$

# Understanding the GDP deflator

1 of 2

- Example with three goods
- For good  $i = 1, 2, 3$ :
  - $P_{it}$ : the market price of good  $i$  in period  $t$
  - $Q_{it}$ : the quantity of good  $i$  produced in period  $t$
- $\text{NGDP}_t$ : nominal GDP in period  $t$
- $\text{RGDP}_t$ : real GDP in period  $t$

# Understanding the GDP deflator

2 of 2

$$\begin{aligned}\text{GDP deflator}_t &= \frac{\text{NGDP}_t}{\text{RGDP}_t} = \frac{P_{1t}Q_{1t} + P_{2t}Q_{2t} + P_{3t}Q_{3t}}{\text{RGDP}_t} \\ &= \left( \frac{Q_{1t}}{\text{RGDP}_t} \right) P_{1t} + \left( \frac{Q_{2t}}{\text{RGDP}_t} \right) P_{2t} + \left( \frac{Q_{3t}}{\text{RGDP}_t} \right) P_{3t}\end{aligned}$$

- The GDP deflator is a weighted sum of prices
- The weight on each price reflects that good's relative importance in GDP
- Note that the weights *change* over time

# Consumer price index (CPI)

- A measure of the overall level of prices
- Published by the Bureau of Labor Statistics (BLS)
- Uses of CPI:
  - tracking changes in the typical household's cost of living
  - adjusting many contracts for inflation ("COLAs")
  - allowing comparisons of dollar amounts over time

# How the BLS constructs the CPI

- It determines the composition of the typical consumer's "basket" of goods
  - Extensive BLS surveys
- It tracks the prices of all items in the basket and computes the total cost
- CPI in a given month equals

$$100 \times \frac{\text{cost of basket in that month}}{\text{cost of basket in base period}}$$

# NOW YOU TRY

- Basket: 20 pizzas, 10 records
- Prices:

	Pizza	Records
2020	10	15
2021	11	15
2022	12	16
2023	13	15

For each year, compute:

- the cost of the basket
- the CPI (using 2020 as the base year)
- the inflation rate from the preceding year

