Business Cycles

Part 1: Introduction
Lecture 1: Measurement of macroeconomic variables,
concept of modern macroeconomic modeling

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Overview

Macroeconomics:

- Better called aggregate economics
- Macroeconomics analyzes aggregate economic variables like output growth, inflation, unemployment, and interest rates.
- Focus on dynamic/intertemporal nature of economic decision-making
- Economics is “Micro”. “Macro” just studies issues at aggregated (country) level
- Modern macroeconomics uses microfounded, dynamic, general, equilibrium models. We will study macroeconomic data and learn to build models to help us understand the data.

Key questions:

- Why does the economy grow over time?
- Why are some countries rich and others poor?
- Why are there business cycles or why do economies experience recessions?
- Why do financial crises happen?
- What is the role of government?

Purpose of this course:

- The course aims at building up a solid knowledge base of core topics in macroeconomics, which enables you to analyze various matters in a well-informed and concise way.

Learning Outcomes

Students who successfully complete this class will be able to:

1) State the stylized facts of business cycles.
2) Build simple models to explain the stylized facts.
3) Extend the models to analyze problems beyond those considered in class.
4) Qualitatively evaluate the effectiveness of alternative macroeconomic policies.
5) Be prepared for more specialized courses, for example, the one on monetary policy.

How are Questions and Themes Analyzed?

Questions are addressed in a variety of modern theoretical models.

Intuition vs. mathematic formalism

- Intuition is very important. You study economics, not mathematics!
- Nevertheless, some expertise on mathematics is necessary for the analysis of many macroeconomic topics.
- Formalism (the math) and intuition are not substitutes, but complements.
- The goals of the course are therefore twofold: 1. Develop a broad understanding of core topics on macroeconomics, 2. Learn mathematical tools in order to conduct independent analysis on important macroeconomic questions.

Prerequisites / What I expect from you

The course presumes knowledge of

- microeconomics and macroeconomics at the intermediate level
- elementary differential calculus
- high school level algebra

} Refresher in the first exercise session, Appendix of the textbook

What I expect from you:

- Come to class prepared, on time, and ready to participate.
- Read the relevant textbook chapters each week!!!
- Prepare the assignments for the exercise session before the exercise session takes place.
- Actively participate in the learning process.

Outline

Part 1: Introduction

- Lecture 1: Measurement of macroeconomic variables, concept of modern macroeconomic modelling

Part 2: Microeconomic Foundations

- Lecture 2: Consumption-savings problem
- Lecture 3: Equilibrium in an endownment economy, fiscal policy
- Lecture 4: Production and labor supply

Part 3: The Real Business Cycle Model

- Lecture 5: The real business cycle model
- Lecture 6: Effects of shocks, taking the model to the data, criticism of the RBC model

Outline

Part 4: The New Keynesian Model

- Lecture 7: Deriving the New Keynesian Model
- Lecture 8: The Effects of Shocks in the New Keynesian Model

Part 5: Financial Crises

- Lecture 9: Monetary Policy and the Zero Lower Bound on Interest Rates
- Lecture 10: The Great Recession

Mock Exam

- Lecture 11: Mock Exam

Most (not all) parts are more or less self-contained. If you get completely lost during the lectures of one part, you can have a fresh start at the beginning of the next part.

Literature

Main textbook (selected chapters):

- Sims, Eric, Julio Garin, and Robert Lester (2021). Intermediate Macroeconomics, https://www3.nd.edu/~esims1/GLS_may_2021.pdf.

Other useful macro textbooks:

- Williams, Stephen D., (2017). Macroeconomics. Pearson, Sixth Edition.
- Gottfries, Nils (2013). Macroeconomics, Palgrave, First Edition.
- Sorensen, Peter Birch, and Whitta-Jacobsen, Hans Jorgen (2010). Introducing Advanced Macroeconomics: Growth and Business Cylces, McGraw-Hill, Second Edition.
- Wickens, Michael (2011). Macroeconomic Theory. A Dynamic General Equilibrium Approach, Princeton University Press, Second Edition.
- Romer, David, (2012). Advanced Macroeconomics, McGraw-Hill, Fourth Edition.
- Heijdra, Ben j. (2009). Foundations of Modern Macroeconomics, Oxford University Press, Second Edition.

Academic papers:

- Will be announced during the course.

Videos of Lecture and Exercise Session

- We have uploaded the recorded lectures and exercise sessions from last year on WueCampus.
- You can either follow the lecture and exercise session in presence or remotely.
- Videos might also be useful to watch certain parts again at a later point in time.
- The recorded videos are is copyright protected. Sharing and distributing the content, especially for commercial purposes, is not allowed.

