2. Data and Empirics

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

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Gross domestic product

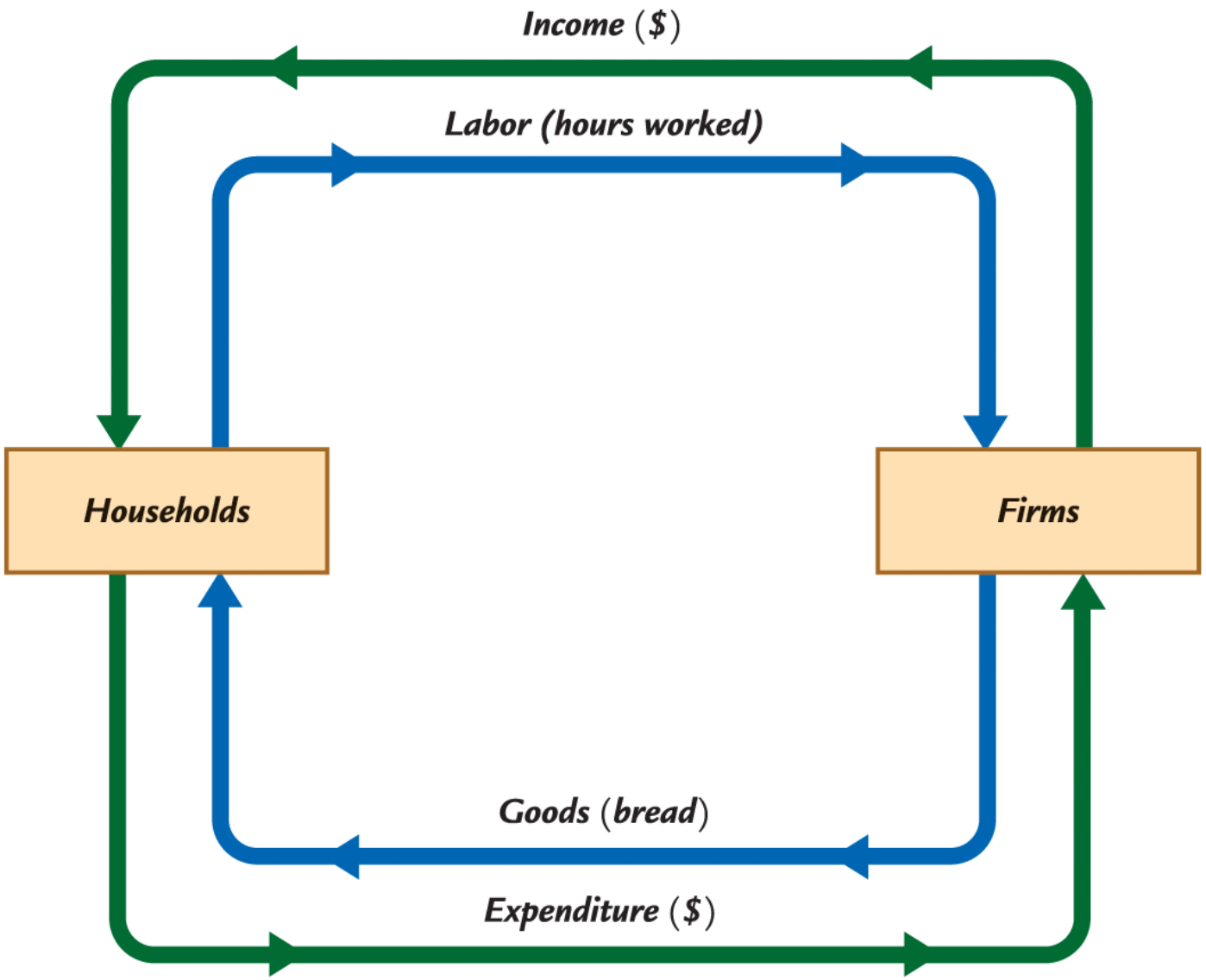
Gross domestic product: Expenditure and income