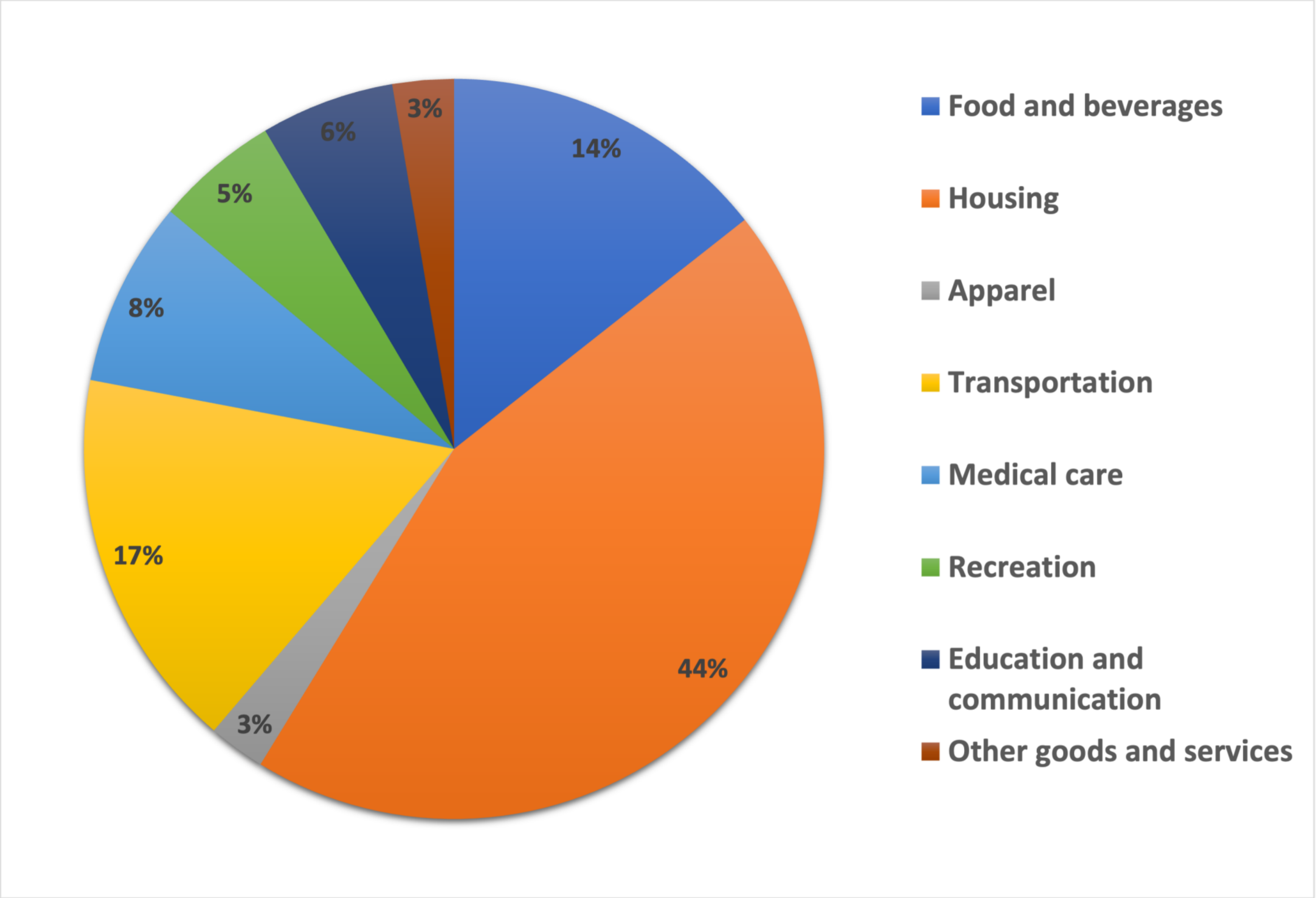
# NOW YOU TRY

Answer

	Cost of Basket	CPI	Inflation Rate
2020	350	100	n.a.
2021	370	105.7	5.7%
2022	400	114.3	8.1%
2023	410	117.1	2.5%



# CPI basket composition



# Understanding the CPI

1 of 2

- Example with three goods
- For good  $i = 1, 2, 3$ :
  - $P_{it}$ : the market price of good  $i$  in period  $t$
  - $C_i$ : amount of good  $i$  in the CPI's basket
- $E_t$ : cost of the CPI basket in month  $t$
- $E_b$ : cost of the basket in the base period

# Understanding the CPI

2 of 2

$$\begin{aligned}\text{CPI}_t &= \frac{E_t}{E_b} = \frac{P_{1t}C_1 + P_{2t}C_2 + P_{3t}C_3}{E_b} \\ &= \left(\frac{C_1}{E_b}\right)P_{1t} + \left(\frac{C_2}{E_b}\right)P_{2t} + \left(\frac{C_3}{E_b}\right)P_{3t}\end{aligned}$$

- The CPI is a weighted sum of prices
- The weight on each price reflects that good's relative importance in the CPI's basket
- Note that the weights *remain fixed* over time

# The CPI may overstate inflation

1 of 2

- *Substitution bias*
  - Fixed weights  $\Rightarrow$  doesn't reflect substitution toward goods with lower relative prices
- *Introduction of new goods*
  - New goods make consumers better off and, in effect, increase the real value of the dollar
  - ... but it does not reduce the CPI because it uses fixed weights
- *Unmeasured changes in quality*
  - Quality improvements increase the value of the dollar but are often not fully measured

# The CPI may overstate inflation

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- How large is this measurement bias?
  - 1995: between 1.1–1.3 percent per year
  - The BLS therefore made adjustments to reduce the bias
  - Now, the CPI's bias is presumably under 1 percent per year but remains significant