Lecture 1: Measurement of macroeconomic variables, concept of modern macroeconomic modelling

Learning Objective of Todays Lecture

1. Review concepts of main macroeconomic variables: GDP, inflation, unemployment rate.
2. Understand the concept of macroeconomic modeling.
3. Understand the Lucas critique and why modern macroeconomics builds on microeconomics.

Literature

Required reading:

- Textbook chapters 1-3

Optional reading

- Lucas, Robert E., Jr. (1976), “Econometric Policy Evaluation: A Critique,” in Karl Brunner und Alan Meltzer (eds.), The Phillips Curve and Labor Markets. Carnegie-Rochester Conference Series on Public Policy, Vol. 1, pp. 19-46.
- Ljungqvist, Lars (2008). Lucas Critique, The New Palgrave Dictionary of Economics, second edition, eds. Steven Durlauf and Larry Blume, Palgrave Macmillan, 2008.
- Relevant chapters from a basic macroeconomic textbook (Mankiw, Blanchard, …), if you are not familiar with the basic IS-LM, AS-AD and Phillips-curve models.

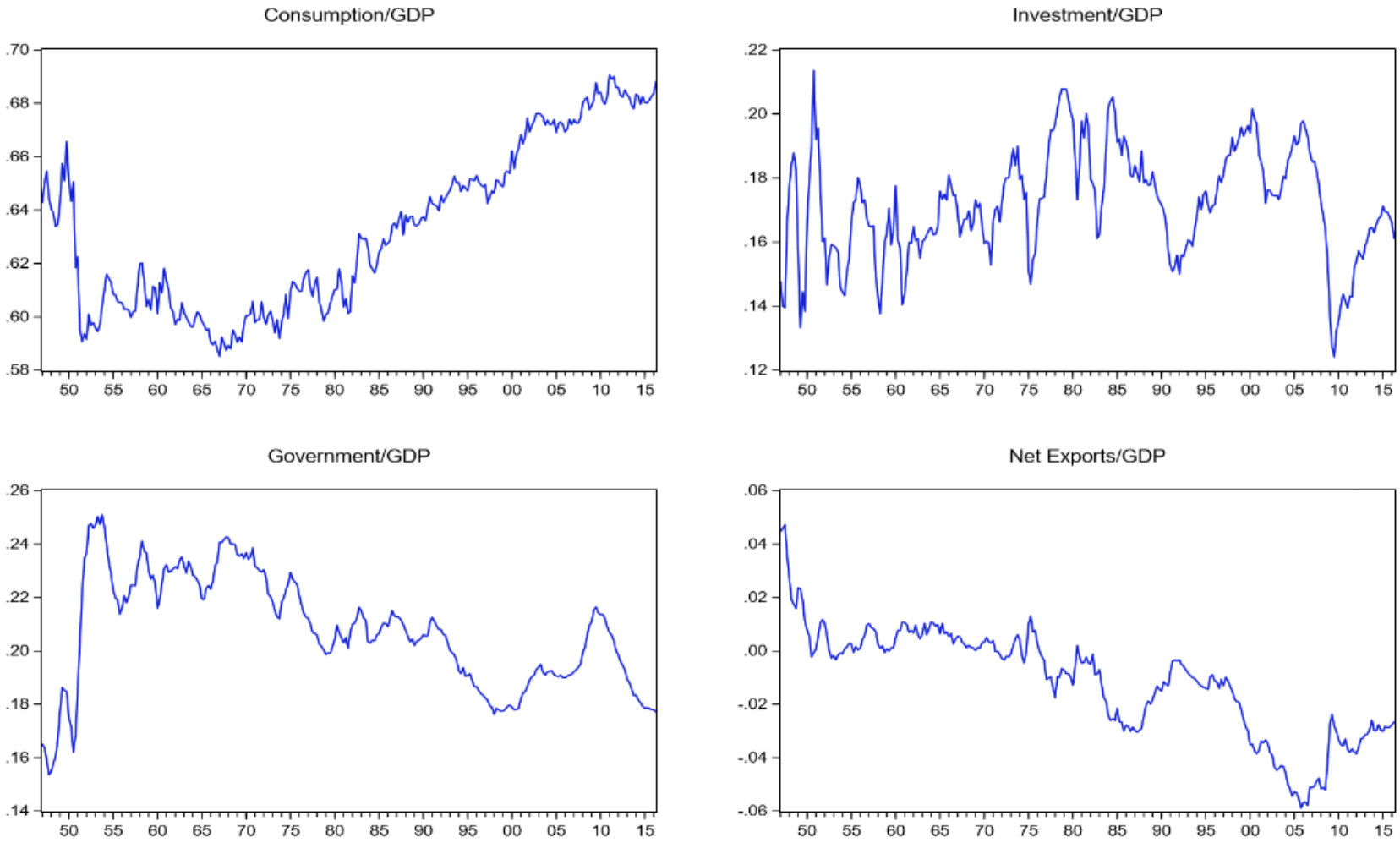
Basic Accounting

GDP: current value of all final goods and services produced within a country during a particular period of time

- "Final" means that intermediate goods are excluded from the calculation
  → Avoid double counting
- GDP: a measure of production and a flow concept
- Production = Income = Expenditure
- Income approach: $GDP_t = Wages_t + Interest_t + Rent_t + Profit_t$
- Expenditure approach:
  $GDP_t = Consumption_t + Investment_t + Government_t + Net\ Exports_t$
  Short notation: $Y_t = C_t + I_t + G_t + NX_t$
- Per capita GDP often used as a measure of the standard-of-living or well-being in an economy, though there are many problems with GDP. But still the best aggregate measure of economic output that we have.

Components of GDP (US)

Figure 1.2: GDP Components as a Share of Total GDP



Real vs. Nominal I

- GDP is defined in terms of current prices (in euros, dollars, etc.):

$$GDP_t = p_{1,t}y_{1,t} + p_{2,t}y_{2.t} + \cdots + p_{N,t}y_{N,t} = \sum_{i=1}^{N} p_{i,t}y_{i,t}$$

- Effectively, prices are weights reflecting relative valuations of different goods
- But makes comparisons across time difficult
- Want a “real” or “inflation-adjusted” measure of GDP
