Introduction and Measurement Issues

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Macroeconomic 1 (Econ 112)
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Plan for this Class

Dynamic Stochastic General Equilibrium

1. **Introduction**
2. Measurement Issues

1: partial eqn: individual optimisation

2: general eqn:

Consumers optimise
- working hours (labour supply)
- consumption (output demand)

Firms optimise
- labour (labour demand)
- output (production) (output supply)
- capital demand

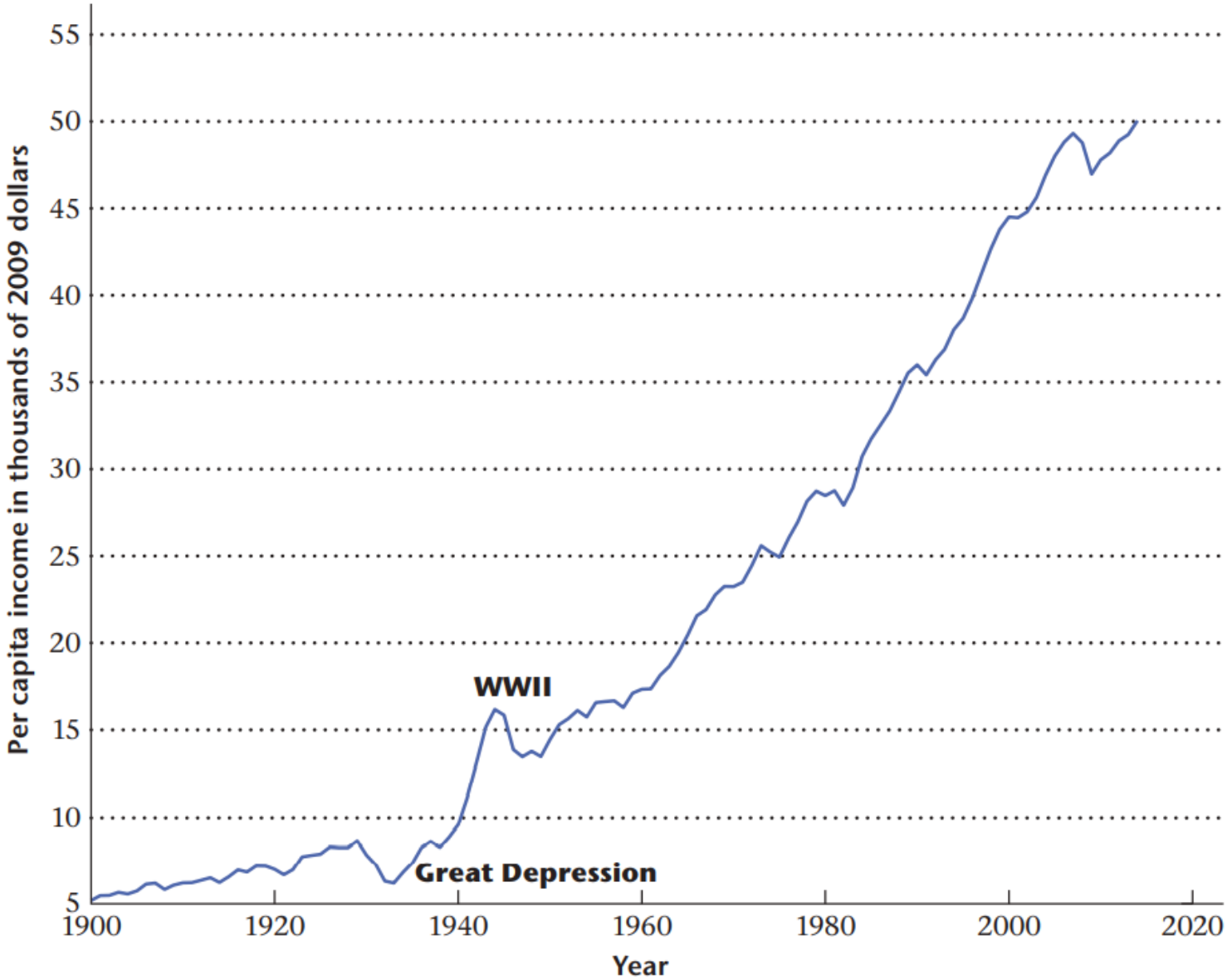
What is Macroeconomics?

- The study of the aggregate behavior of economic agents.
  - Consumers.
  - Firms.
  - Governments.
- Tools: Economic models, which consist of descriptions of consumers and firms, their objectives and constraints, and how they interact.
- Built on microeconomics, or microfoundations.
- Distinctive features: Long-run growth, business cycles, general equilibrium.

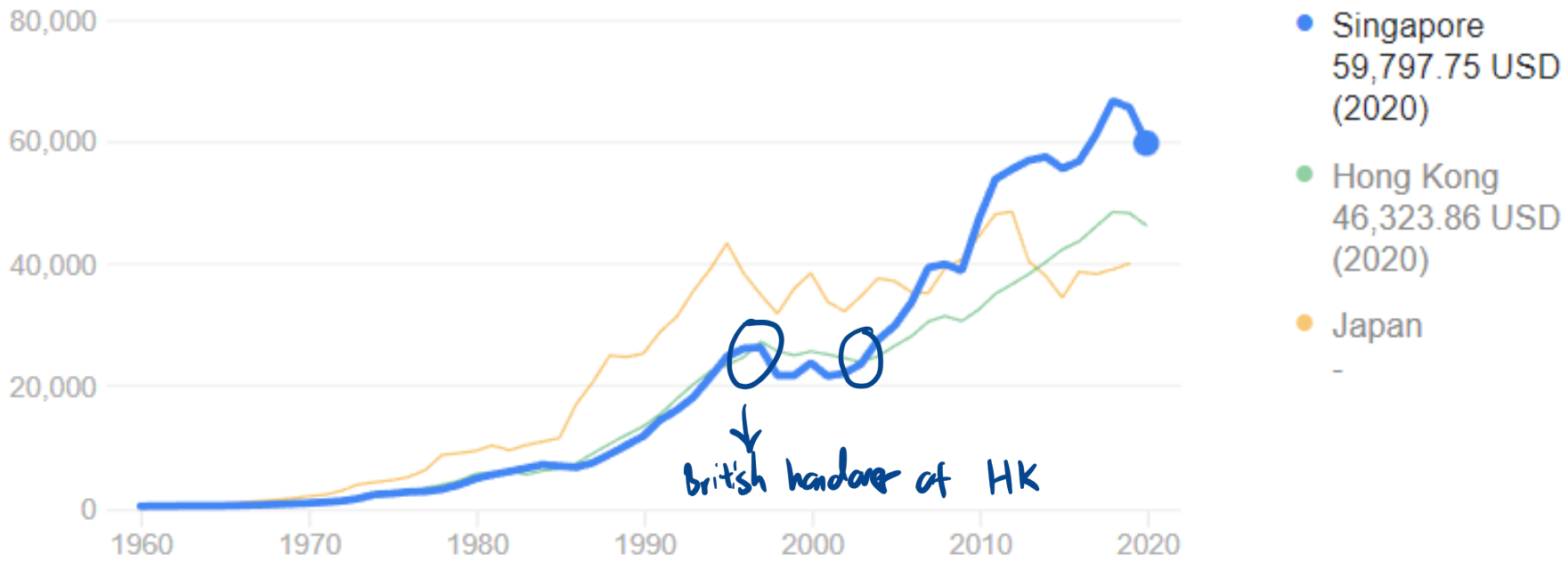
Gross Domestic Product (GDP)

- Let's start with the most basic data.
- Gross Domestic Product (GDP) is the quantity of goods and services produced within a country's borders during some specified period of time.
  - Also how much income earned by those contributing to domestic output.
  - Data usually reported in value. → without money, report in quantities
- What we care in the data: Per capita real GDP, which adjusts for
  - inflation (price growth); and
  - population growth.

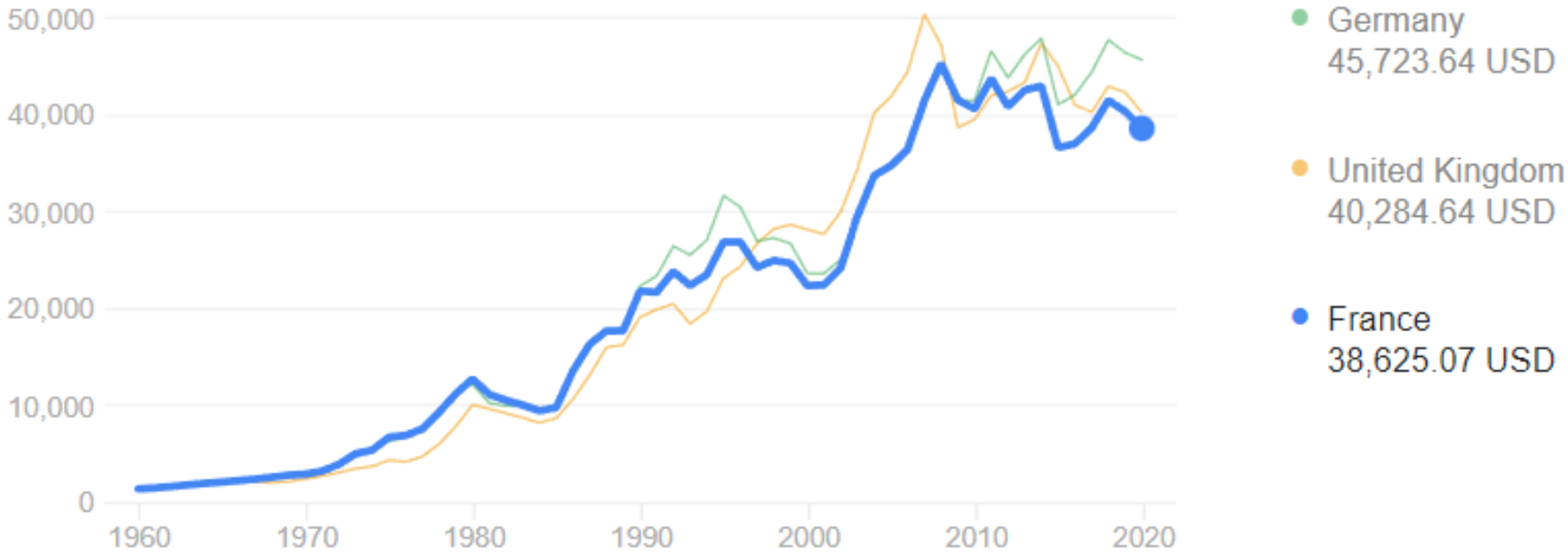
US Data (Per Capita Real)



Singaporean Data (Per Capita Nominal)



European Data (Per Capita Nominal)



Motivating Questions From The Figures

1. What causes sustained economic growth?
2. Could economic growth continue indefinitely, or is there some limit to growth?
3. Is there anything that governments can or should do to alter the rate of economic growth?
4. What causes business cycles?
5. Could the dramatic decreases and increases in economic growth that occurred during the Great Depression and World War II be repeated?
6. Should governments act to smooth business cycles?