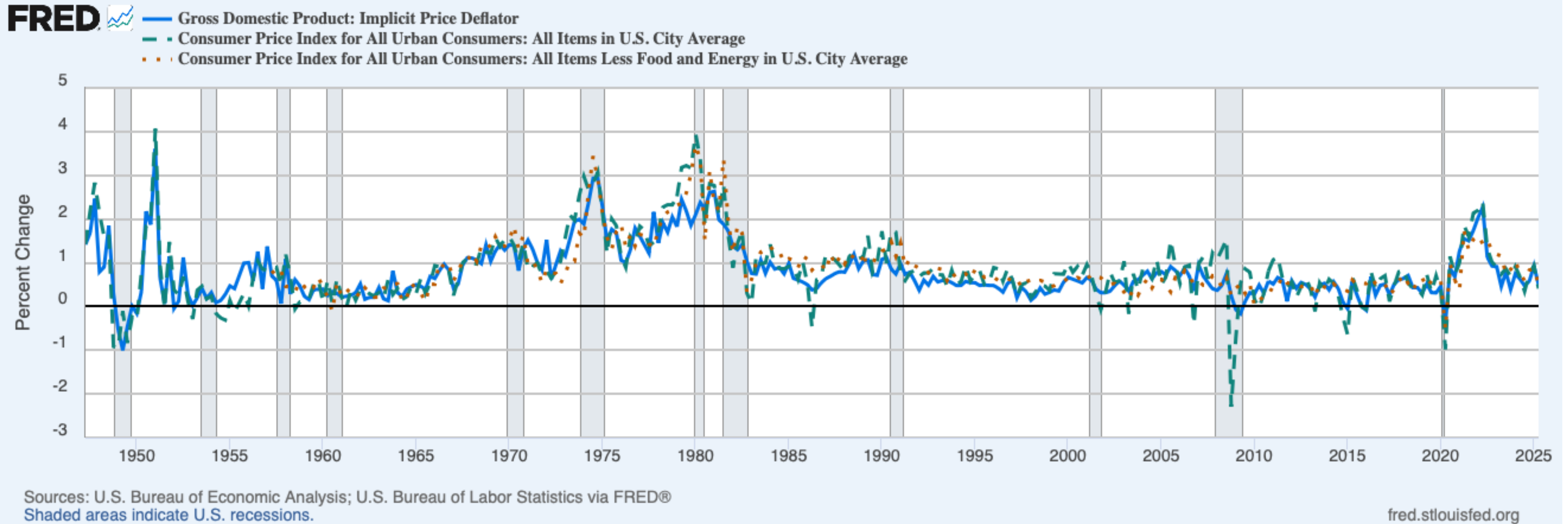
# CPI versus GDP deflator

- Prices of capital goods:
  - included in GDP deflator (if produced domestically)
  - excluded from CPI
- Prices of imported consumer goods:
  - excluded from GDP deflator
  - included in CPI
- The basket of goods:
  - changes every year for the GDP deflator
  - fixed for the CPI

# Core inflation

- Another measure of inflation that excludes food and energy prices
- Food and energy prices are volatile in the short-run
- Often viewed as a better gauge of underlying inflation trends

# GDP deflator, CPI, core inflation





## NOW YOU TRY

- If your grandmother receives social security benefits, how is she affected by the CPI's bias?
- Where does the government get the money to pay cost of living adjustments to social security recipients?
- If you pay income and social security taxes, how does the CPI's bias affect you?
- How does your grandmother's "basket" differ from the CPI's?

Gross domestic product  
Inflation measures  
**Labor market statistics**

# Categories of the population

- *Employed,  $E$* 
  - working at a paid job
- *Unemployed,  $U$* 
  - not employed but looking for a job
- *Labor force,  $LF$* 
  - the amount of labor available for producing goods and services
  - all employed plus unemployed persons
- *Not in the labor force,  $NILF$* 
  - not employed, not looking for work

# Two important labor force concepts

- *Unemployment rate,  $UR$* 
  - percentage of the labor force that is unemployed
  - $UR = \dots?$
- *Labor force participation rate,  $LFPR$* 
  - fraction of the adult population that “participates” in the labor force
  - ... i.e., is working or looking for work
  - $LFPR = \dots?$

