Economics 2
Spring 2020

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LECTURE 15

MEASUREMENT AND BEHAVIOR OF REAL GDP

March 12, 2020

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II. REAL GDP

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B. Nominal GDP

C. What we mean by real GDP

D. A little about measuring GDP

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2. Huge differences across countries
3. Short-run fluctuations

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B. Facts

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D. Adjusting for price changes

E. Quality changes and new goods in calculating inflation

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2. Determinants of average labor productivity: capital per worker and technology
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E. The long-run consequences of small differences in growth rates

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Announcements

- We are splitting Problem Set 4 into two parts.
  - Part 1 will be posted after lecture today. It is due next Tuesday (March 17).
  - We will again be using Gradescope for problem set submission.

Announcements

- Roughly the last 2 minutes of last Tuesday's lecture were not included in the course capture.
    - Lecture notes for this material (which go into more detail than Prof. Romer did in the lecture) are now included at the end of the outline and slides file for Lecture 14 on the course website.

Announcements

- Research reading for Tuesday, March 17 (by William Nordhaus):
  - Read only the assigned pages.
  - Read for approach and findings; think about relevance for the measurement of inflation and growth in standards of living.

I. Macroeconomics versus Microeconomics

Macroeconomics

- Definition:
  - The study of the aggregate economy.
- Concerned with:
  - Total output.
  - Aggregate price level and inflation.
  - The unemployment rate.
  - The overall level of interest rates; the exchange rate; overall exports and imports.

II. Real GDP

Real Gross Domestic Product (Real GDP)

- The market value of the final goods and services newly produced in a country during some period of time, adjusted for price changes.

Economists' Definition of "Real"

- Adjusted for changes in prices.
- Another way to say it: Measured in terms of goods and services, rather than dollars.
- In contrast, "nominal" means measured in terms of dollars.

Nominal GDP

- Nominal GDP: The market value of the final goods and services newly produced in a country during some period of time, ***<u>not</u>*** adjusted for price changes.
- Thus, for the United States, it is measured in dollars.
- Example: Nominal GDP in 2019 = $\sum_{i} P_{i,2019} \bullet Q_{i,2019}$,

where i represents each possible good in the economy (and ∑ is the symbol for a sum).

- Note that we use 2019 prices in computing 2019 nominal GDP, 2018 prices in computing 2018 nominal GDP, ….

Calculating Real GDP

- Choose a base year (for example, 2012), and always use prices from the base year to multiply the quantities.
- Example: If 2012 is the base year:

$$\text{2019 real GDP} = \sum_i P_{i,2012} \bullet Q_{i,2019}.$$

- That is, if 2012 is the base year, 2019 real GDP is the answer to the question, "How much would all the final goods and services newly produced in the United States in 2019 have been worth at 2012 prices?"

Growth Rate of Real GDP

- The percentage change in real GDP from one year to the next.
- Note: The percentage change in some variable, X, from period t − 1 to period t is defined as:

$$\frac{X_t - X_{t-1}}{X_{t-1}} \bullet 100.$$

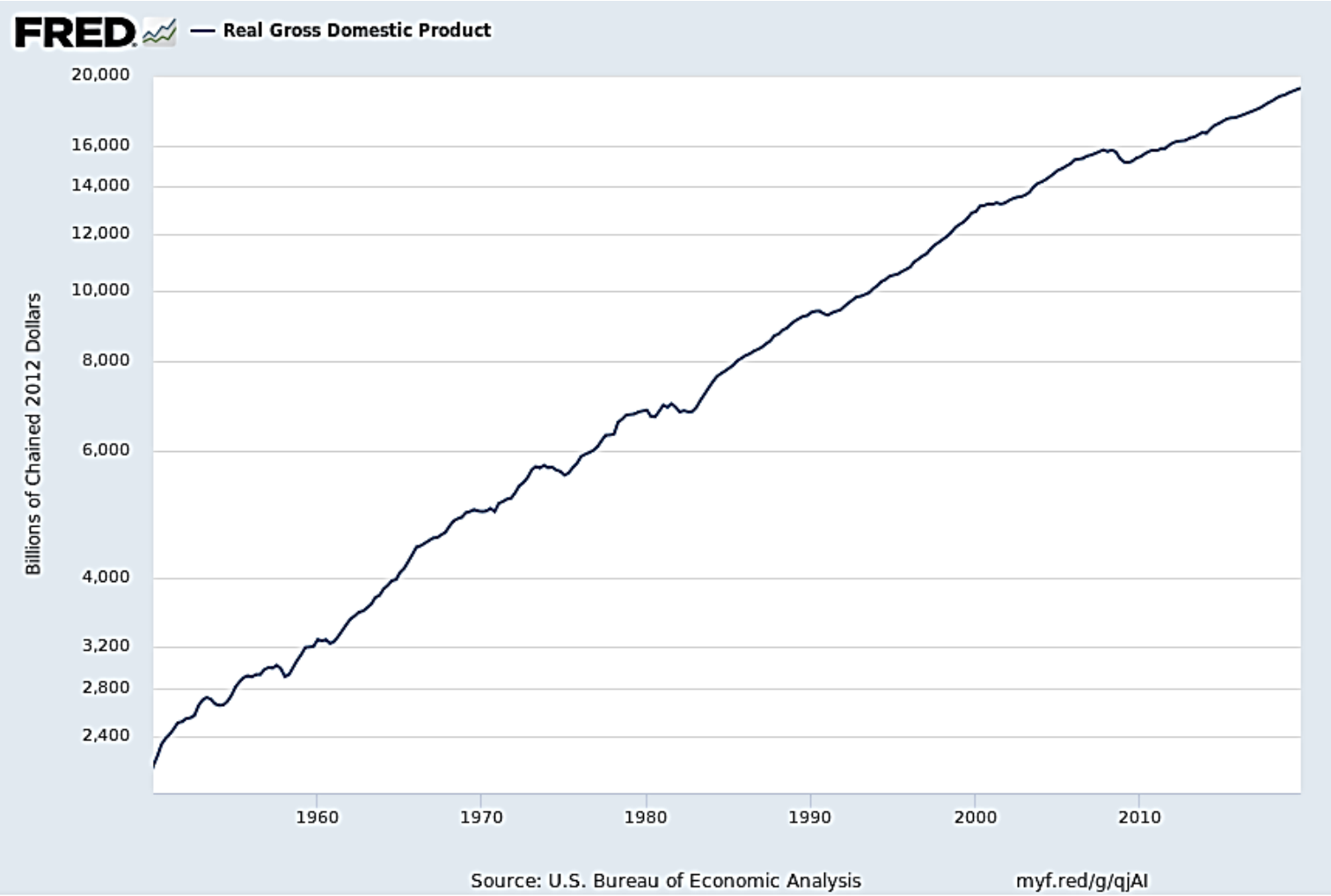
A Little about Measuring GDP

- Key points:
  - ***Final*** goods and services.
  - ***Newly produced***.
  - ***Within the country***.
  - ***In some period of time***.