- How to do this?

Real vs. Nominal II

- In a single good world (most of this course), something real is denominated in quantities of goods, whereas nominal is measured in units of money (i.e., euros)
- So, suppose you produce 10 cans of beer valued at € 2 per can. Real quantity is 10 cans, nominal value is € 20

$$Real = \frac{Nominal}{Price} = \frac{py}{p} = y$$

- Not so obvious how to do this with many different goods

Real vs. Nominal III

- Case with two goods:

$$Nominal = p_1 y_1 + p_2 y_2$$

  - Use the concept of (real) relative prices: How many units of good 2 can I get with one unit of good 1:

$$\frac{p_1}{p_2} = \frac{\frac{€}{good\ 1}}{\frac{€}{good\ 2}} = \frac{good\ 2}{good\ 1}$$

  - Example, suppose the price of apples is \$5 and the price of oranges is \$1. The relative price is 5 – you can get five oranges by giving up one apple.
  - We could define real output (or GDP) in one of two ways: in units of good 1 or units of good 2:

$$Real_1 = y_1 + \frac{p_2}{p_1}\, y_2 \text{ (Units are good 1)}$$

$$Real_2 = \frac{p_1}{p_2}\, y_1 + y_2 \text{ (Units are good 2)}$$

Real vs. Nominal IV

- The previous approach is inconvenient with many goods
- Solution: Use money as the numeraire and report GDP in nominal terms as Euros of output and then go to real GDP by holding prices fixed.
- "Constant price" GDP.
  - Value quantities of goods at different points in time using fixed prices (base year prices). So real GDP is denominated in units of money but facilitates comparisons over time.

$$Real\ GDP_t = p_{1,0}y_{1,t} + p_{2,0}y_{2,t} + \cdots + p_{N,0}y_{N,t} = \sum_{i=1}^{N} p_{i,0}y_{i,t}$$

  - Can "back out" a measure of aggregate prices via the implicit price index: ratio of nominal (current dollar) GDP to real (constant dollar) GDP: **GDP Deflator**

$$GDP\ Deflator = \frac{\sum_{i=1}^{N} p_{i,t}y_{i,t}}{\sum_{i=1}^{N} p_{i,0}y_{i,t}}$$

  - **Inflation**: rate of growth of price index

Chain-Weighted Real GDP

Growth rates of constant price GDP depend on the chosen base year, because relative prices vary over time

- Example: Economy with two goods, haircuts (y_1) and computers (y_2)

$$GDP_t = € 5 * 100 + € 500 * 10 = € 5500$$
$$GDP_{t+1} = € 10 * 100 + € 300 * 20 = € 7000$$