Natural Logarithm Representation

in terms of ↓ dollar

- So far we are showing figures in level, what about growth rate?
- Useful Trick: natural logarithm.
- Let y_t be an an observation on an economic time series in period t; say per capita real GDP.
- We can compute growth rate g_t as

$$g_t = \frac{y_t}{y_{t-1}} - 1$$

- Property of natural log: $\ln(1+x) \approx x$ if x is small. Hence,

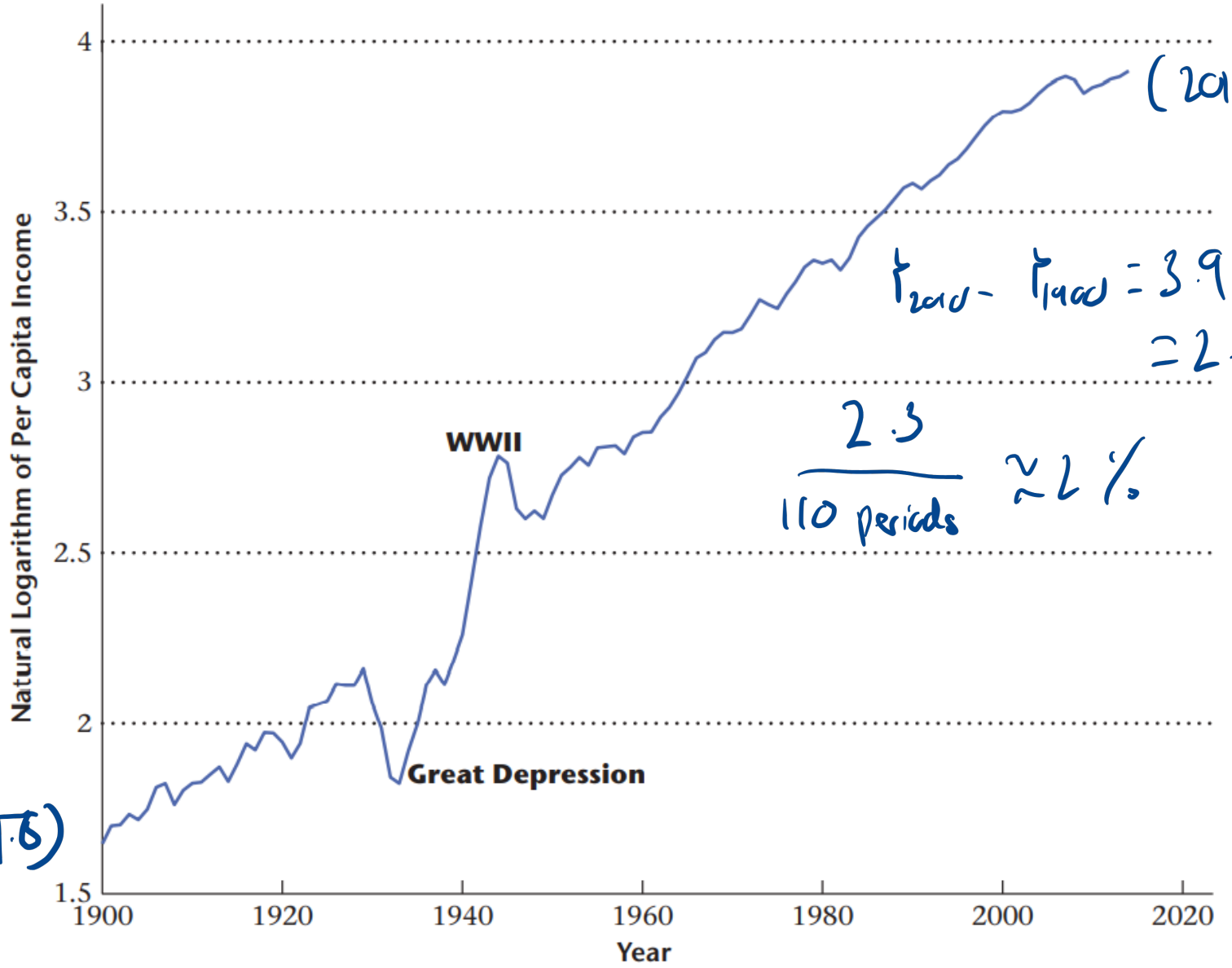
$$\frac{y_t}{y_{t-1}} = 1 + g_t \quad \Rightarrow \quad \ln\left(\frac{y_t}{y_{t-1}}\right) = \ln(1+g_t) \approx g_t$$

*ge is small

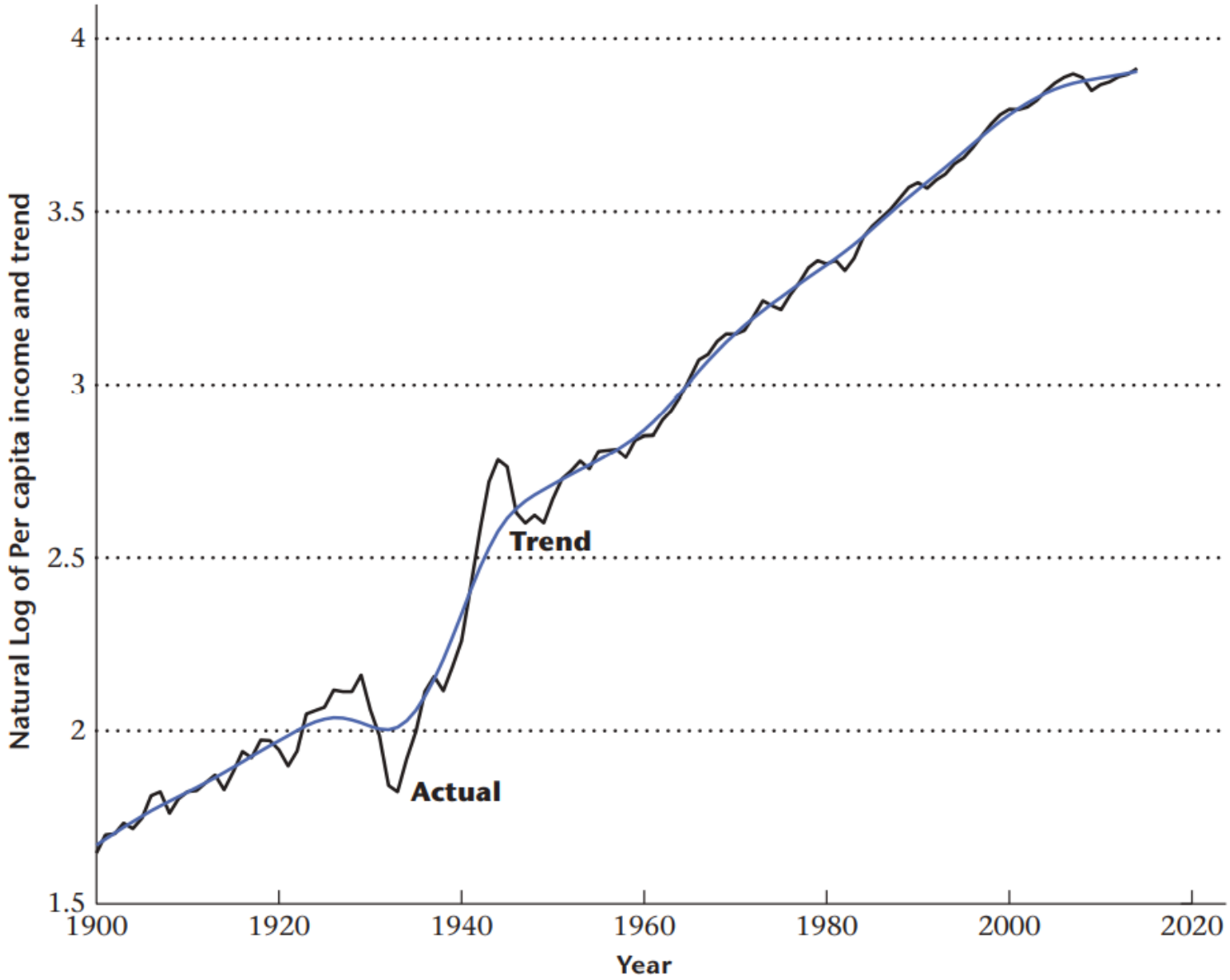
- But $\ln(y_t/y_{t-1}) = \ln y_t - \ln y_{t-1}$, which implies