3 Approaches to Measuring GDP

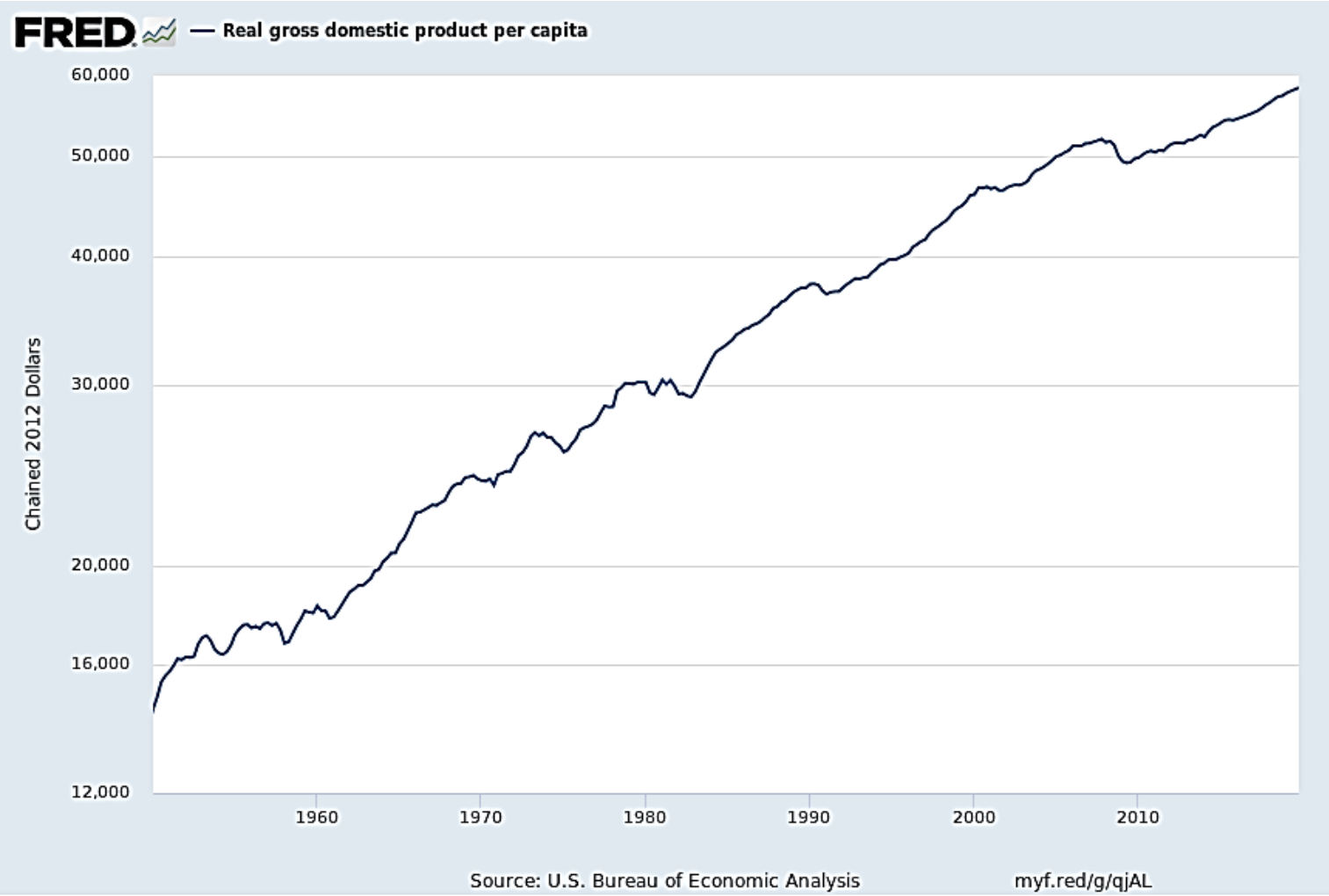
- Expenditure: Use market prices and the quantities of final goods.
  - Can divide into consumption (C), investment (I), government purchases (G), and net exports (NX).
- Production (value added): follow goods through each stage of production.
- Income: Income from producing new goods and services within the country.
  - Can divide into labor income and capital income.