Base year t:

$$Real\ GDP_t = € 5 * 100 + € 500 * 10 = 5500$$
$$Real\ GDP_{t+1} = € 5 * 100 + € 500 * 20 = 10500$$

Growth rate: $\frac{10500}{5500} - 1 = 0.91 = 91\%$

Base year $t + 1$:

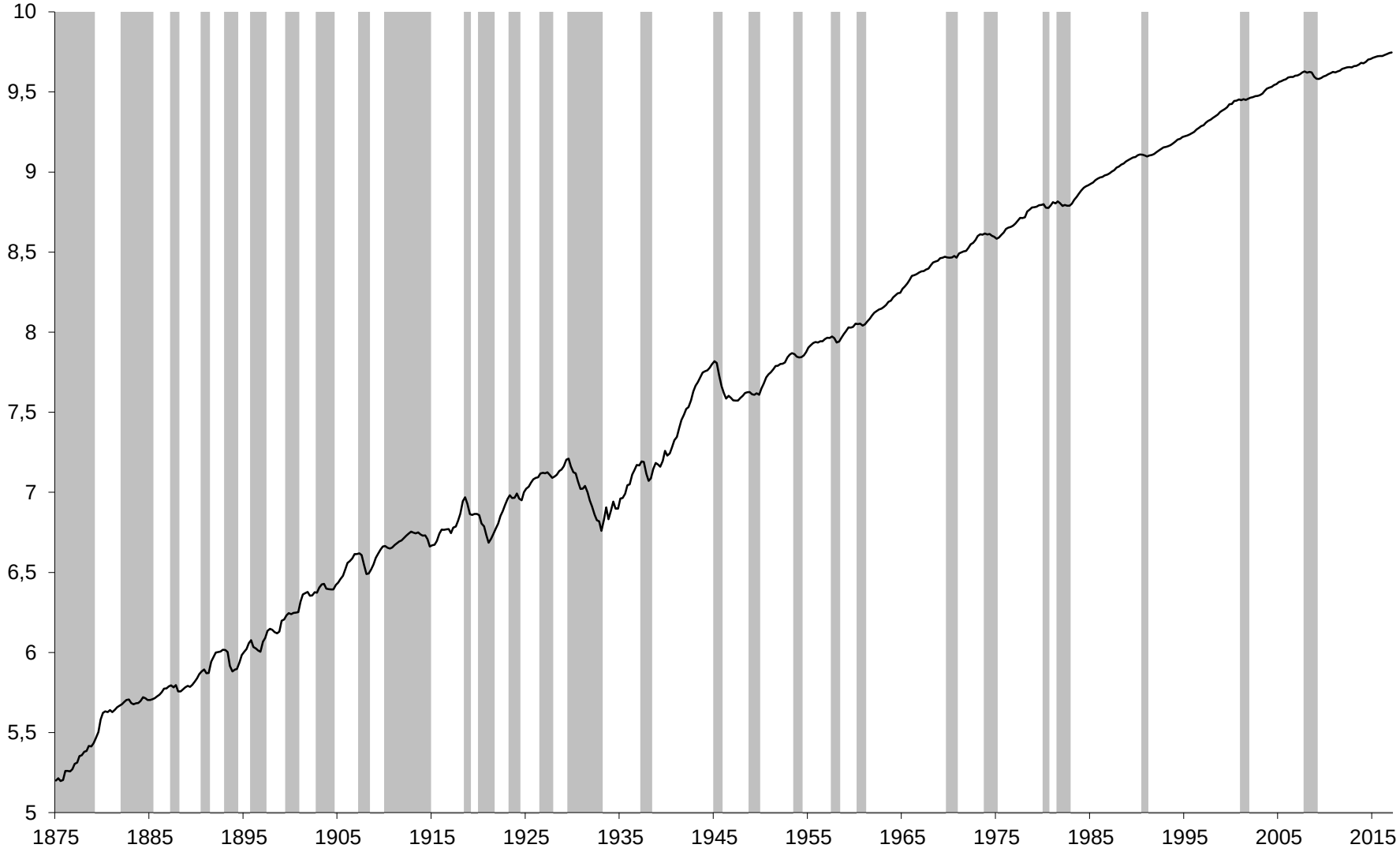
$$Real\ GDP_t = € 10 * 100 + € 300 * 10 = 4000$$
$$Real\ GDP_{t+1} = € 10 * 100 + € 300 * 20 = 7000$$