Two definitions:

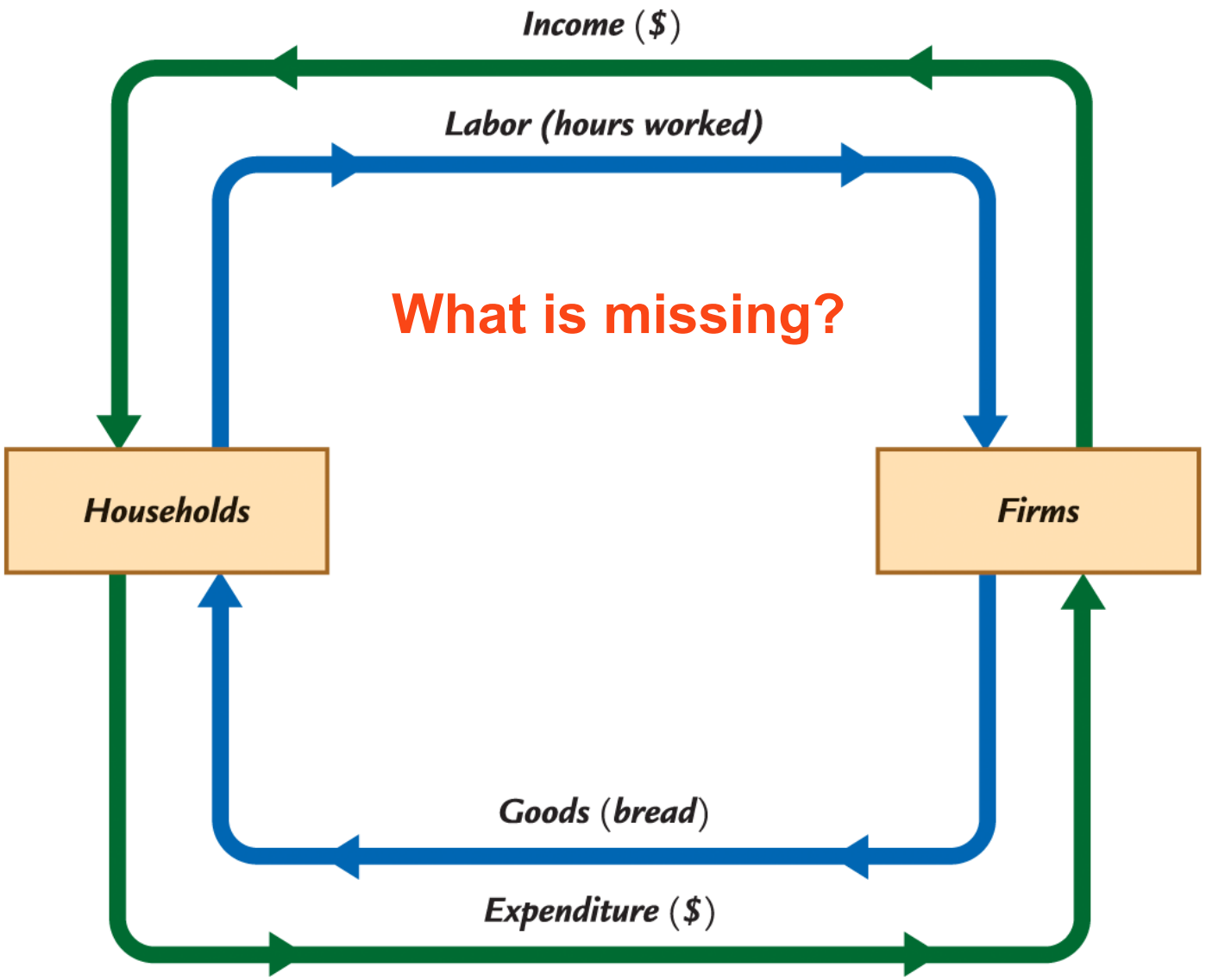
- Total expenditure on domestically produced final goods and services
- Total income earned by domestically located factors of production

Expenditure equals income because every dollar a buyer spends becomes income to the seller.

