2. Data and Empirics

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

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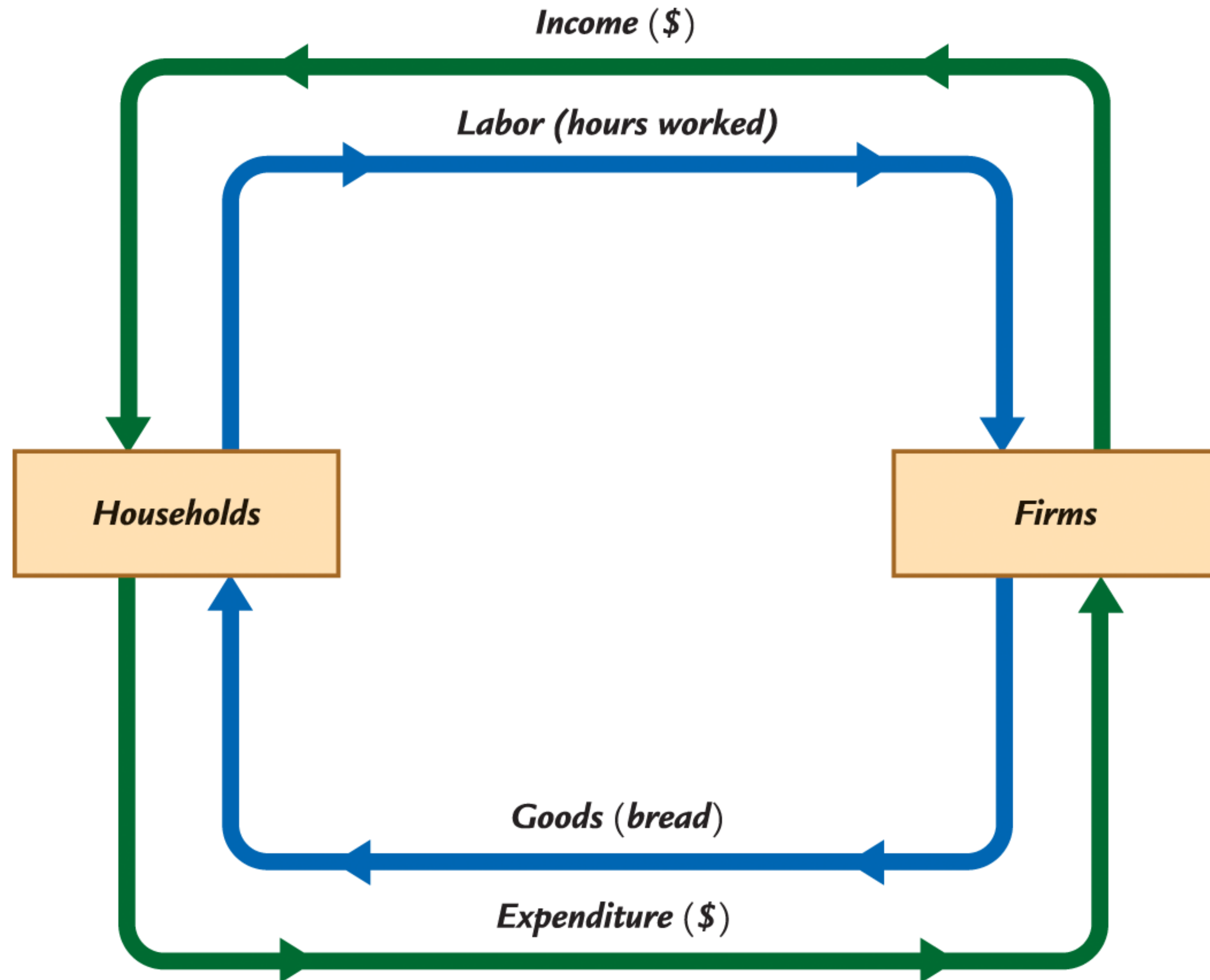# Gross domestic product
Inflation measures
Labor market statistics

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 ⊃ 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
Nondurable goods	4,077	11,988	14
Durable goods	2,168	6,375	7
Services	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*: sending 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
Nonresidential fixed investment	4,037	11,870	14
Residential fixed investment	1,186	3,487	4
Inventory investment	51	1,500	0

Source: BEA (https://www.bea.gov/sites/default/files/2025-01/gdp4q24-adv.pdf), Census Bureau, own calculations

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
Federal	1,867	5,490	6
Defense	1,070	3,146	4
Nondefense	797	2,343	3
State and local	3,122	9,180	11

Source: BEA (https://www.bea.gov/sites/default/files/2025-01/gdp4q24-adv.pdf), Census Bureau, own calculations

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

- GNP − GDP = factor payments from abroad − factor payments to abroad

- Examples of factor payments:

  - wages, rent

  - profits

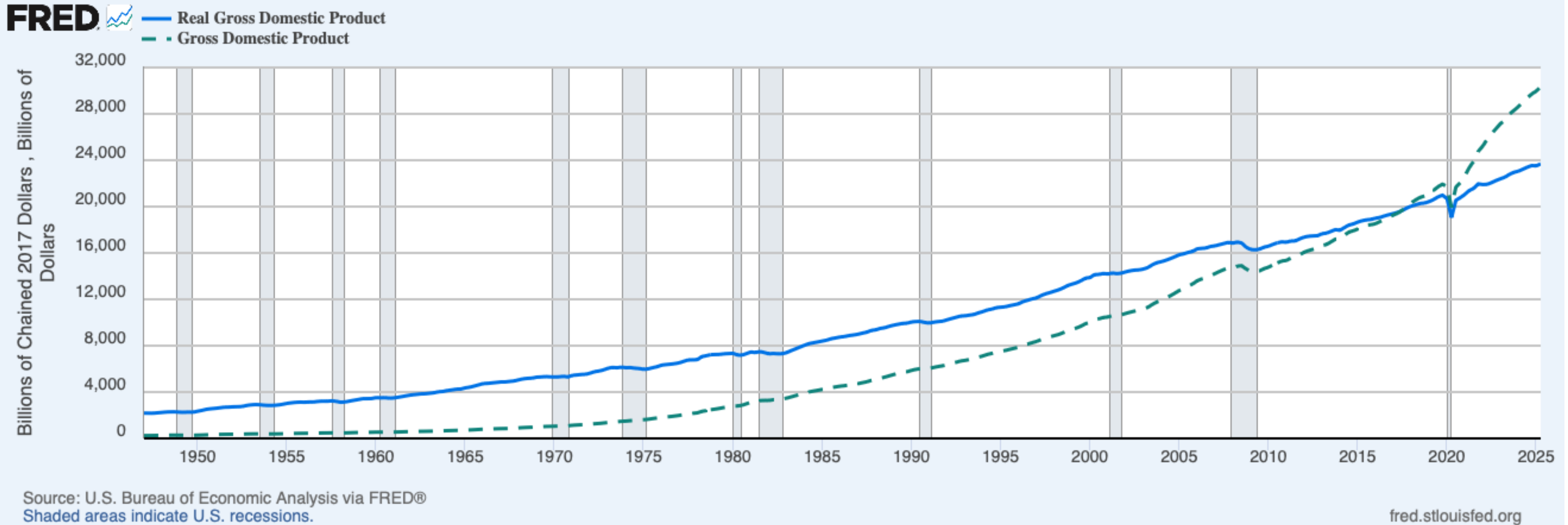 - interest and dividends on assets

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

FRED
— Real Gross Domestic Product
--- Gross Domestic Product

Source: U.S. Bureau of Economic Analysis via FRED®
Shaded areas indicate U.S. recessions.

fred.stlouisfed.org

Gross domestic product
Inflation measures
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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

- 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

- NGDP_t: nominal GDP in period t

- RGDP_t: real GDP in period t

Understanding the GDP deflator

$$\text{GDP deflator}_t = \frac{\text{NGDP}_t}{\text{RGDP}_t} = \frac{P_{1t}Q_{1t} + P_{2t}Q_{2t} + P_{3t}Q_{3t}}{\text{RGDP}_t}$$

$$= \left(\frac{Q_{1t}}{\text{RGDP}_t} \right) P_{1t} + \left(\frac{Q_{2t}}{\text{RGDP}_t} \right) P_{2t} + \left(\frac{Q_{3t}}{\text{RGDP}_t} \right) P_{3t}$$

- 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:

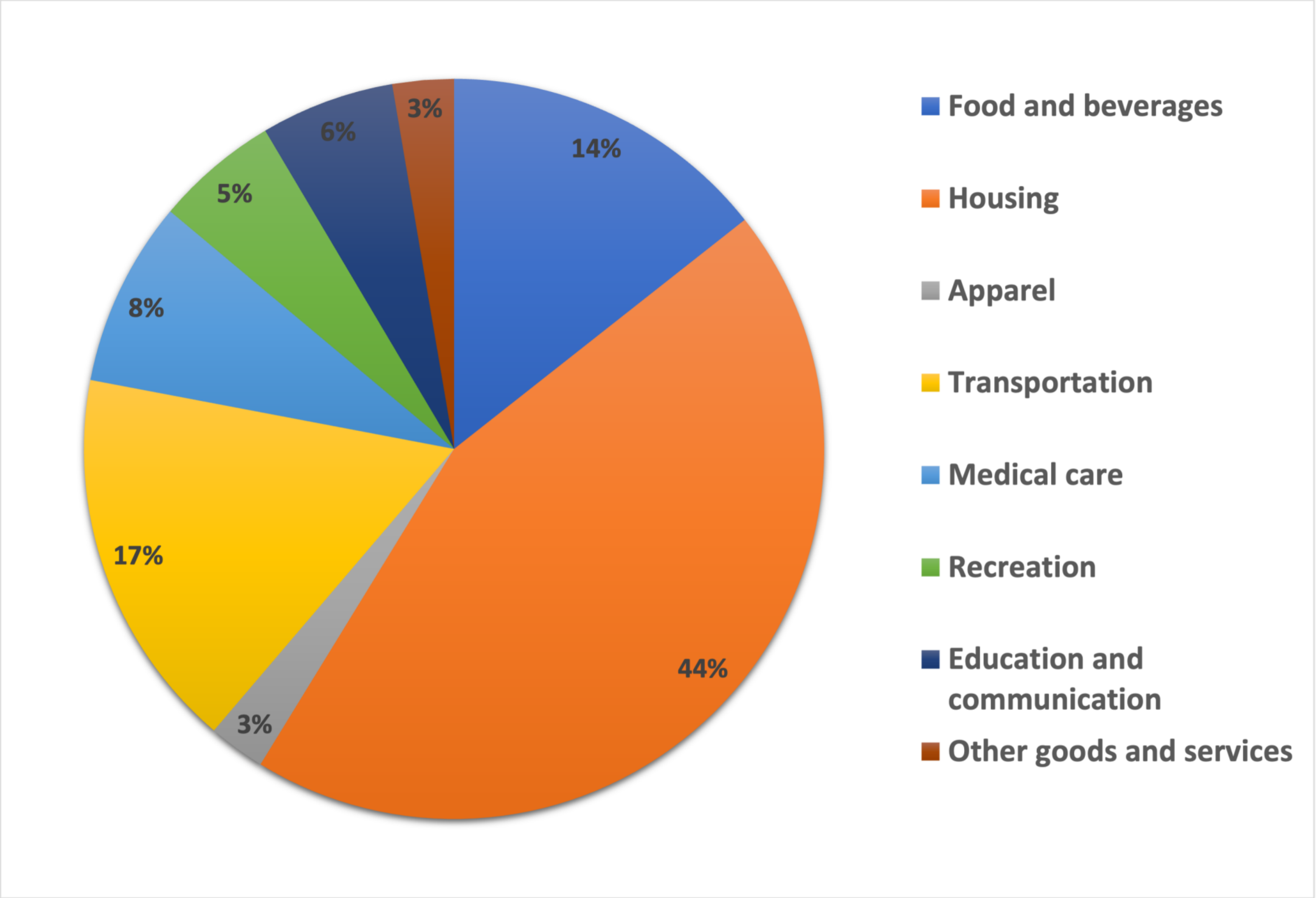|	Pizza	Records
2020	10	15
2021	11	15
2022	12	16
2023	13	15

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

- 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

$$\text{CPI}_t = \frac{E_t}{E_b} = \frac{P_{1t}C_1 + P_{2t}C_2 + P_{3t}C_3}{E_b}$$

$$= \left(\frac{C_1}{E_b}\right)P_{1t} + \left(\frac{C_2}{E_b}\right)P_{2t} + \left(\frac{C_3}{E_b}\right)P_{3t}$$

- 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

- *Substitution bias*

  - Fixed weights ⇒ 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

- 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
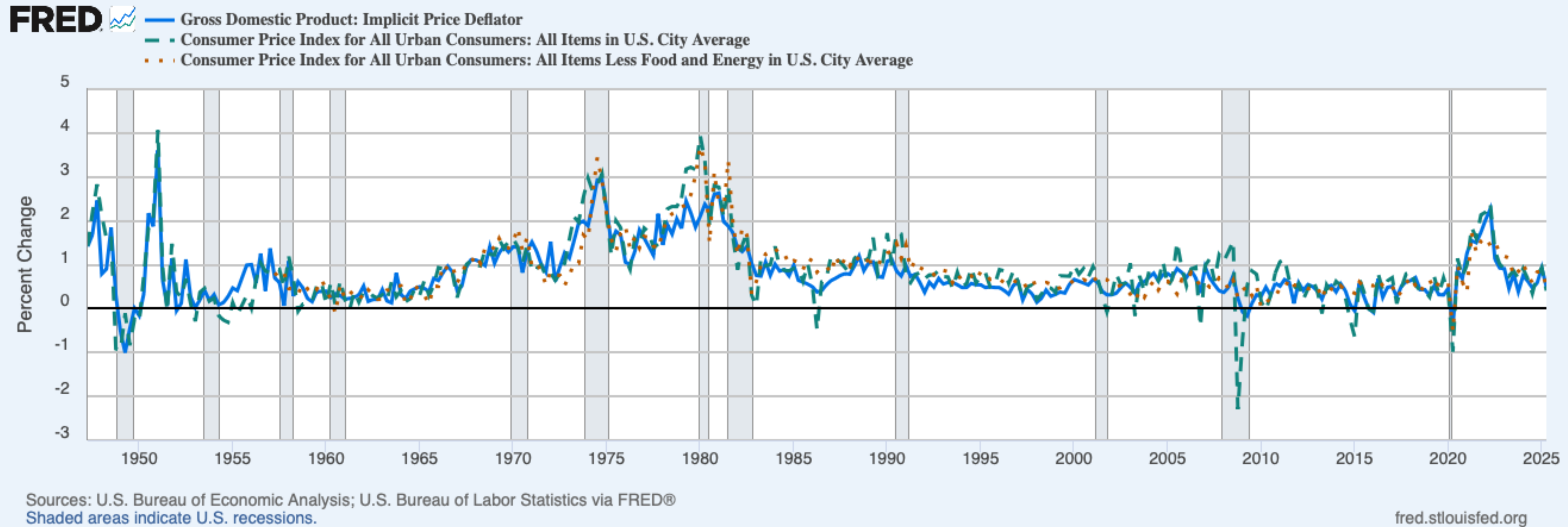
CPI versus GDP deflator