Growth rate: $\frac{7000}{4000} - 1 = 0.75 = 75\%$

Solution: Use chain-weighted real GDP

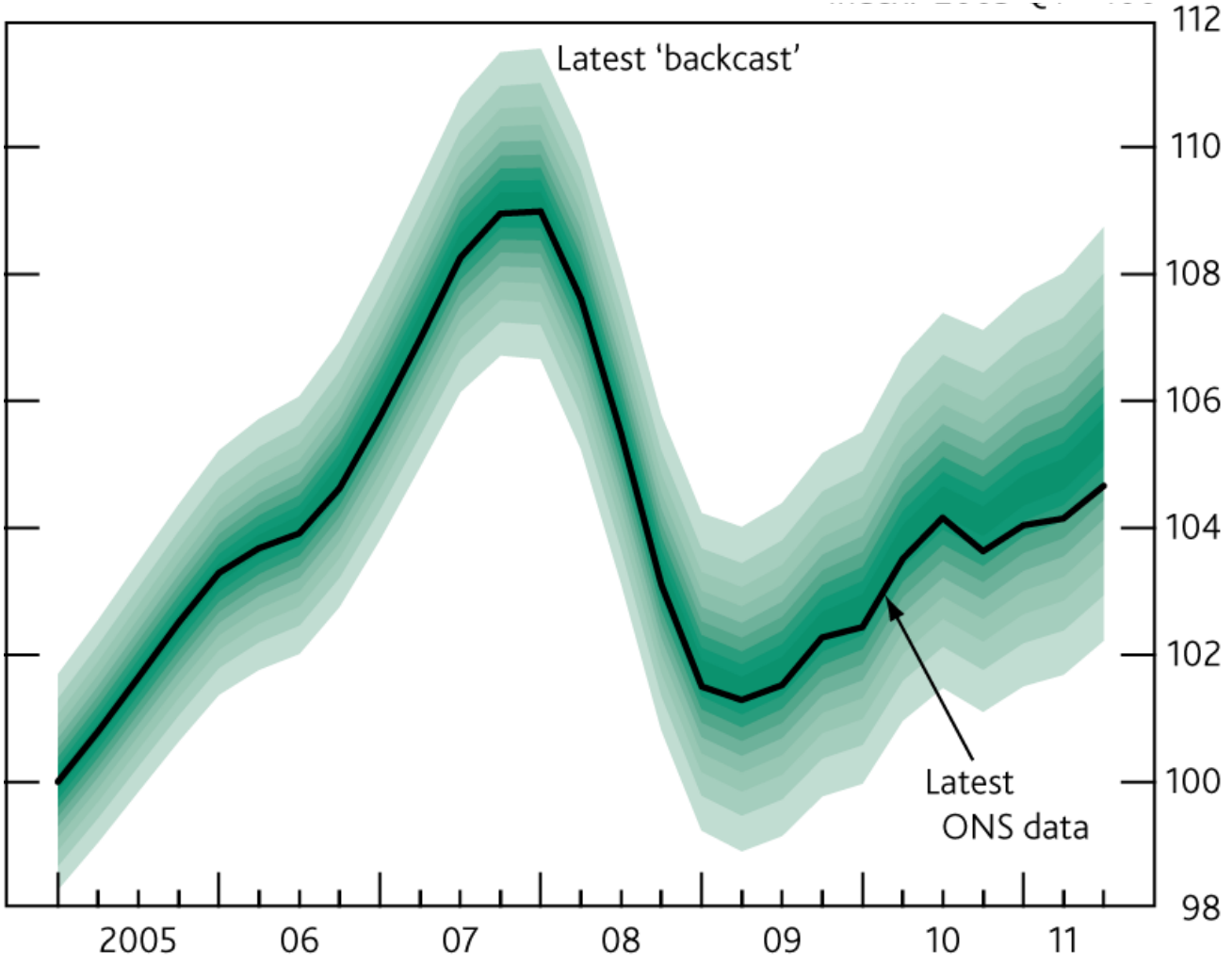
- Calculate real GDP in any two consecutive years based two times using t and $t + 1$ as the respective base year.
- Compute for both cases the growth rate.
- Take mean of both growth rates.

Log Real GDP


10
9,5
9
8,5
8
7,5
7
6,5
6
5,5
5
1875
1885
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015

GDP is an Estimate

Real GDP UK (Index, 2005Q1=100)



Sources: ONS and Bank of England calculations.