The circular flow



The circular flow



Value added

Value added is…

Value added

Value added is the value of output minus the value of the intermediate goods used to produce that output.

It represents the increase in the value of a product or service at each stage of the production process.

It measures the contribution of a specific economic activity or sector to the overall economy.

VAT?

NOW YOU TRY

Identifying value added

- A farmer grows a bushel of wheat and sells it to a miller for $1.00.
- The miller turns the wheat into flour and sells it to a baker for $3.00.
- The baker uses the flour to make a loaf of bread and sells it to an engineer for $6.00.
- 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
  = sum of value added at all stages of production
- The value of the final goods already includes the value of the intermediate goods, so including intermediate *and* final goods in GDP would be double counting.

The expenditure components of GDP

- consumption, ***C***
- investment, ***I***
- government spending, ***G***
- net exports, ***NX***

An important identity:

$$Y = C + I + G + NX$$

value of total output

aggregate expenditure

Consumption (*C*)

Definition: The value of all goods and services bought by households, including:

- ***Durable goods***
  last a long time.
  Examples: cars, home appliances
- ***Nondurable goods***
  last a short time.
  Examples: food, clothing
- ***Services***
  are intangible/non-physical items or activities, purchased by consumers.
  Examples: dry cleaning, air travel, concerts

U.S. consumption, 2022

	Total (billions of dollars)	Per Person (dollars)
Gross Domestic Product	25,461	76,324
Consumption	17,363	52,047
Nondurable goods	3,757	11,261
Durable goods	2,186	6,552
Services	11,420	34,234

Investment (*I*)

- Spending on capital, a physical asset used in future production
- Includes:
  - **Business fixed investment**—Spending on plant and equipment
  - **Residential fixed investment**—Spending by consumers and landlords on housing units
  - **Inventory investment**—The change in the value of all firms' inventories

U.S. investment, 2022

	Total (billions of dollars)	Per Person (dollars)
Gross Domestic Product	25,461	76,324
Investment	4,625	13,864
Nonresidential fixed investment	3,340	10,012
Residential fixed investment	1,127	3,377
Inventory investment	159	475

Government Spending (*G*)

- ***G*** includes all government spending on goods and services.
  - National defense
  - Purchases of trains and installation of subway rail
  - Services provided by a Park Ranger to visitors of national parks
- ***G*** excludes transfer payments (e.g., unemployment insurance payments) because they do not represent spending on goods and services.

U.S. government spending, 2022

	Total (billions of dollars)	Per Person (dollars)
Gross Domestic Product	25,461	76,324
Government Purchases	4,446	13,328
Federal	1,647	4,936
Defense	925	2,773
Nondefense	722	2,163
State and local	2,800	8,392

Net Exports (*NX*)

- ***NX*** = exports – 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, 2022

	Total (billions of dollars)	Per Person (dollars)
Gross Domestic Product	25,461	76,324
Net Exports	–973	–2,916
Exports	2,981	8,935
Imports	3,953	11,851

NOW YOU TRY

An expenditure-output puzzle?

Suppose a firm:

- produces $10 million worth of final goods today and puts all 10 million in inventory.
- Then, tomorrow sells only $9 million 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 are assuming 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 versus 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
  minus factor payments to abroad
- Examples of factor payments: wages, profits, rent, interest and dividends on assets