$$g_t \approx \ln y_t - \ln y_{t-1}.$$

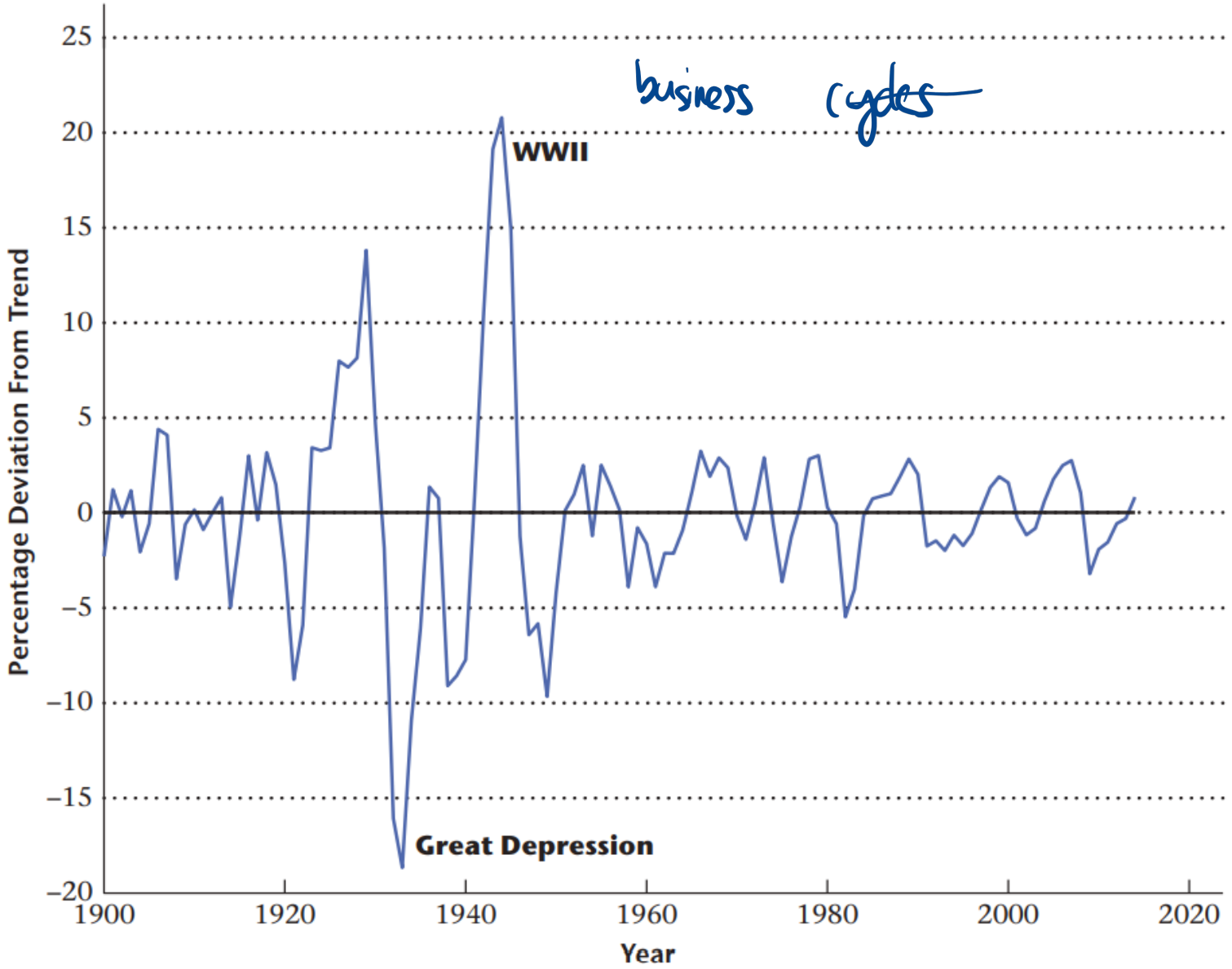
US Data (Natural Log Per Capita Real)



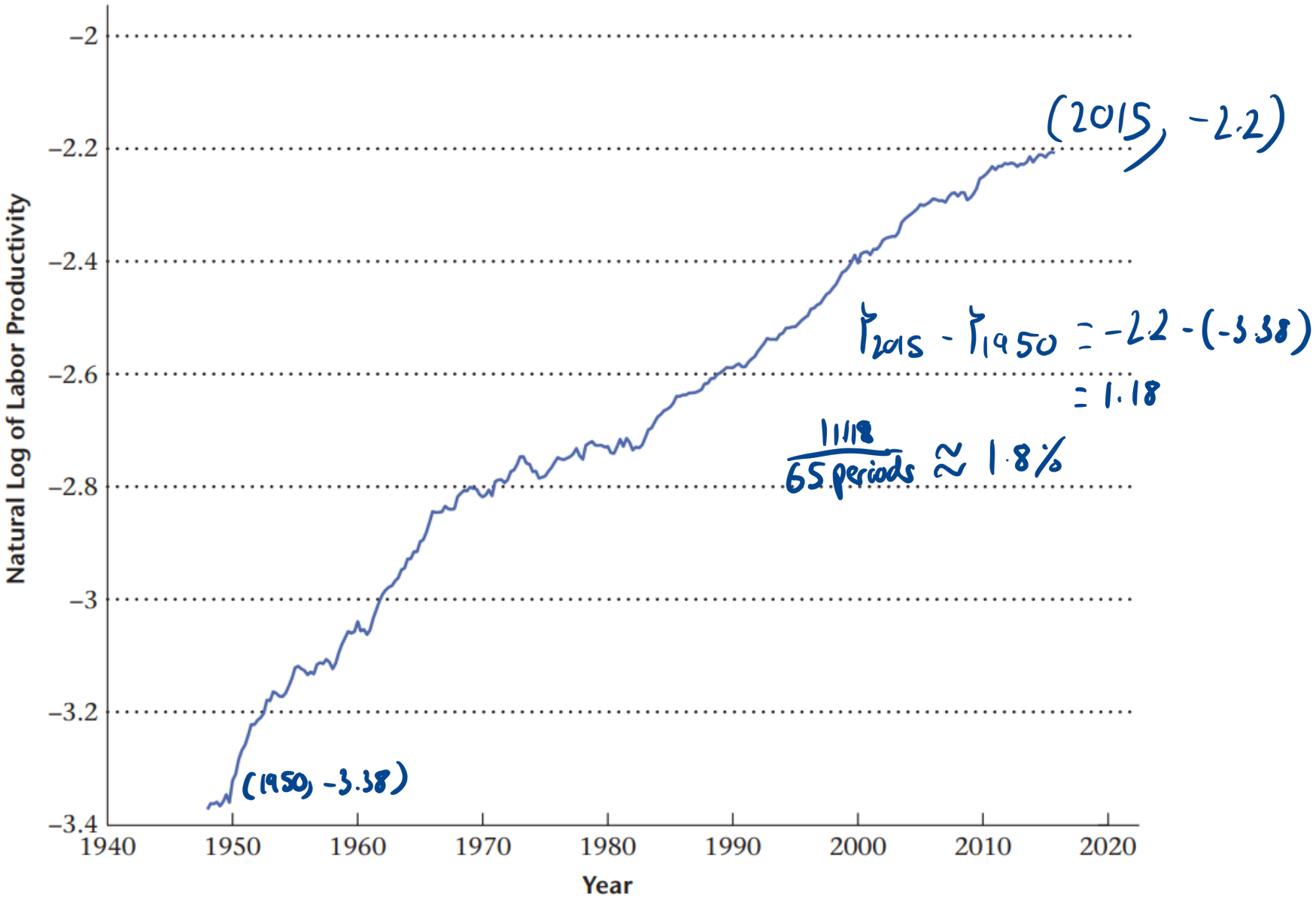
US Data with Fitted Trend (Natural Log Per Capita Real)



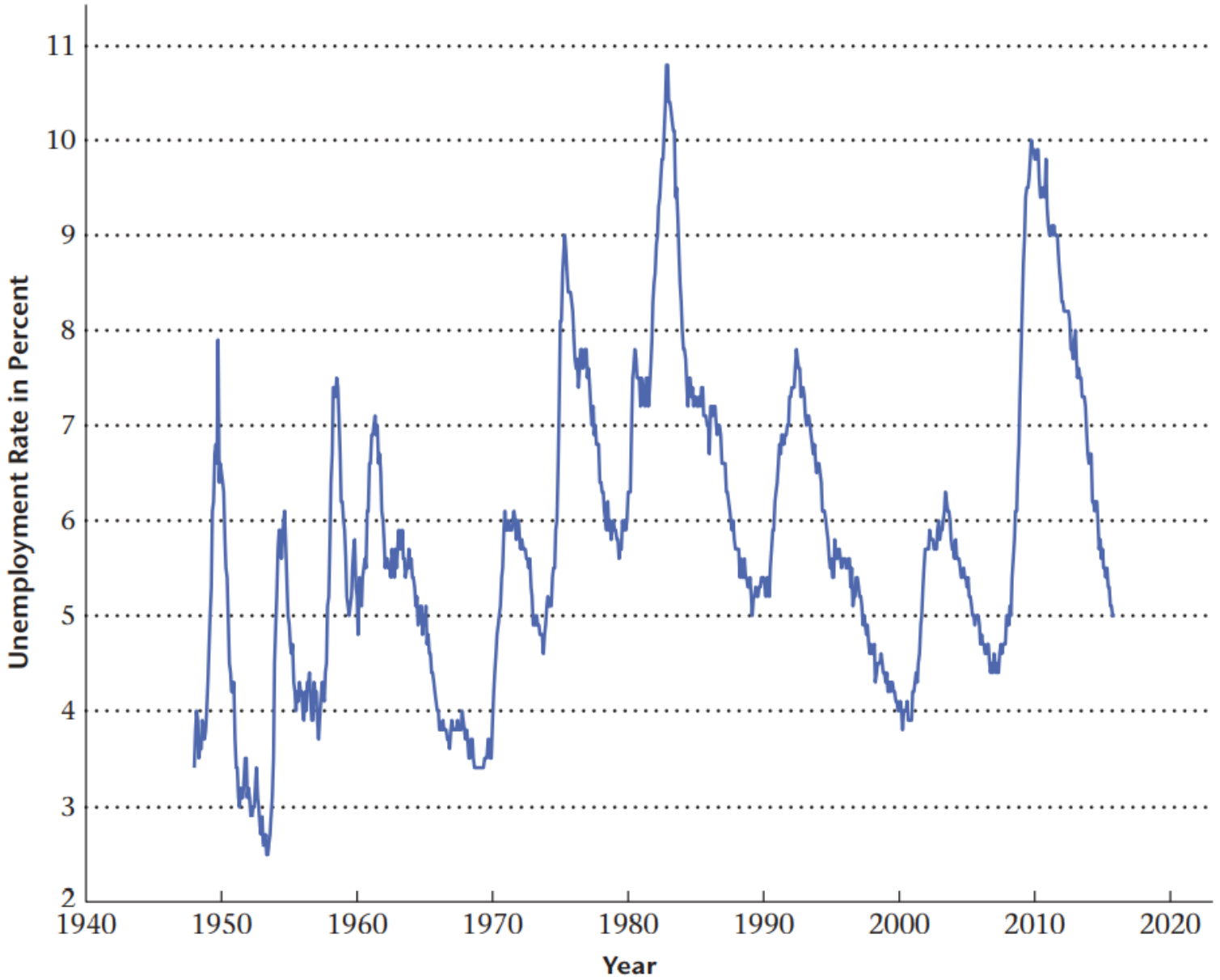
Deviation from Trend in Real Per Capita GDP