- 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

Legend:
- Gross Domestic Product: Implicit Price Deflator
- Consumer Price Index for All Urban Consumers: All Items in U.S. City Average
- Consumer Price Index for All Urban Consumers: All Items Less Food and Energy in U.S. City Average

Sources: U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics via FRED®
Shaded areas indicate U.S. recessions.

fred.stlouisfed.org

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

  - $UR = ...?$

- *Labor force participation rate, $LFPR$*

  - fraction of the adult population that "participates" in the labor force

  - … i.e., is working or looking for work

  - $LFPR = ...?$

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, $LFPR$*
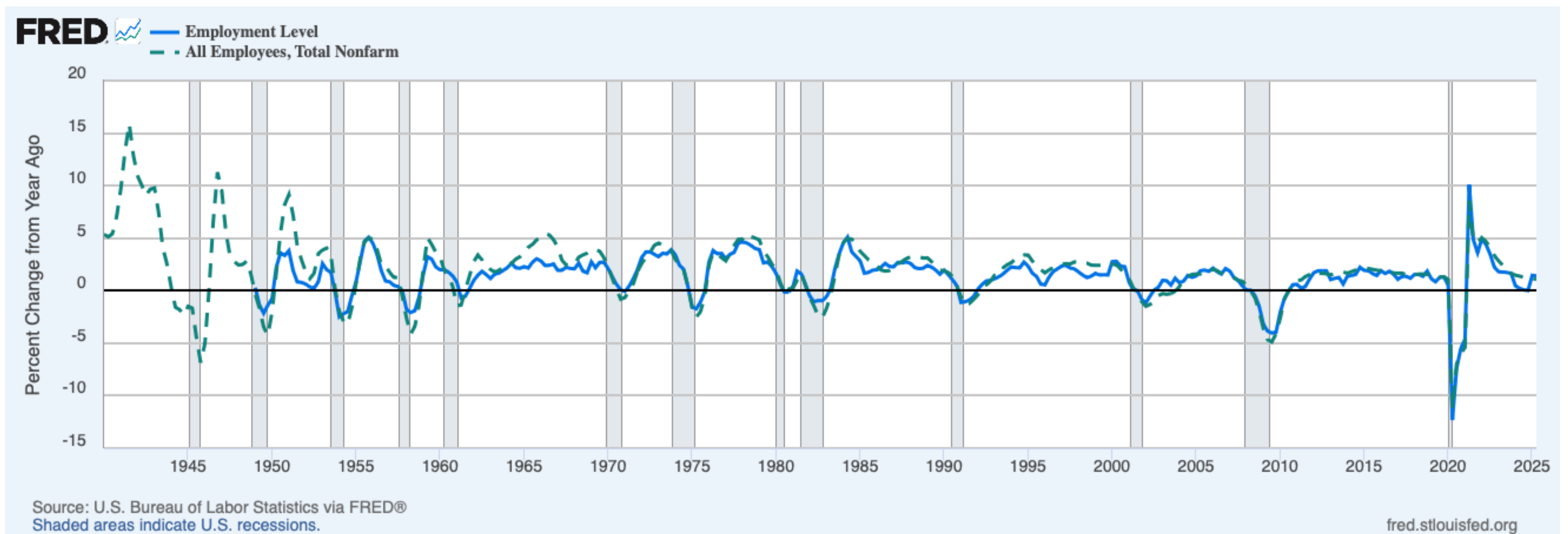
  - fraction of the adult population that "participates" in the labor force

  - … 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

- 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

- 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