Real GDP in the United States, 1950–2019



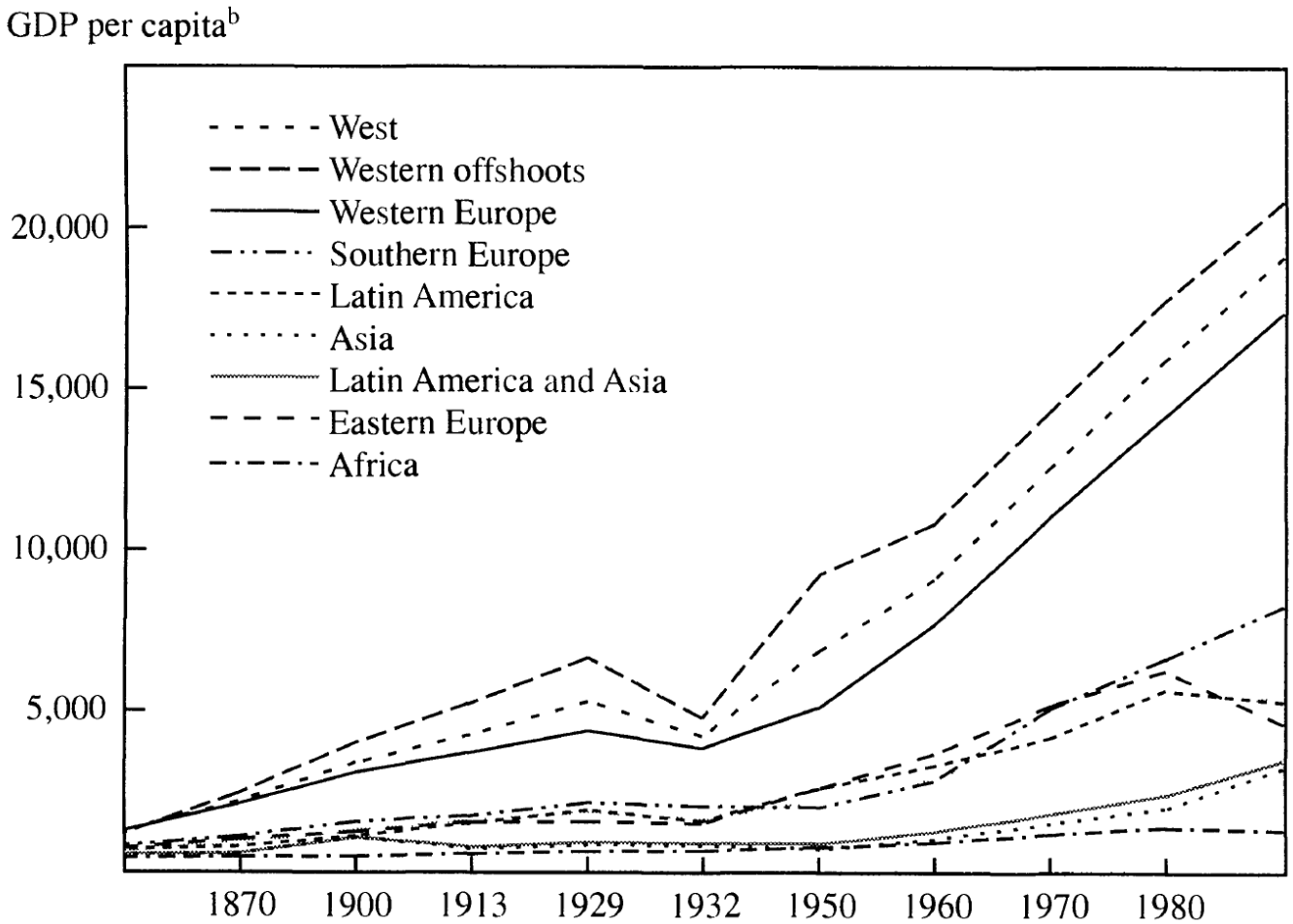
Source: FRED (Federal Reserve Economic Data); data from Bureau of Economic Analysis.

Real GDP per Capita in the U.S., 1950–2019



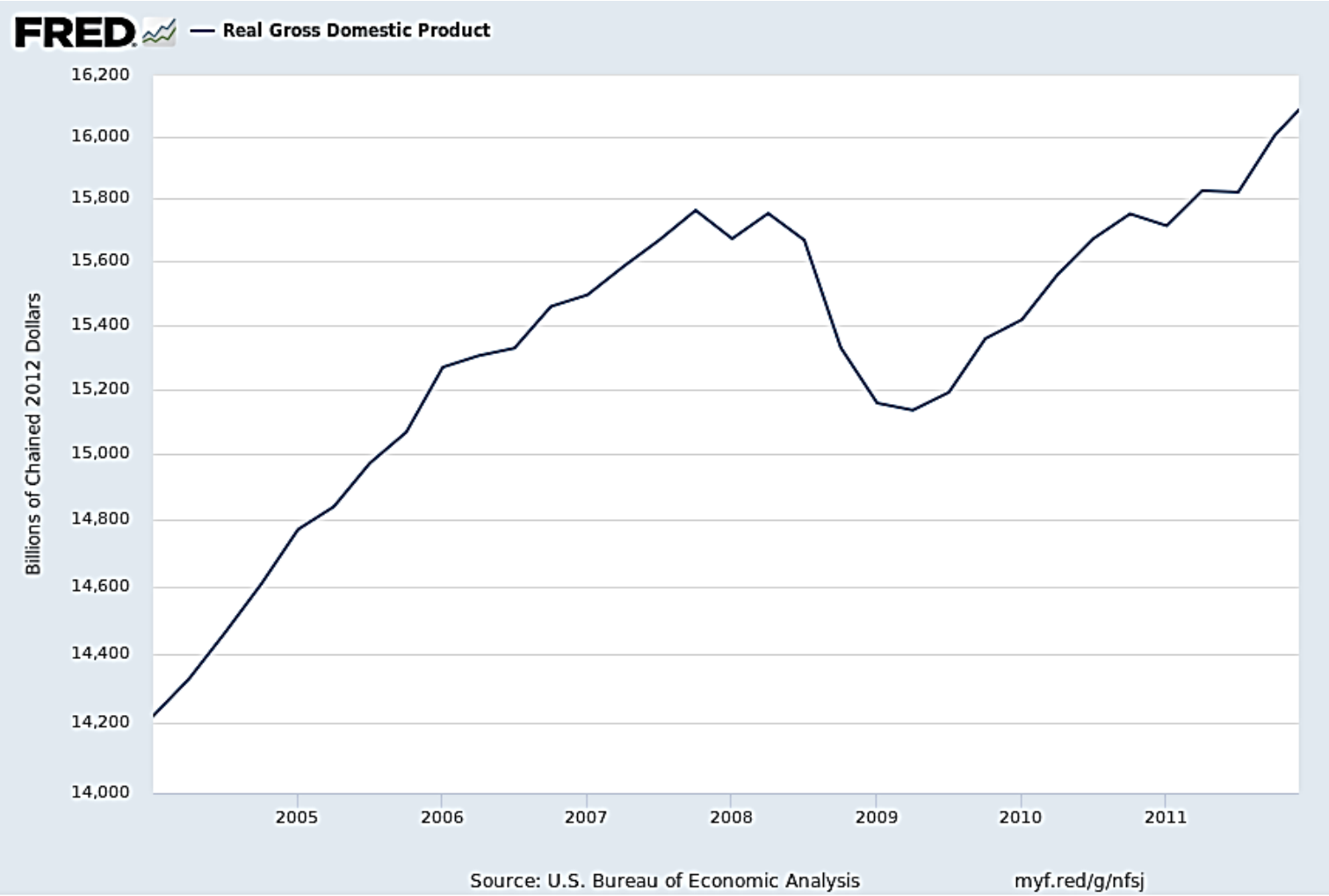
Source: FRED; data from Bureau of Economic Analysis.