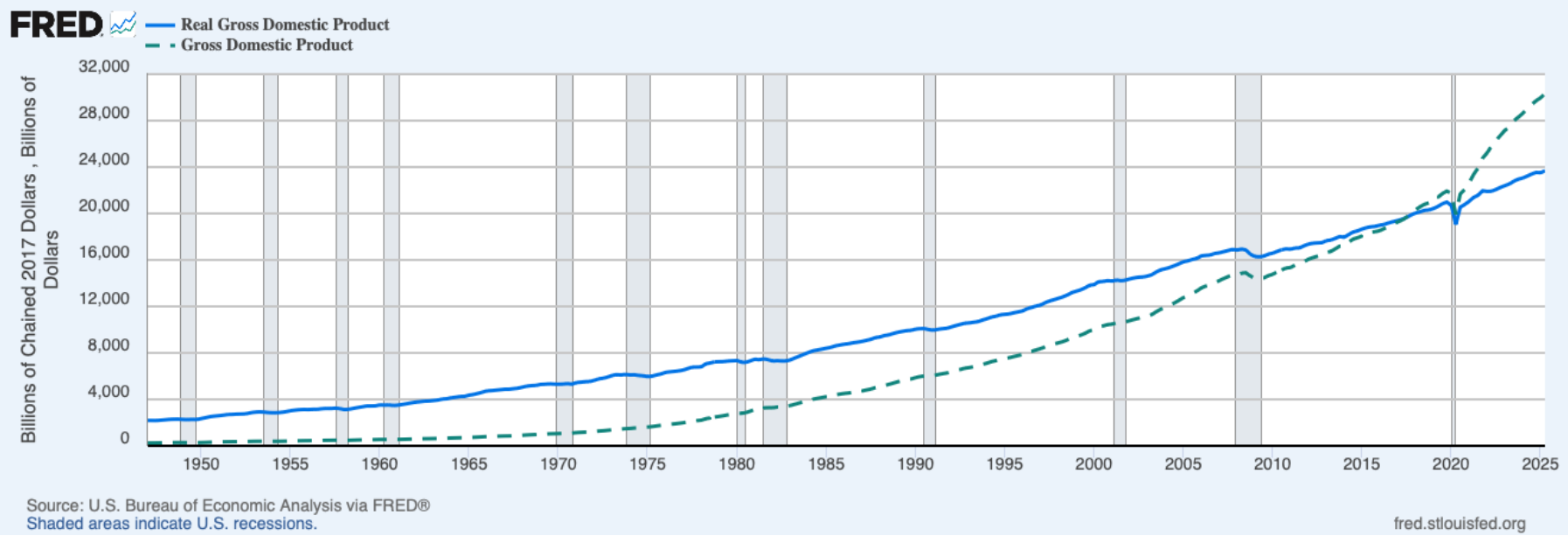
Real versus nominal GDP

- 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 because real GDP is constructed using constant base-year prices.

U.S. nominal and real GDP, 1947–2025



Inflation measures

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, part 1

Example with three goods

For good ***i*** = 1, 2, 3

P_{it} = the market price of good ***i*** in month ***t***

Q_{it} = the quantity of good ***i*** produced in month ***t***

$NGDP_t$ = nominal GDP in month ***t***

$RGDP_t$ = real GDP in month ***t***

Understanding the GDP deflator, part 2

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

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

The GDP deflator is a weighted average 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:
  - 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

1. It surveys consumers to determine the composition of the typical consumer's "basket" of goods.
2. Every month, it collects data on the prices of all items in the basket and computes the cost of the basket.
3. CPI in any month equals

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

NOW YOU TRY

Compute the CPI

Basket: 20 pizzas, 10 records

Prices:

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

For each year, compute:

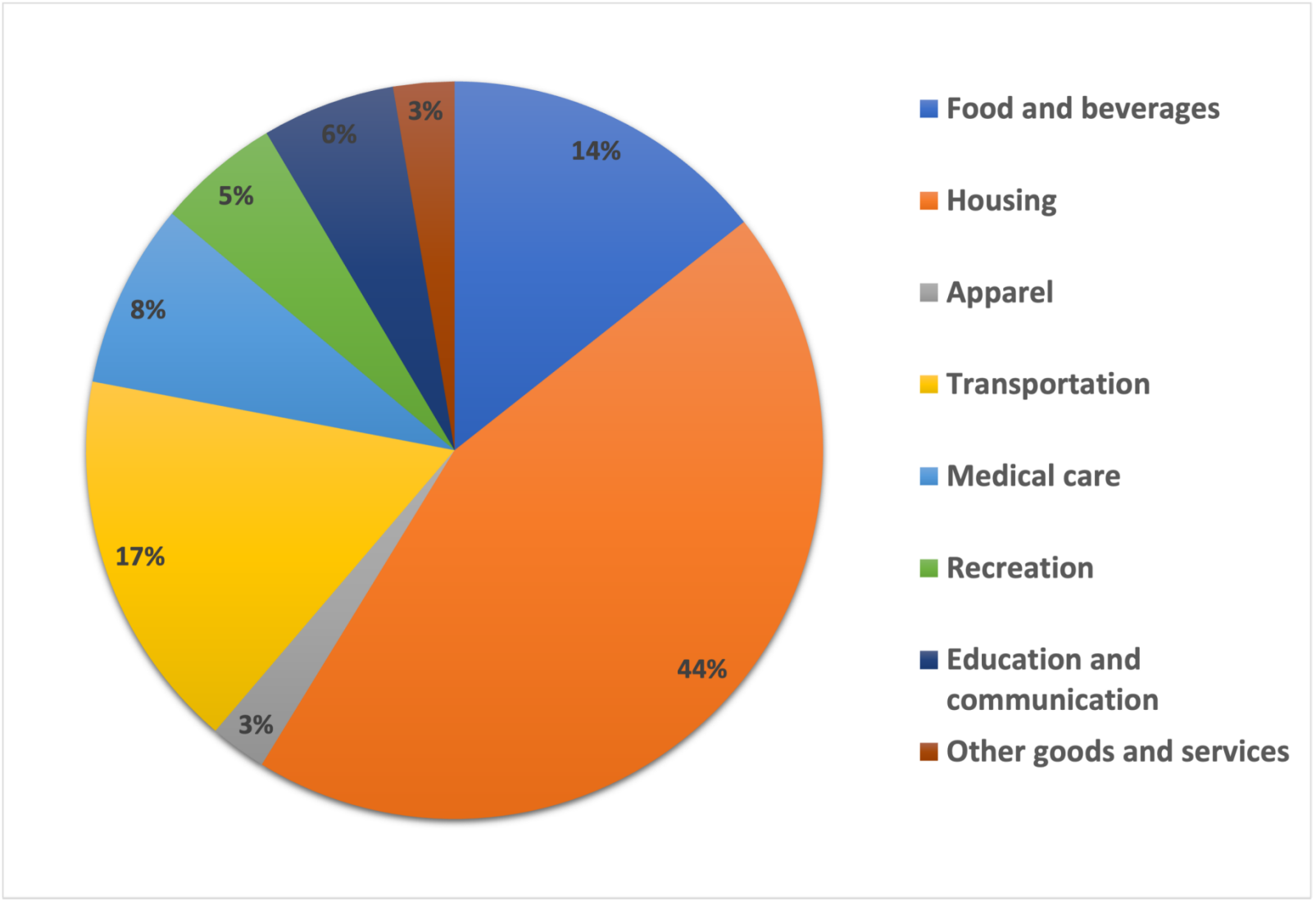
- the cost of the basket
- the CPI (using 2020 as the base year)
- the inflation rate from the preceding year

NOW YOU TRY

Compute the CPI, answers

	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%

The composition of the CPI's "basket"



Understanding the CPI, part 1

Example with three goods

For good ***i*** = 1, 2, 3

C_i = amount of good ***i*** in the CPI's basket

P_{it} = price of good ***i*** in month ***t***

E_t = cost of the CPI basket in month ***t***

E_b = cost of the basket in the base period

Understanding the CPI, part 2

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

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

The CPI is a weighted average 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.

Why the CPI may overstate inflation

- **Substitution bias**:
  The CPI uses fixed weights, so it cannot reflect consumers' ability to substitute toward goods whose relative prices have fallen.
- **Introduction of new goods**:
  The introduction of new goods makes consumers better off and, in effect, increases the real value of the dollar. But it does not reduce the CPI because the CPI uses fixed weights.
- **Unmeasured changes in quality**:
  Quality improvements increase the value of the dollar but are often not fully measured.