Productivity

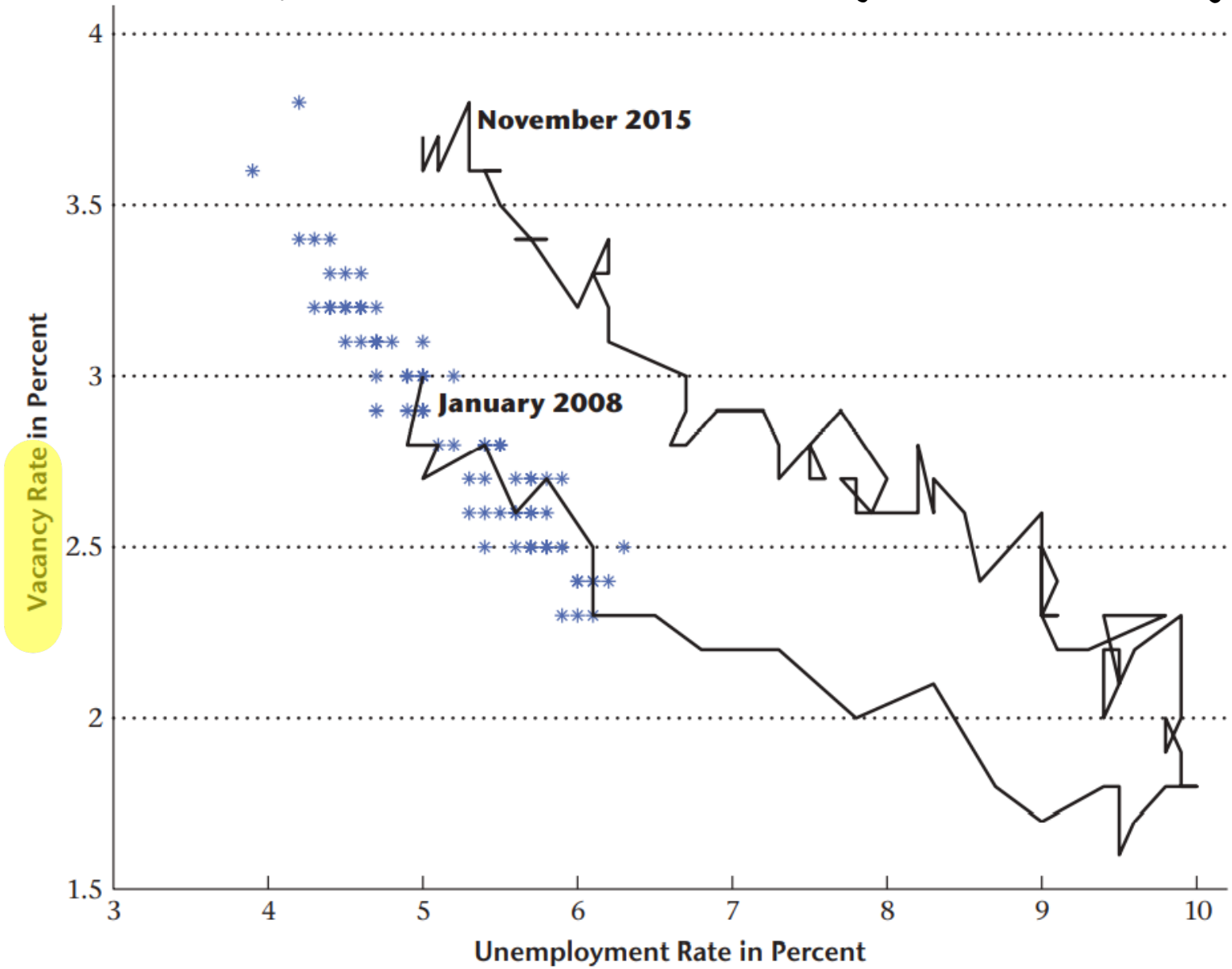


Unemployment



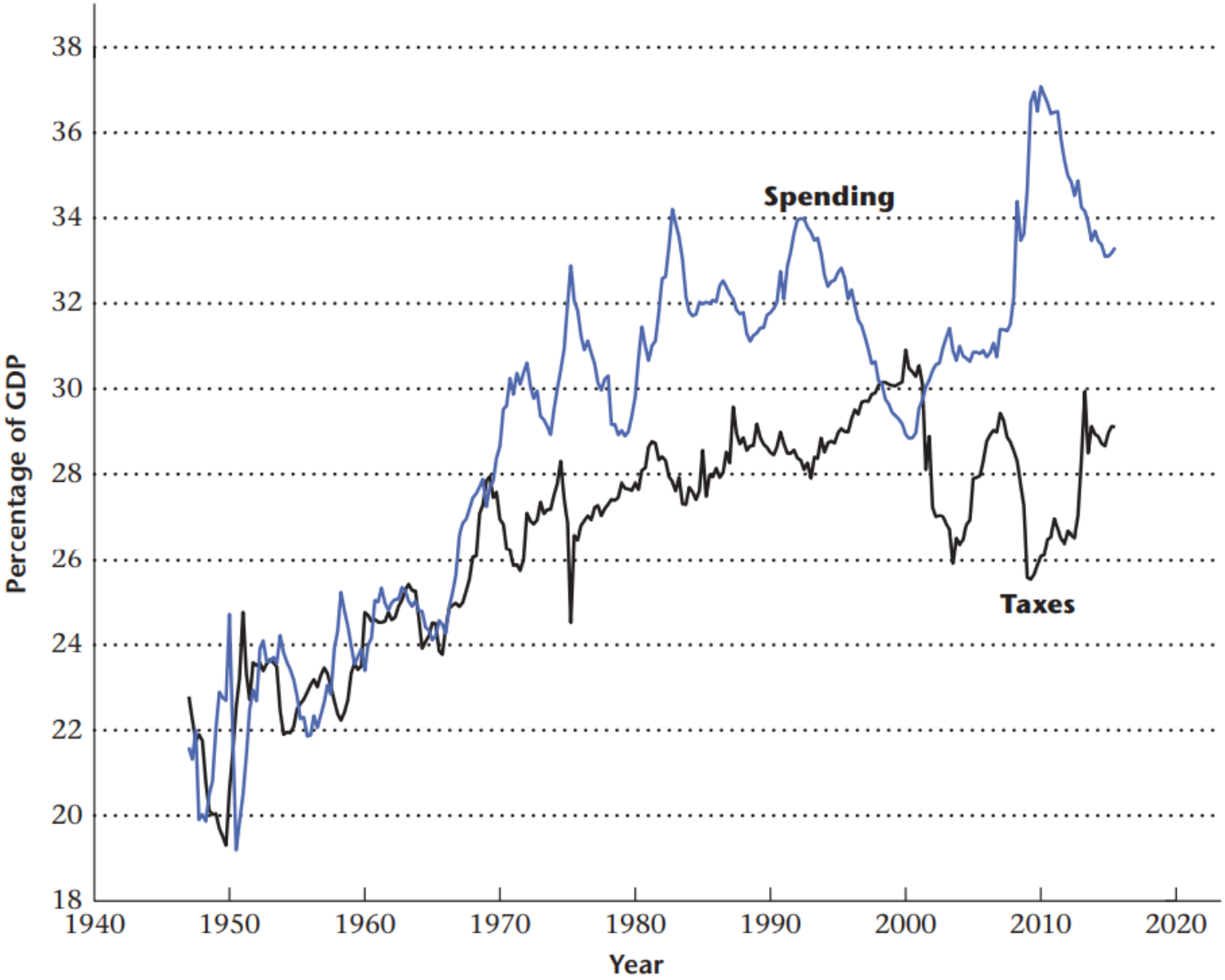
Beveridge Curve : empirical relationship between vacancy rate & unemployment rate

no.