Real GDP per Capita over Time and Regions



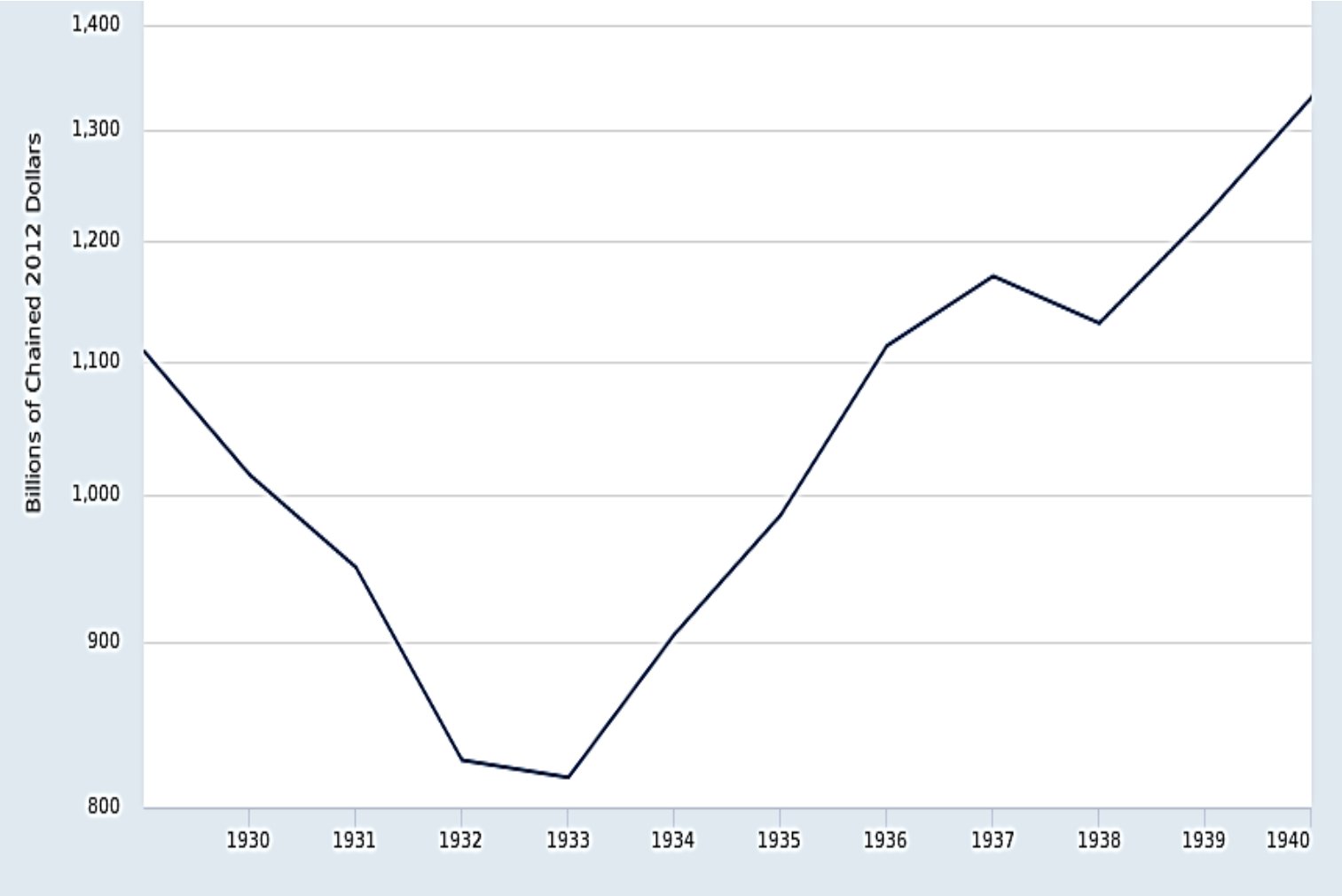
Source: Bloom and Sachs, "Geography, Demography, and Economic Growth in Africa."