The size of the CPI's bias

- In 1995, a Senate-appointed panel of experts estimated that the CPI overstates inflation by 1.1–1.3 percent per year due to factors such as substitution bias, quality change bias, and new product bias.
- The BLS therefore made adjustments to reduce the bias.
- Now, the CPI's bias is probably under 1 percent per year and 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:

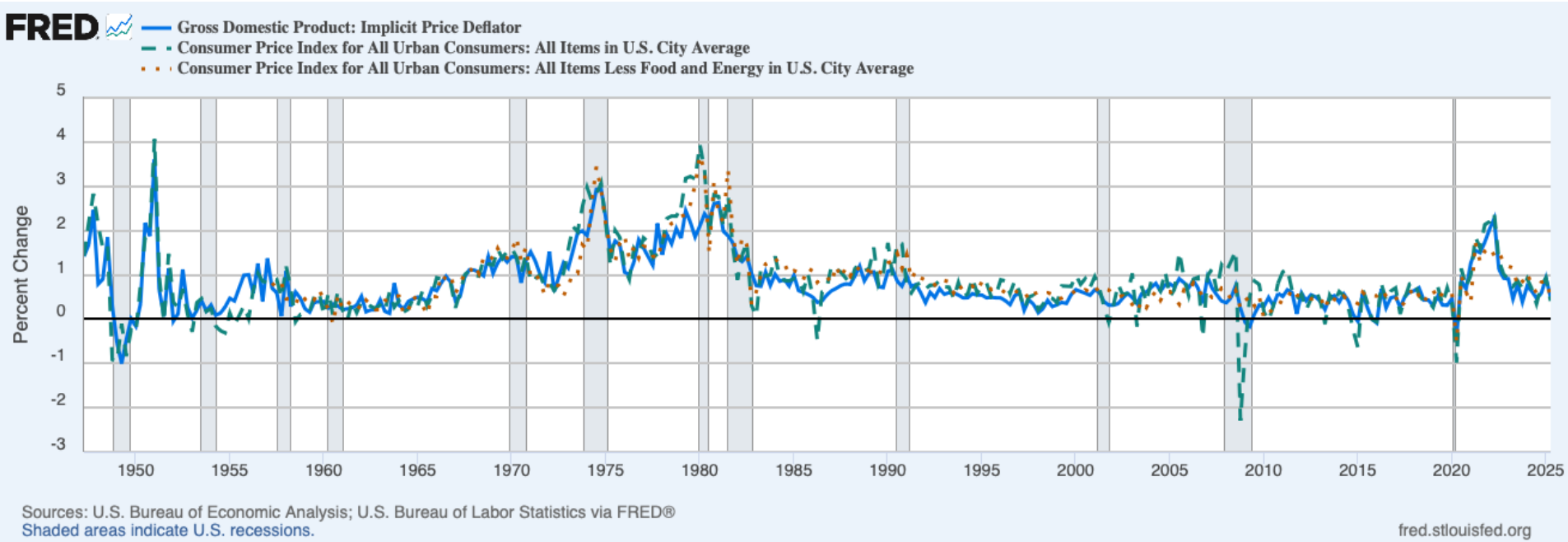
- included in CPI
- excluded from GDP deflator

The basket of goods:

- CPI: fixed
- GDP deflator: changes every year

Core Inflation

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


FRED
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
Percent Change
5
4
3
2
1
0
-1
-2
-3
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Sources: U.S. Bureau of Economic Analysis; U.S. Bureau of Labor Statistics via FRED®
Shaded areas indicate U.S. recessions.
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NOW YOU TRY

Questions for discussion

1. If your grandmother receives Social Security, how is she affected by the CPI's bias?
2. Where does the government get the money to pay COLAs to Social Security recipients?
3. If you pay income and Social Security taxes, how does the CPI's bias affect you?
4. How does your grandmother's "basket" differ from the CPI's?