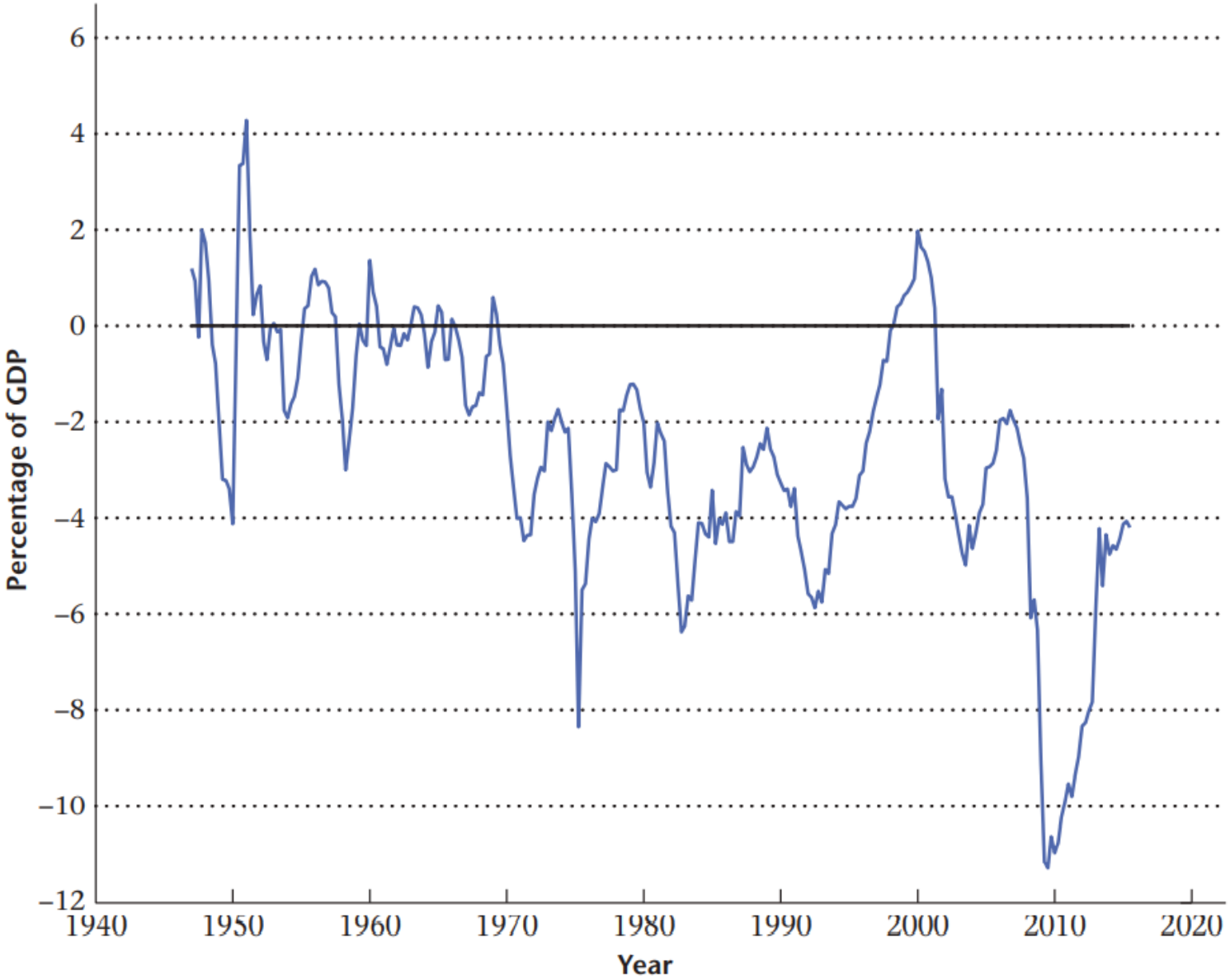


Taxes and Government Spending

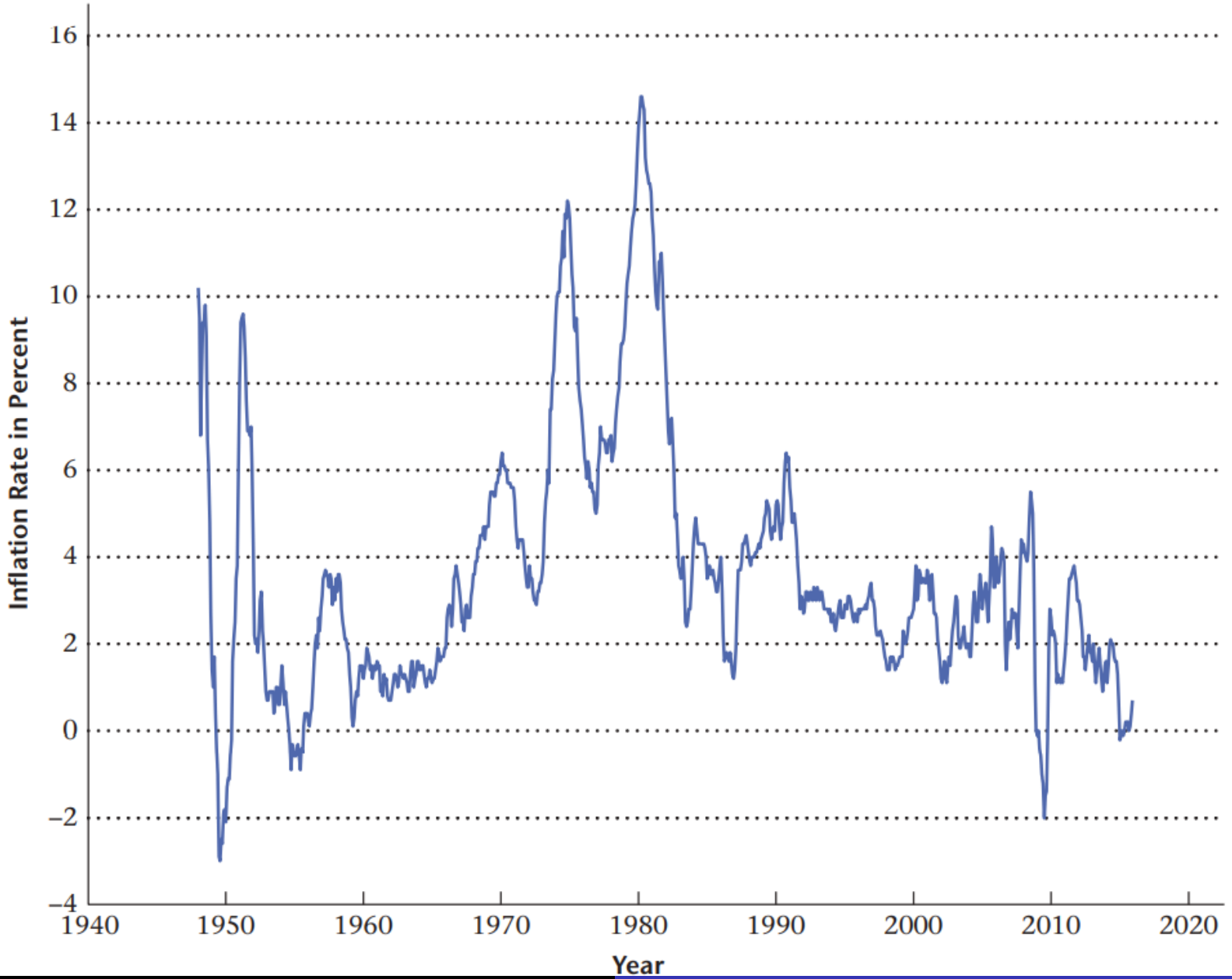
* SG maintains budget surplus



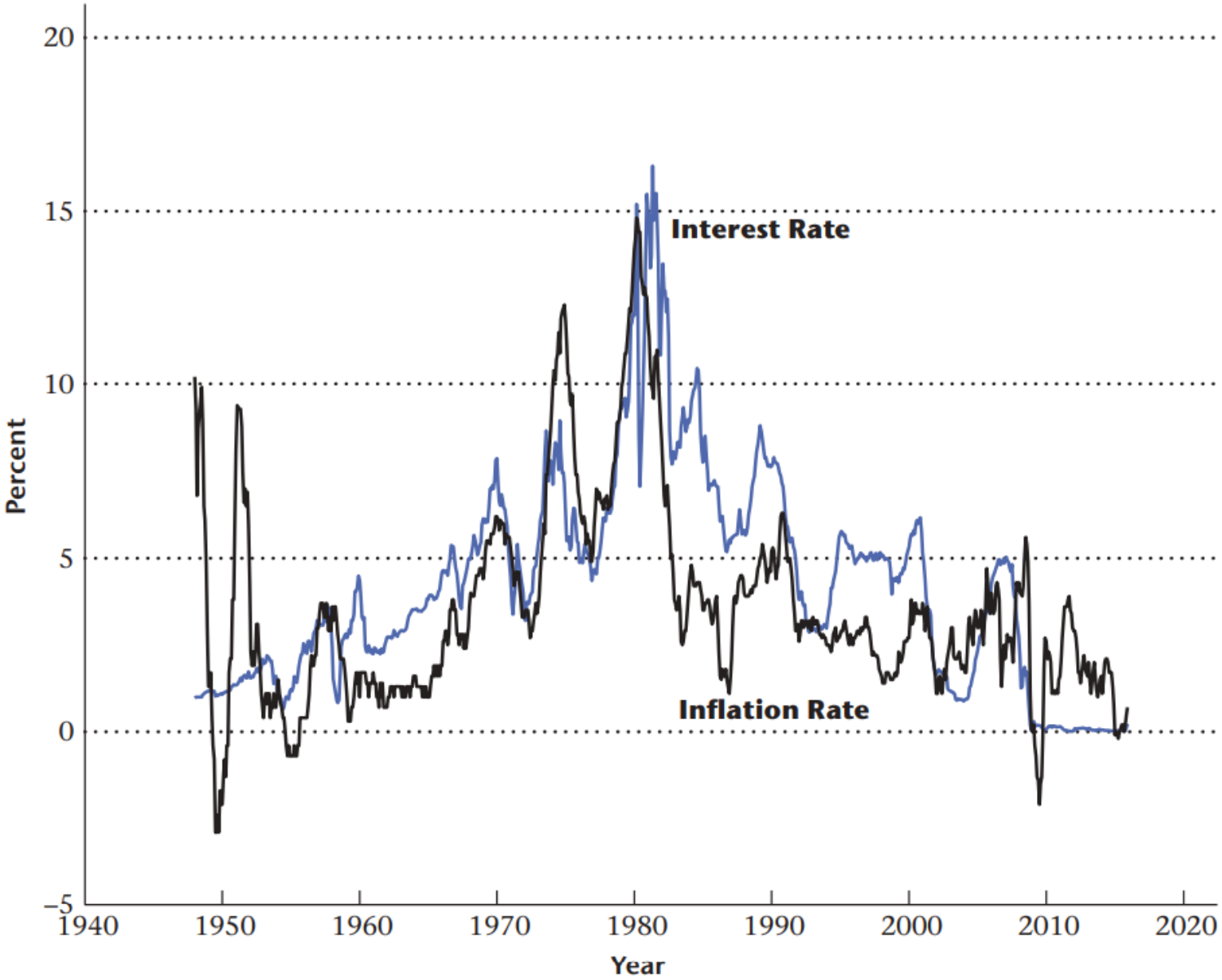
Government Budget Surplus



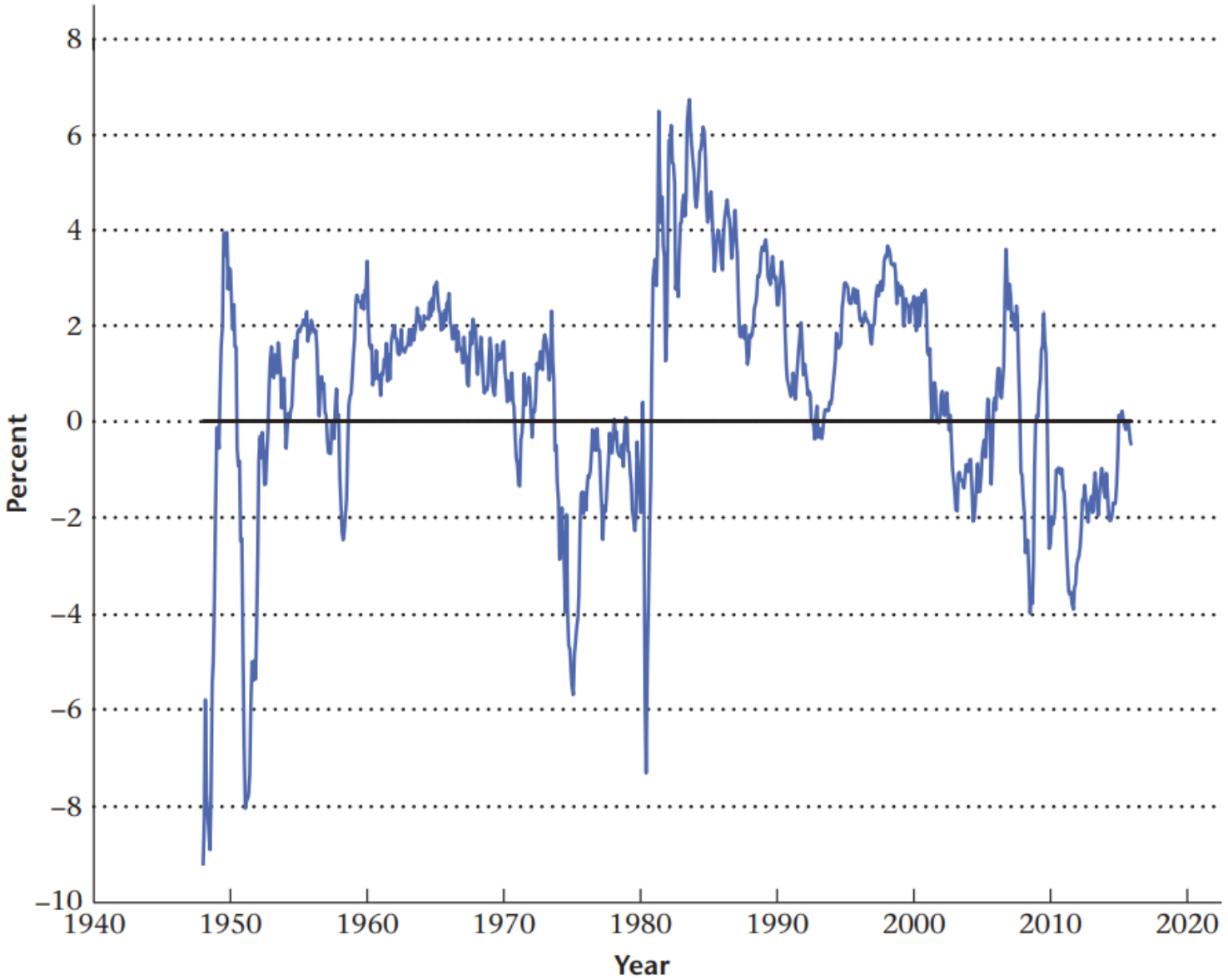
Inflation


16
14
12
10
8
6
4
2
0
−2
−4
Inflation Rate in Percent
1940
1950
1960
1970
1980
1990
2000
2010
2020
Year

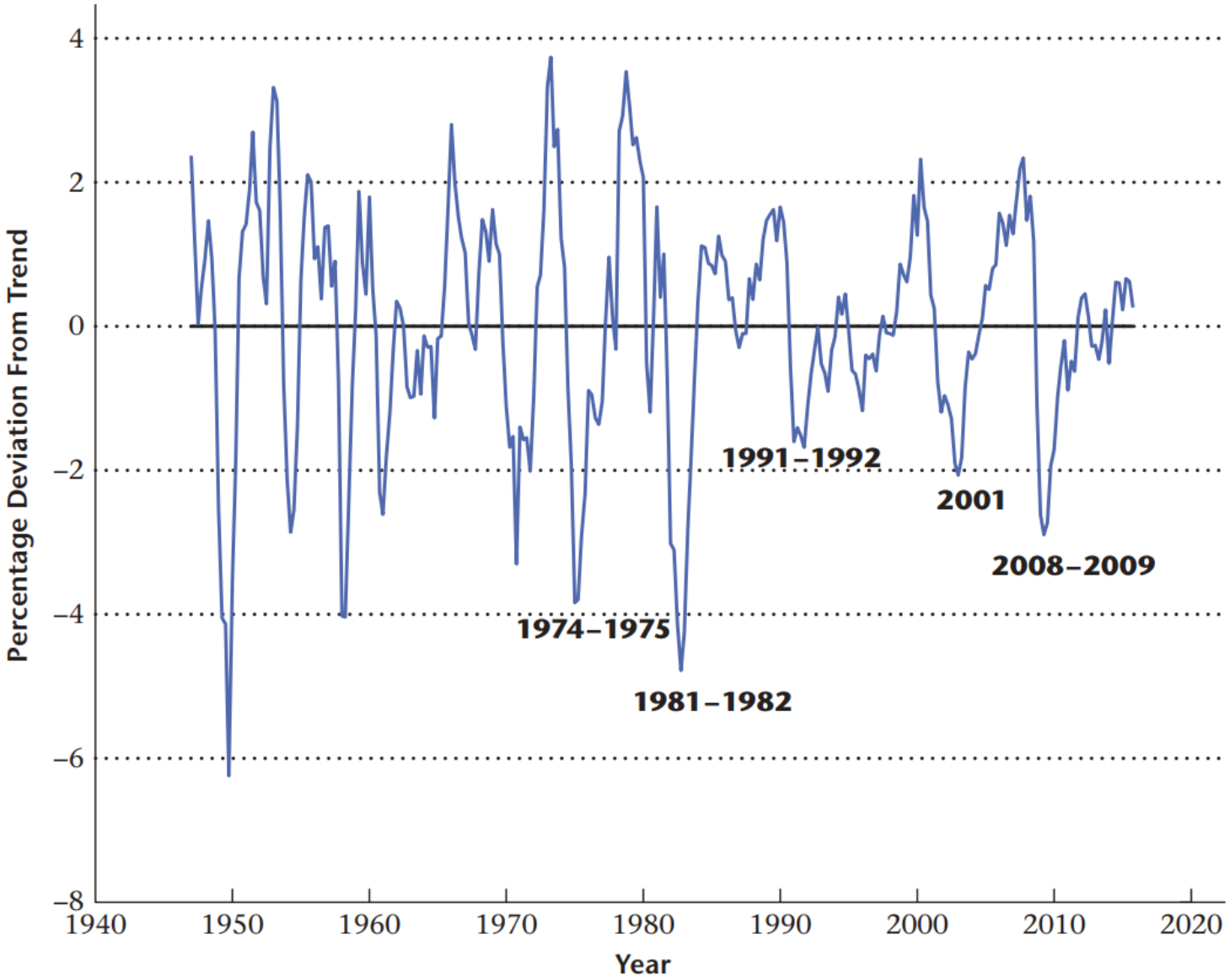
Nominal Interest Rate



Real Interest Rate



Business Cycle



Macroeconomic Models

- Basic elements
  1. The consumers and firms that interact in the economy.
  2. The set of goods that consumers wish to consume.
  3. Consumers' preferences over goods.
  4. The technology available to firms for producing goods.
  5. The resources available.

- Competitive equilibrium or "general equilibrium"
  1. Economic agents (consumers, firms, or even governments...) optimize.
  2. Markets are competitive: Individual consumers and firms do not influence price and take price as given (price takers).
  3. Market clearing: In each market, quantity of goods supplied is equal to the quantity of goods demanded.