U.S. Real GDP, 2004–2011



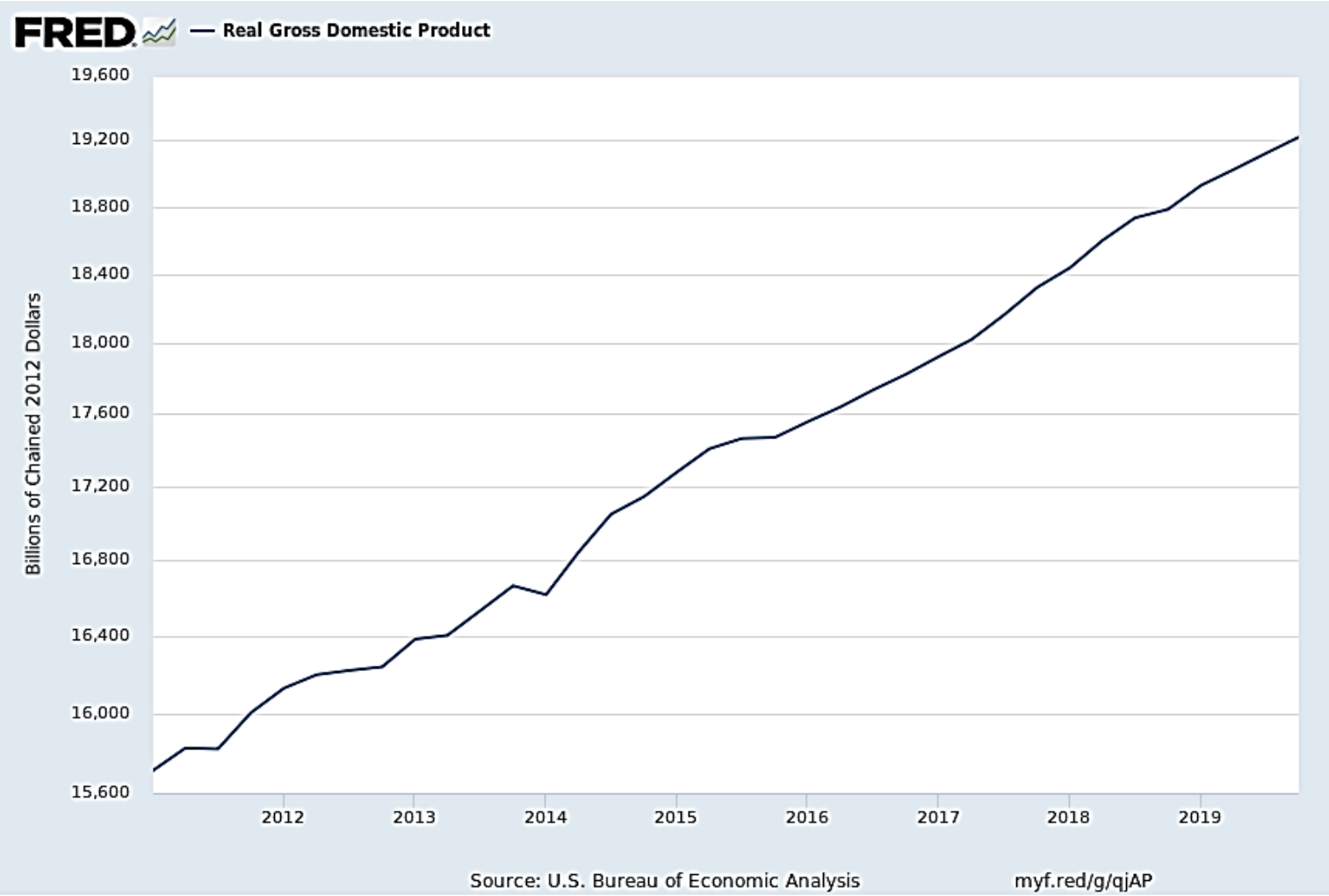
Source: FRED; data from Bureau of Economic Analysis.

U.S. Real GDP, 1929–1940



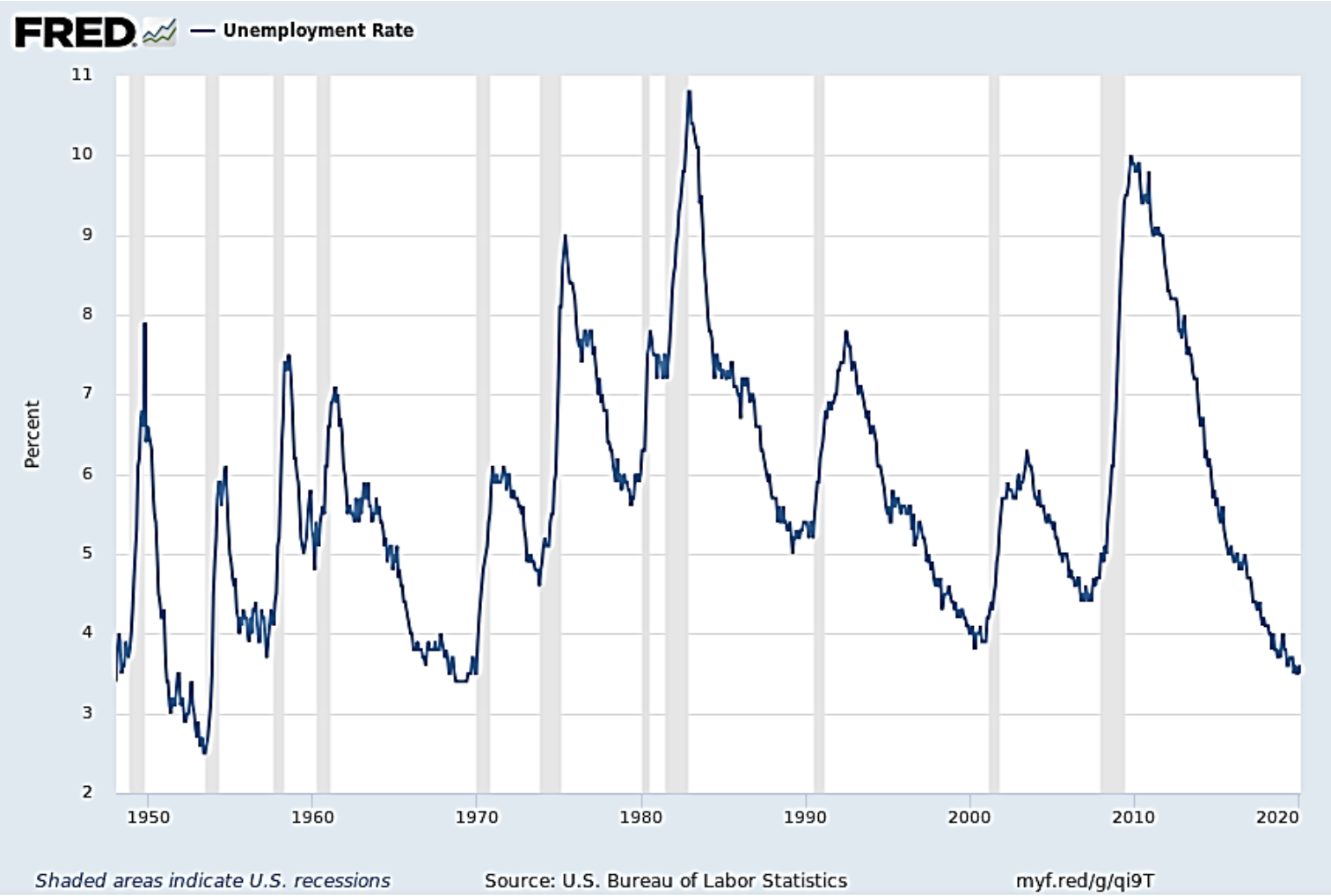
Source: FRED; data from Bureau of Economic Analysis.