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

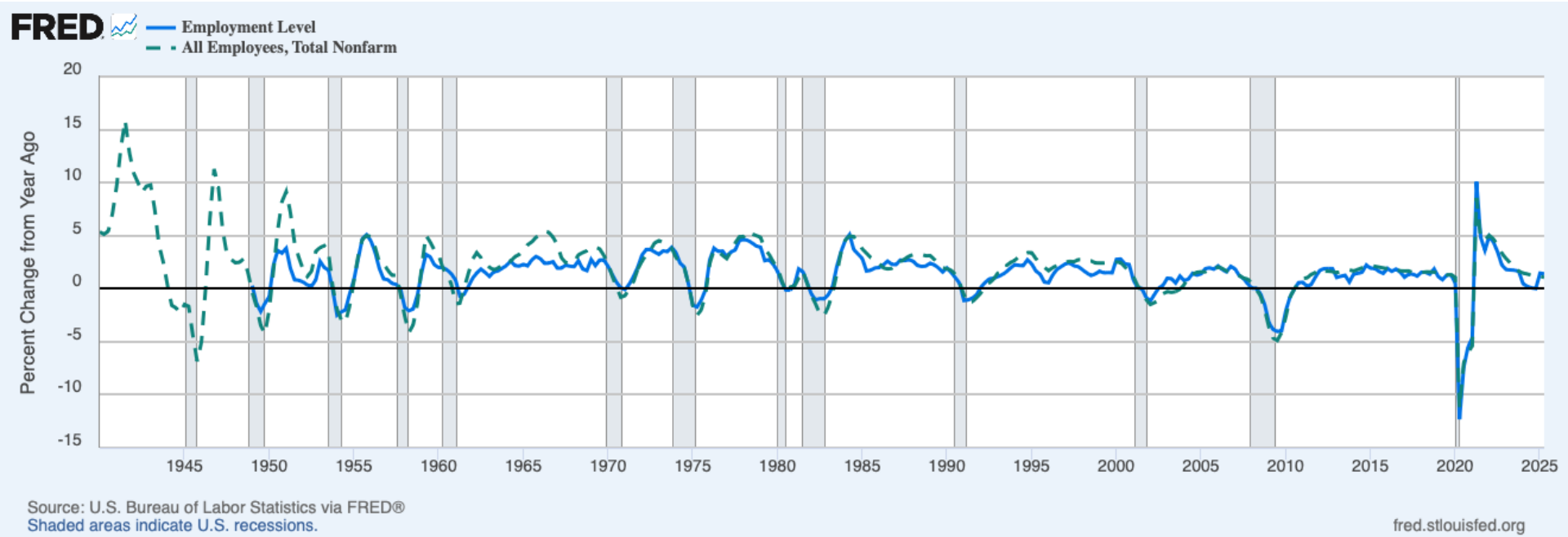
- **Unemployment rate (UR)**
  percentage of the labor force that is unemployed
- UR = ???
- **Labor-force participation rate (LFPR)**
  fraction of the adult population that "participates" in the labor force—that is, is working or looking for work
- LFPR = ???

Two important labor-force concepts

- **Unemployment rate (UR)**
  percentage of the labor force that is unemployed
- UR = U/LF = U/(E+U)
- **Labor-force participation rate (LFPR)**
  fraction of the adult population that "participates" in the labor force—that is, is working or looking for work
- LFPR = LF/(LF+NILF) = (E+U)/(E+U+NILF)

How to measure labor market movements

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


FRED
Employment Level
All Employees, Total Nonfarm
Percent Change from Year Ago
20
15
10
5
0
-5
-10
-15
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
Source: U.S. Bureau of Labor Statistics via FRED®
Shaded areas indicate U.S. recessions.
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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: +144,000 to +19,000 June: +147,000 to +14,000
- Total: +291,000 to +33,000 (difference is 258,000)
- 45% (116,000) from state and local government employment

CHAPTER SUMMARY, PART 1

- 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, PART 2

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