Plan for this Class

1. Introduction

2. **Measurement Issues**

National Income Accounting

- The chief aim: To obtain a measure of the GDP.
- Three approaches:
  1. Product approach.
  2. Expenditure approach.
  3. Income approach.
- Each approach should return exactly the same measure of GDP.

Fictional Island Economy

Table 2.1 Coconut Producer

Total Revenue	$20 million
Wages	$5 million
Interest on Loan	$0.5 million
Taxes	$1.5 million

Table 2.2 Restaurant

Total Revenue	$30 million
Cost of Coconuts	$12 million
Wages	$4 million
Taxes	$3 million

Table 2.3 After-Tax Profits

Coconut Producer	$13 million
Restaurant	$11 million

Table 2.4 Government

Tax Revenue	$5.5 million
Wages	$5.5 million

- Imagine an economy with a coconut producer, a restaurant, consumers (include business owners), and a government.
- Coconut producer:
  - 10 million coconuts, sold at $2 each.
  - $5 million wages to workers.
  - $0.5 million in loan interest to consumers.
  - $1.5 million in taxes to the government.
  - 6 million coconuts go to the restaurant.
  - 4 million coconuts go to the consumers.
- Restaurant:
  - Use coconuts to produce meals (drink, soup, shredded). Sells $30 million meals.
  - Cost of coconuts: $12 million
  - Wages to workers: $4 million.
  - Taxes: $3 million.
- Government use taxes ($4.5 million from producers and $1 million from workers) to pay soldiers and provide national defense.

Product Approach

Table 2.1 Coconut Producer

Total Revenue	$20 million
Wages	$5 million
Interest on Loan	$0.5 million
Taxes	$1.5 million

Table 2.2 Restaurant

Total Revenue	$30 million
Cost of Coconuts	$12 million
Wages	$4 million
Taxes	$3 million

Table 2.3 After-Tax Profits

Coconut Producer	$13 million
Restaurant	$11 million

Table 2.4 Government

Tax Revenue	$5.5 million
Wages	$5.5 million

- Also called value-added approach.

$$\text{GDP} = \text{Sum of value added}$$

where value added is the difference between total revenue and cost of intermediate goods (coconuts).

- Value added of coconut producer: $20 million.
- Value added of restaurant: Revenue - cost of coconuts = $18 million.
- Value added of government: $5.5 million.
- GDP = $20 + $18 + $5.5 = $43.5 million.

Expenditure Approach

Table 2.1 Coconut Producer

Total Revenue	$20 million
Wages	$5 million
Interest on Loan	$0.5 million
Taxes	$1.5 million

Table 2.2 Restaurant

Total Revenue	$30 million
Cost of Coconuts	$12 million
Wages	$4 million
Taxes	$3 million

Table 2.3 After-Tax Profits

Coconut Producer	$13 million
Restaurant	$11 million

Table 2.4 Government

Tax Revenue	$5.5 million
Wages	$5.5 million

- Total spending on all final goods and services production in the economy.

$$\text{Total expenditure} = C+I+G+(X-M)$$

where C denotes consumption, I is investment expenditure, G is government expenditure, X is exports, and M is imports.

- Consumption:
only count final coconuts
$30 (restaurant) + $8 (coconut producer)
$= $38 million.
- Investment expenditure:
Zero.
- Government expenditure:
$5.5 million.
- GDP $= $38 + $5.5 $= $43.5 million.

Income Approach

Table 2.1 Coconut Producer

Total Revenue	$20 million
Wages	$5 million
Interest on Loan	$0.5 million
Taxes	$1.5 million

Table 2.2 Restaurant

Total Revenue	$30 million
Cost of Coconuts	$12 million
Wages	$4 million
Taxes	$3 million

Table 2.3 After-Tax Profits

Coconut Producer	$13 million
Restaurant	$11 million

Table 2.4 Government

Tax Revenue	$5.5 million
Wages	$5.5 million

- Total income received by economic agents contributing to production.
- Wage income: (before tax)
  $5 (coconut producer) + $4 (restaurant) + $5.5 (government) = $14.5 million.
  ↳ National defense
- Interest income:
  $0.5 million.
- Business income (after-tax profit):
  $13 (cononut producer) + $11 (restaurant) = $24 million.
- Taxes (from producers):
  $4.5 million.
- GDP = $14.5 + $0.5 + $24 + $4.5 = $43.5 million.

Components of Aggregate Expenditure

Table 2.9 Gross Domestic Product for 2015

Component of GDP	$Billions	% of GDP
GDP	17,937.8	100.0
Consumption	12,267.9	68.4
Durables	1,328.8	7.4
Nondurables	2,649.8	14.8
Services	8,289.3	46.2
Investment	3,017.8	16.8
Fixed Investment	2,911.3	16.2
Nonresidential	2,302.4	12.8
Residential	608.9	3.4
Inventory Investment	106.5	0.6
Net Exports	531.9	3.0
Exports	2,253.0	12.6
Imports	2,784.9	15.5
Government Expenditures	3,184.0	17.8
Federal Defense	740.9	4.1
Federal Nondefense	483.9	2.7
State and Local	1,959.3	10.9

Price Index

- A price index is a weighted average of the prices of a set of the goods and services produced in the economy over a period of time.
- We use price indices to measure the inflation rate, which is the rate of change in the price level.
- Nominal vs. Real GDP

Example

Table 2.10 Data for Real GDP Example

	Apples	Oranges
Quantity in Year 1	$Q_1^a = 50$	$Q_1^o = 100$
Price in Year 1	$P_1^a = \$1.00$	$P_1^o = \$0.80$
Quantity in Year 2	$Q_2^a = 80$	$Q_2^o = 120$
Price in Year 2	$P_2^a = \$1.25$	$P_2^o = \$1.60$

- Nominal GDP in each year is

$$GDP_1 = P_1^a Q_1^a + P_1^o Q_1^o = (\$1.00 * 50) + (\$0.80 * 100) = \$130$$

$$GDP_2 = P_2^a Q_2^a + P_2^o Q_2^o = (\$1.25 * 80) + (\$1.60 * 120) = \$292$$

- Percentage change is

$$\left(\frac{GDP_2}{GDP_1} - 1\right) \times 100\% = \left(\frac{292}{130} - 1\right) \times 100\% = 125\%$$

Example (Cont'd)

Table 2.10 Data for Real GDP Example

	Apples	Oranges
Quantity in Year 1	$Q_1^a = 50$	$Q_1^o = 100$
Price in Year 1	$P_1^a = \$1.00$	$P_1^o = \$0.80$
Quantity in Year 2	$Q_2^a = 80$	$Q_2^o = 120$
Price in Year 2	$P_2^a = \$1.25$	$P_2^o = \$1.60$

reference year

- Real GDP can be computed using base-year prices

$$GDP_1 = P_1^a Q_1^a + P_1^o Q_1^o = (\$1.00 * 50) + (\$0.80 * 100) = \$130$$

$$GDP_2 = P_1^a Q_2^a + P_1^o Q_2^o = (\$1.00 * 80) + (\$0.80 * 120) = \$176$$

- Percentage change is

$$\left(\frac{GDP_2}{GDP_1} - 1\right) \times 100\% = \left(\frac{176}{130} - 1\right) \times 100\% = 35.4\%$$

Example (Cont'd)

Table 2.10 Data for Real GDP Example

	Apples	Oranges
Quantity in Year 1	$Q_1^a = 50$	$Q_1^o = 100$
Price in Year 1	$P_1^a = \$1.00$	$P_1^o = \$0.80$
Quantity in Year 2	$Q_2^a = 80$	$Q_2^o = 120$
Price in Year 2	$P_2^a = \$1.25$	$P_2^o = \$1.60$

- Alternatively we can use year 2 as the base year to compute real GDP

$$GDP_1 = P_2^a Q_1^a + P_2^o Q_1^o = (\$1.25 * 50) + (\$1.60 * 100) = \$222.50$$

$$GDP_2 = P_2^a Q_2^a + P_2^o Q_2^o = (\$1.25 * 80) + (\$1.60 * 120) = \$292$$

Still use year 2 for year 1

- Percentage change is

$$\left(\frac{GDP_2}{GDP_1} - 1\right) \times 100\% = \left(\frac{292}{222.5} - 1\right) \times 100\% = 31.2\%$$

- The choice of base year matters!