U.S. Real GDP, 2011–2019



Source: FRED; data from Bureau of Economic Analysis.

The U.S. Unemployment Rate, 1948–2020



Source: FRED; data from Bureau of Labor Statistics.

III. Inflation

Calculating the Consumer Price Index

- Choose a base year (for example, 1983), and find the basket of goods and services households purchased in 1983.

- Then the CPI in 2019 is:

$$\mathrm{CPI}_{2019} = \frac{\text{Price of 1983 market basket in 2019}}{\text{Price of 1983 market basket in 1983}} \bullet 100.$$

- That is, if 1983 is the base year, the 2019 CPI is the answer to the question, "By what ratio would households' spending have to be higher in 2019 than it was in 1983 for them to buy the same things they bought in 1983?"

Calculating the Consumer Price Index—Algebra

- Choose a base year (for example, 1983), and always use ***quantities*** from the base year to multiply the prices.

- Then the CPI in 2019 is:

$$\mathrm{CPI}_{2019} = \frac{\sum_{\mathrm{i}} \mathrm{P}_{\mathrm{i},2019} \bullet \mathrm{Q}_{\mathrm{i},1983}}{\sum_{\mathrm{i}} \mathrm{P}_{\mathrm{i},1983} \bullet \mathrm{Q}_{\mathrm{i},1983}} \bullet 100.$$

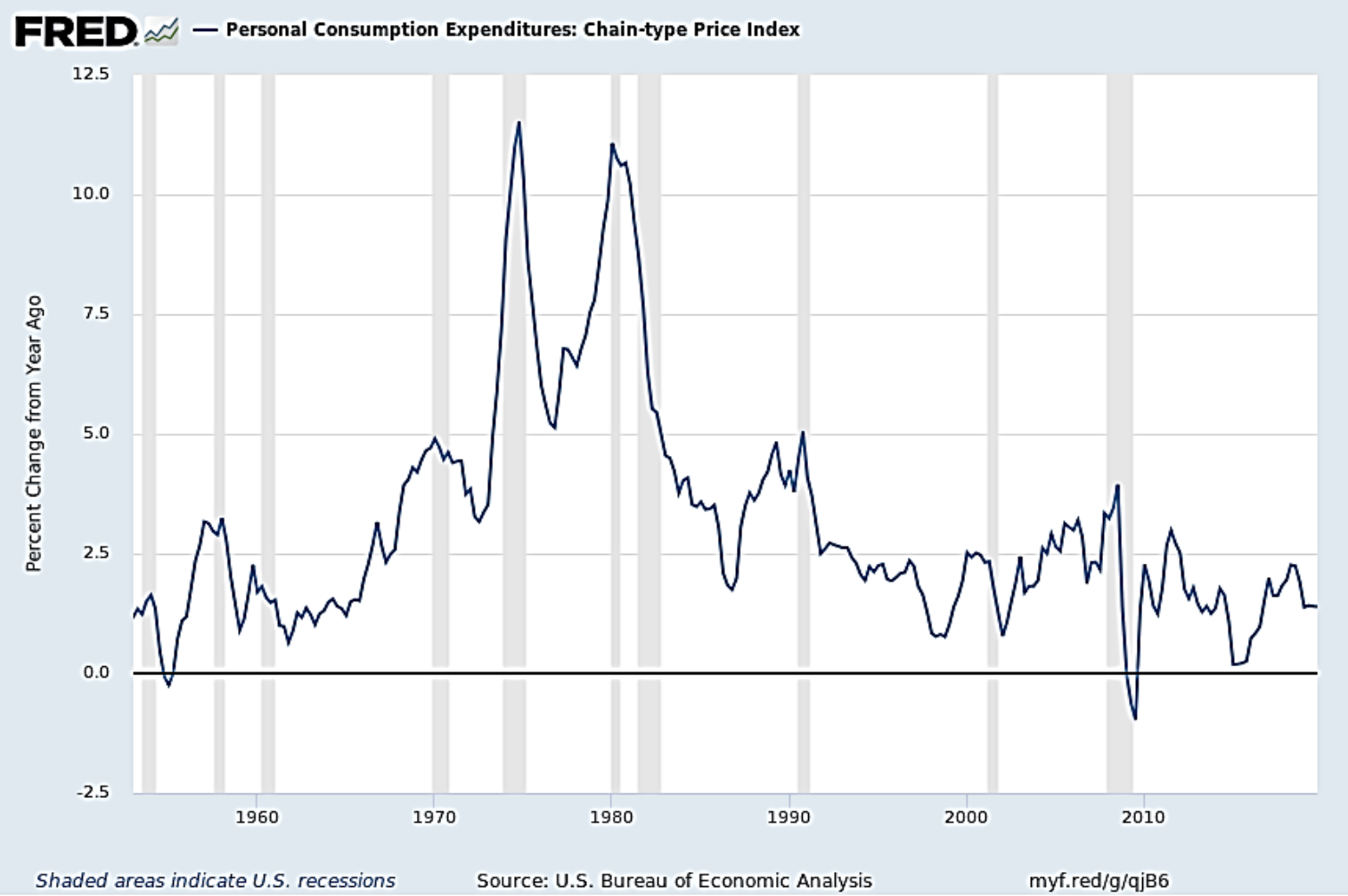
Inflation

- The percent change in a price index.
- Example: the inflation rate from 2018 to 2019 is:

$$\pi_{2019} = \frac{P_{2019} - P_{2018}}{P_{2018}} \bullet 100.$$

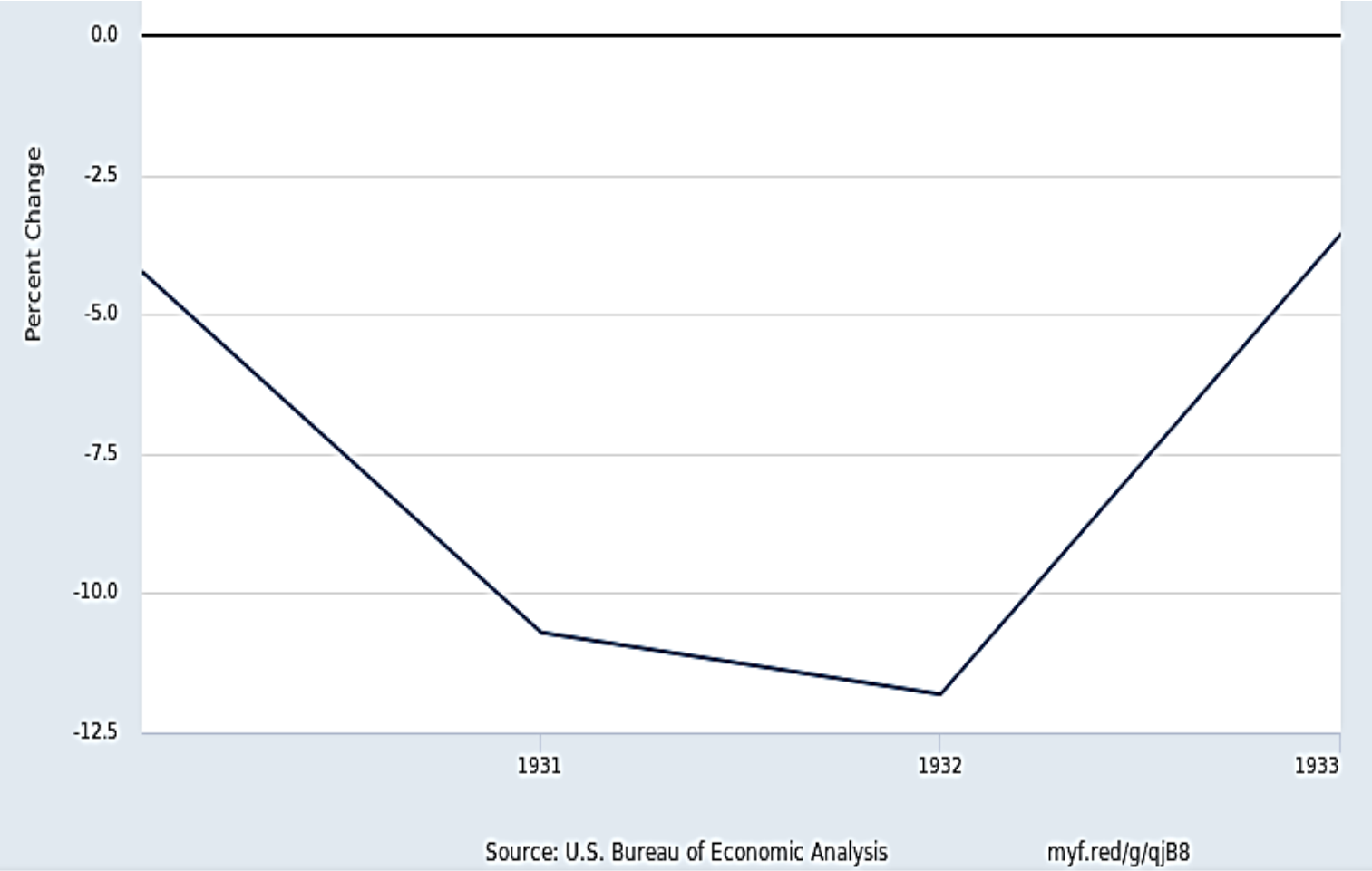
- Note: If inflation is negative, we say there is "deflation."

U.S. Inflation (Percent Change in the Price Index for Personal Consumption Expenditures), 1953–2019



Source: FRED; data from Bureau of Economic Analysis.

U.S. Inflation (Percent Change in the Price Index for Personal Consumption Expenditures), 1930–1933



Source: FRED; data from Bureau of Economic Analysis.

Why Do We Care about Inflation?

- An argument for not caring.
- Redistribution.
- Psychology.
- Efficiency.

Adjusting Variables for Price Changes

- What is $\$X_A$ in Year A equivalent to in terms of Year B dollars?
- Let P_A denote the value of the price index in Year A, and P_B the value of the price index in Year B.
- Then: $\$X_B$, the number of dollars in Year B that is equivalent to $\$X_A$ in Year A, is the solution to:

$$\frac{\$X_B}{P_B} = \frac{\$X_A}{P_A}.$$

- That is, in Year B dollars, $\$X_A$ in Year A is equivalent to:

$$\$X_B = \$X_A \frac{P_B}{P_A}.$$

Adjusting Variables for Price Changes – Example

- Example: What was Richard Nixon's final salary equivalent to in today's dollars?
  - His salary was \$200,000; the CPI in August 1974 was 49.9; the CPI now is 258.82. Thus, $\$X_A \bullet (P_B/P_A)$ is:

$$\$200{,}000\,\frac{258.82}{49.9} = \$1{,}037{,}000.$$

- Today, the president's salary is \$400,000. So, the president's real salary was much higher in 1974 than it is today.

Quality Changes and New Goods in Calculating Inflation

- If the quality of a good improves and its price rises, we try to take out the part of the price increase that is due to the quality improvement (and count only the remainder in calculating inflation).
- If there are new goods, we try to account for the fact that they give households a new way of obtaining utility.