# Two important labor force concepts

- *Unemployment rate, UR*

- percentage of the labor force that is unemployed

- $$UR = \frac{U}{LF} = \frac{U}{E + U}$$

- *Labor force participation rate, LFPR*

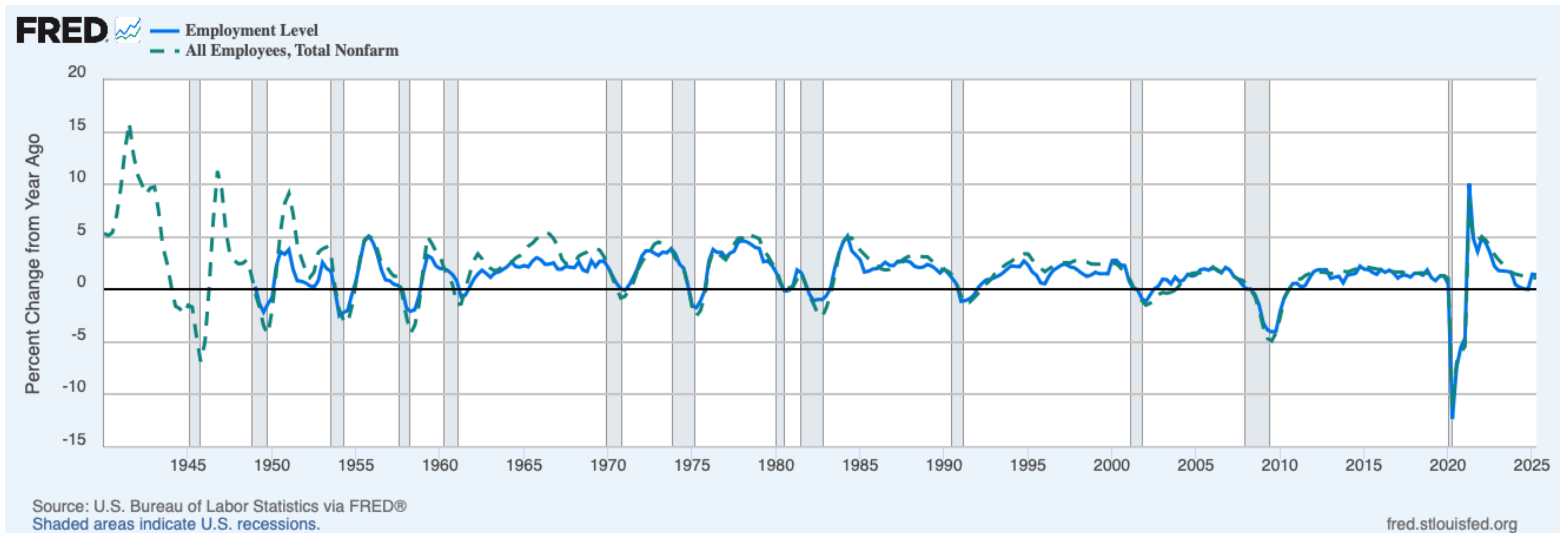
- fraction of the adult population that “participates” in the labor force
- ... i.e., is working or looking for work

- $$LFPR = \frac{LF}{LF + NILF} = \frac{E + U}{E + U + NILF}$$

# Measuring labor market movements

- Bureau of Labor Statistics (BLS)
- Two monthly surveys:
  - Household survey (Current Population Survey, CPS)
    - Smaller sample size, but more expansive scope
    - Includes self-employed, unpaid family workers, agricultural workers + demographic info
  - Establishment survey (Current Employment Statistics, CES)
    - Larger sample size
- Timeliness vs. accuracy
- Numbers are compiled automatically from survey responses

# Labor market movements in the US



# Revisions

- Revisions happen twice, in the two months following initial publication
- Benchmark revision happens annually from tax records
- Why do revisions happen?
  - Late responders
  - Falling response rates → more statistical assumptions
  - Changing labor markets (gig work, immigration, ...)



# A high profile revision

- July 2025 revision of May/June 2025 numbers
  - May: +144K to +19K    June: +147K to +14K
  - Total: +291K to +33K (difference of 258K)
  - 45% (116K) from state and local government employment

# CHAPTER SUMMARY

1 of 2

- Gross domestic product (GDP) measures both total income and total expenditure on the economy's output of goods and services
- Nominal GDP values output at current prices; real GDP values output at constant prices
- Changes in output affect both measures, but changes in prices affect only nominal GDP
- GDP is the sum of consumption, investment, government purchases, and net exports

# CHAPTER SUMMARY

2 of 2

- The overall level of prices can be measured by either:
  - the GDP deflator, the ratio of nominal to real GDP
  - the consumer price index (CPI), the price of a fixed basket of goods purchased by the typical consumer, or
- The unemployment rate is the fraction of the labor force that is not employed