Chain-Weighting Approach

which year to use as base

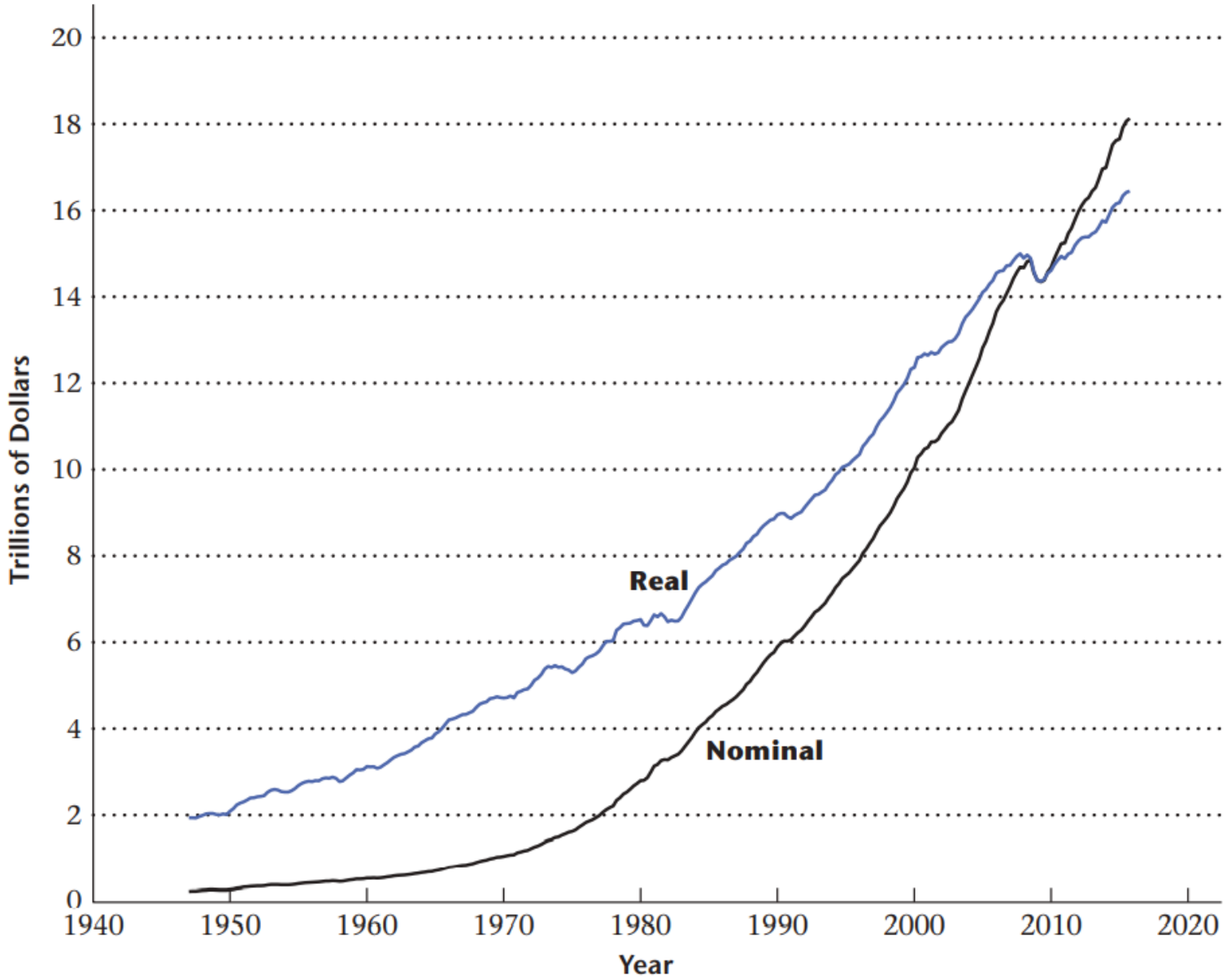
- To avoid this problem, the standard practice is to use a chain-weighting scheme to calculate real GDP. "Fisher Index".
- The idea is to essentially use ~~rolling base~~ period and adopt geometric averages.

$$\left(\sqrt{(1+0.354)\times(1+0.312)}-1\right)\times 100\% = 33.3\%.$$

- The chain weighted ratio g_c is then $1+0.333 = 1.333$. We can use this to compute chained real GDP.
- In practice, we can do this year by year for every two adjacent years ("chained"). And we can choose a year to measure chained real GDP in the prices of that year (say year 1). In that year, nominal GDP = real GDP.
- The real GDP in other years = nominal GDP in base year divides/multiplies by all chain weighted ratios to that year.
  - Year 2 real GDP in year 1 prices = \$292/1.333 = \$219.05.
  - Year 3 real GDP in year 1 prices = \$350/1.333/1.111 = ...
  - Year 0 real GDP in year 1 prices = \$100*1.055 = ...

Not Tested

Chain-Weighted Real GDP (measured in year 2009 dollars)



Measures of the Price Level

- Two commonly used measures.
- Implicit GDP price deflator. (1)

$$\text{Implicit GDP price deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100.$$

- (2) Consumer price index (CPI) is not as broadly based as the implicit GDP price deflator, because it includes only goods and services that are purchased by consumers.

* fix basket of goods & services

- Further, the CPI is a fixed-weight price index, which takes the quantities in some base year as being the typical goods bought by the average consumer during that base year, and then uses those quantities as weights to calculate the index in each year. * fixing quantities

$$\text{Current year CPI} = \frac{\text{Cost of base year quantities at current prices}}{\text{Cost of base year quantities at base year prices}} \times 100$$

CPI Example

Table 2.10 Data for Real GDP Example

	Apples	Oranges
Quantity in Year 1	$Q_1^a = 50$	$Q_1^o = 100$
Price in Year 1	$P_1^a = \$1.00$	$P_1^o = \$0.80$
Quantity in Year 2	$Q_2^a = 80$	$Q_2^o = 120$
Price in Year 2	$P_2^a = \$1.25$	$P_2^o = \$1.60$

- Cost of base year quantities at base year prices:

$$P_1^a Q_1^a + P_1^o Q_1^o = (\$1.00 * 50) + (\$0.80 * 100) = \$130$$

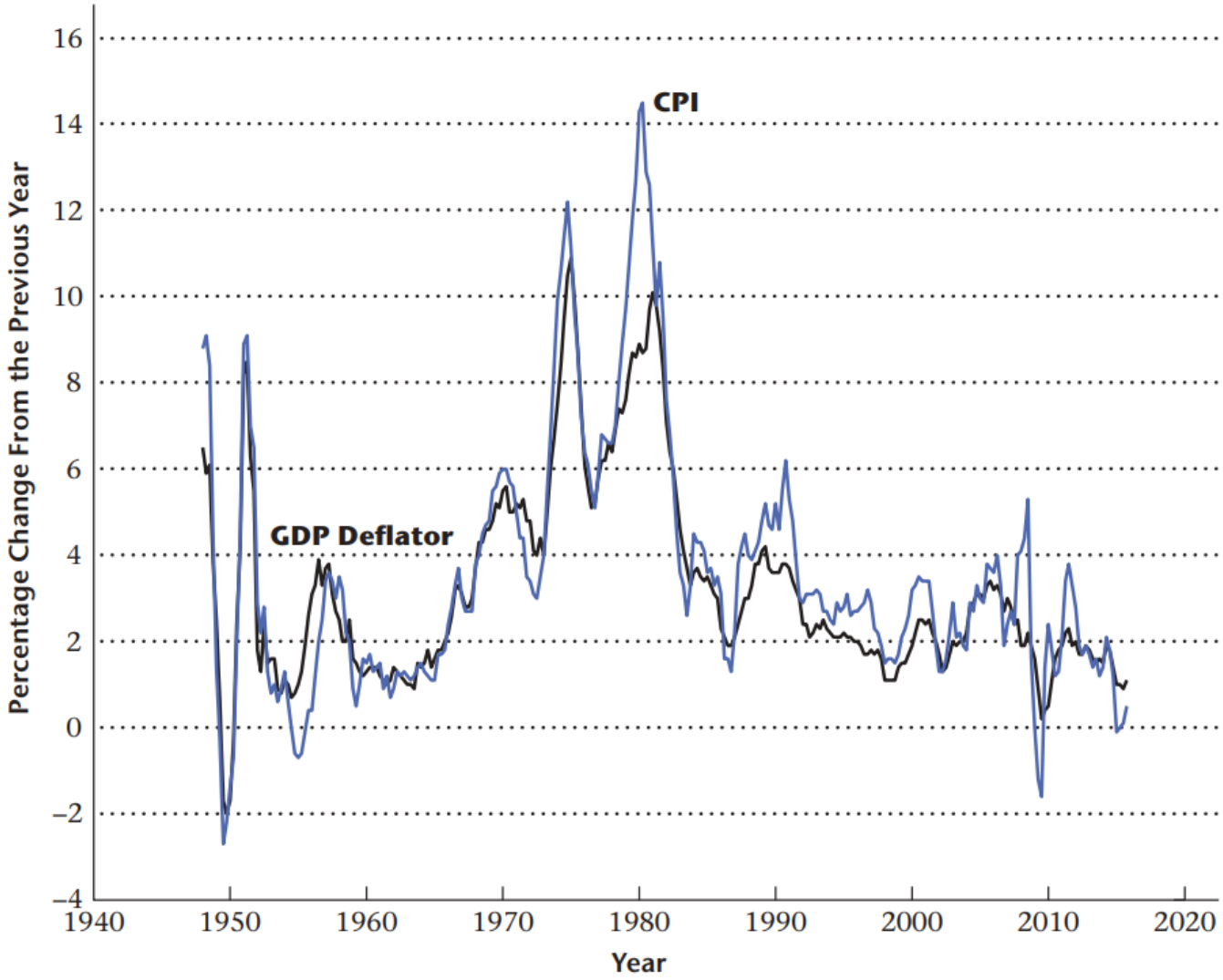
- Cost of base year quantities at current prices:

$$P_2^a Q_1^a + P_2^o Q_1^o = (\$1.25 * 50) + (\$1.60 * 100) = \$222.5$$

- Hence, current year CPI is $\frac{222.5}{130} \times 100 = 171.2$. CPI inflation rate is 71.2%.

CPI vs. GDP Deflator

CPI is much more volatile



Labor Market Measurement

- Current Population Survey (CPS) by the Bureau of Labor Statistics in the US. A monthly household survey. At least 15 years of age.
- People are divided into 3 groups: employed (part-time, full-time), unemployed (actively searching), not in the labor force.

labor force = employed + unemployed

- The various metrics are defined as follows:

$$\text{(1) Unemployment rate} = \frac{\text{Number unemployed}}{\text{Labor force}}$$

$$\text{(2) Participation rate} = \frac{\text{Labor force}}{\text{Total working age population}}$$

$$\text{(3) Employment/Population ratio} = \frac{\text{Employed}}{\text{Total working age population}}$$

Summary

By the end of this class, you should be able to understand the following:

- What does macroeconomics study?
- The key elements of macroeconomic models
- GDP and its accounting.
- Nominal and real GDP.
- GDP deflator and CPI inflation.
- Unemployment rate.

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