Quality Changes, New Goods, and Real GDP

- We can think of real GDP as nominal GDP divided by a price index:
  - If 2012 is the base year, define:

$$\text{GDP Price Index}_t = \frac{\sum_i P_{i,t} \bullet Q_{i,t}}{\sum_i P_{i,2012} \bullet Q_{i,t}}. \qquad (*)$$

  - Then our earlier definition of real GDP implies:

$$\text{Real GDP}_t = \frac{\text{Nominal GDP}_t}{\text{GDP Price Index}_t}.$$

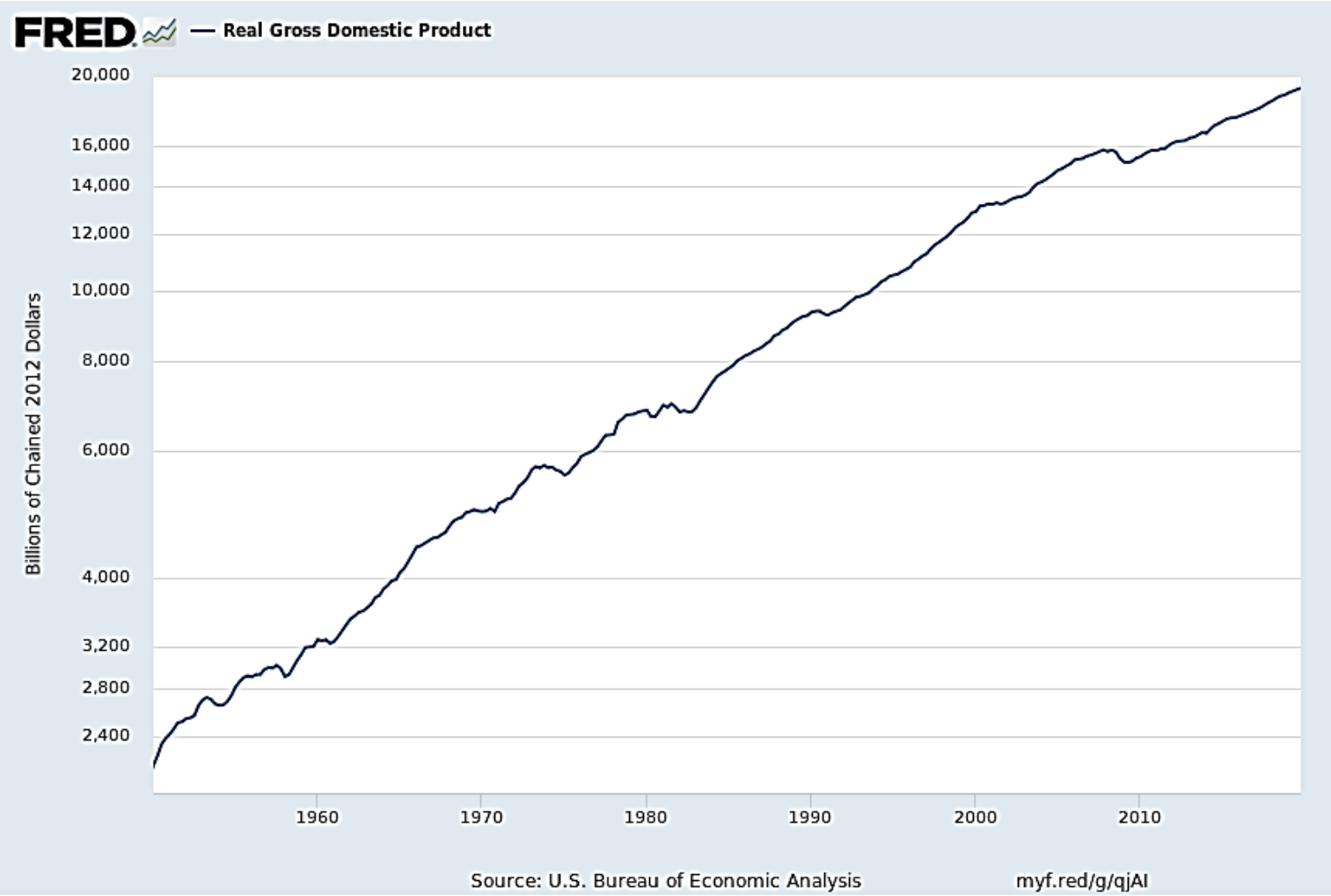
- In practice, rather than using a simple price index like $(*)$, we use a price index that tries to account for quality changes and new goods.

IV. Our Framework for Analyzing Long-Run Growth

Two Key Topics of Macroeconomics

- The long-run trend in output.
- Short-run fluctuations (booms and recessions).

Real GDP in the United States, 1950–2019



Source: FRED (Federal Reserve Economic Data); data from Bureau of Economic Analysis.

In the Long Run, Output Is Determined by the Economy's Available Resources

- Although recessions can cause resource use to be lower than normal, the economy does not remain depressed forever.
- Potential output (Y*): The amount of output that the economy produces when using its resources at normal rates.
- A better name for potential output might be "normal output."

The Three Key Determinants of Potential Output

- Labor
- Capital
- Technology

How Labor, Capital, and Technology Determine Potential Output: The Aggregate Production Function

Decomposition of Potential Output per Person

$$\frac{Y^*}{POP} = \frac{Y^*}{N^*} \bullet \frac{N^*}{POP}$$

where:

- Y^* is potential output;
- POP is population;
- N^* is normal employment.

- $\frac{N^*}{POP}$ is the normal employment-to-population ratio.
- $\frac{Y^*}{N^*}$ is normal average labor productivity.

Determinants of Average Labor Productivity

$$\frac{Y^*}{N^*} = f\left(\frac{K^*}{N^*}, T\right)$$

- $\frac{K^*}{N^*}$ is normal capital per worker.
- T is technology.

Capital

- Aids to the production process that were created in the past.
- Components of Capital:
  - Conventional physical capital (machines, buildings, computers).
  - Infrastructure (roads, telecommunications systems, dams) is also part of physical capital.
  - Human capital (education, job training).

Technology

- The methods for producing things.
- Components of Technology:
  - Production techniques
  - Management techniques
  - Economic institutions
  - Local culture

Aggregate Production Function

(1) $$\frac{Y^*}{POP} = \frac{Y^*}{N^*} \bullet \frac{N^*}{POP}$$

(2) $$\frac{Y^*}{N^*} = f\left(\frac{K^*}{N^*}, T\right)$$

(3) $$\frac{Y^*}{POP} = f\left(\frac{K^*}{N^*}, T\right) \bullet \frac{N^*}{POP}$$