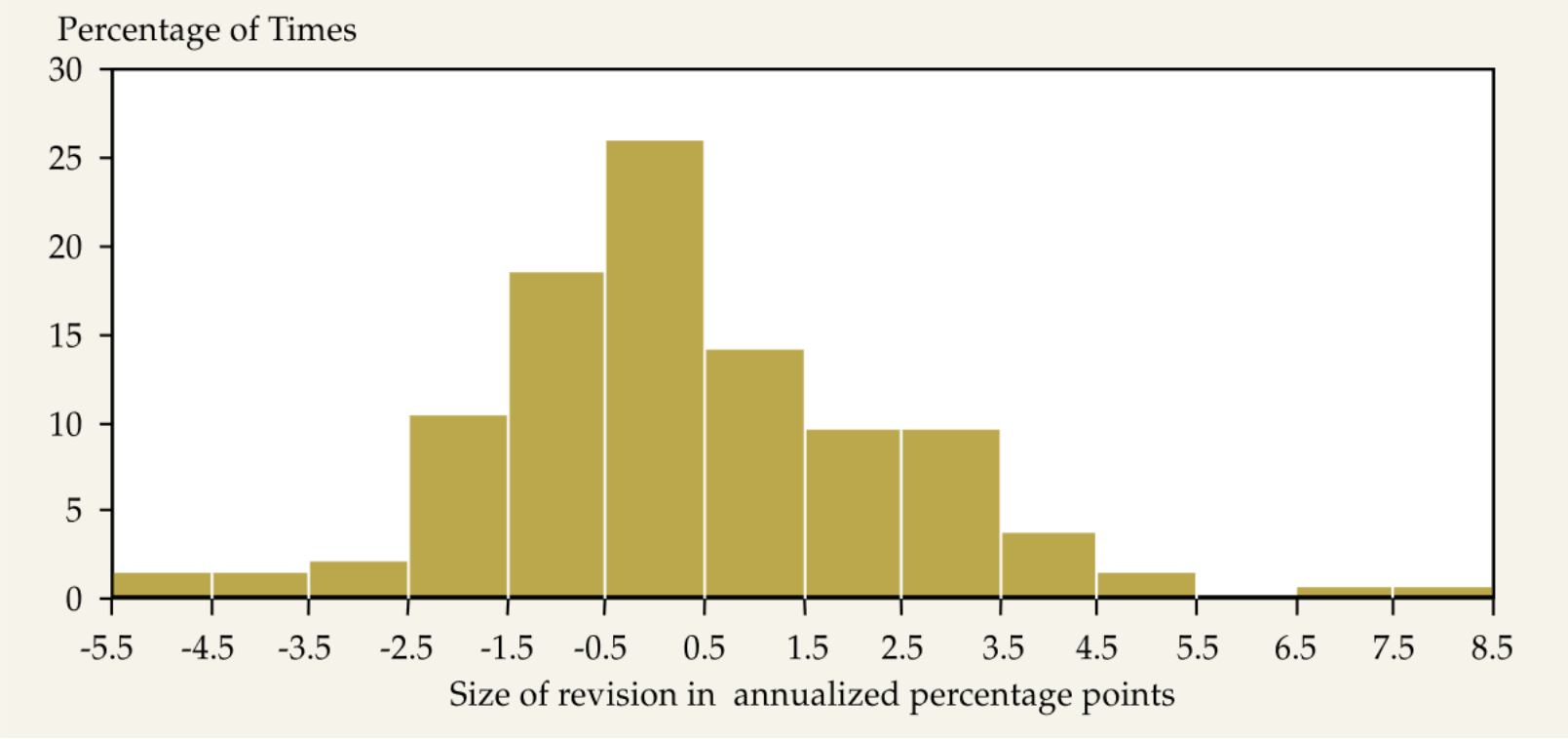
(a) Chained-volume measures. The fan chart depicts an estimated probability distribution for GDP over the past. It can be interpreted in the same way as the fan charts in Section 5 and forms the first part of the fan shown in **Chart 5.5** on page 42.

Revisions are large

GDP is heavily revised over time

- Initial estimates are based on incomplete data. Over time more data becomes available, so that estimates should become more reliable. Example: Tax data
- Further, there are benchmark revisions that incorporate new source data and may also include changes in definitions of variables or changes in methodology.

Size of revisions of US GDP growth rates between 1965 and 1999:



Source: Croushore and Stark (2000)

Consumer Price Index

The CPI measures the aggregate price level relevant for consumers.

- Based on a basket of goods that represents buying habits of a typical consumer.
- Multiply the quantity good in the basket with prices to get the total value of the goods basket:

$$Value_t = p_{1,t}\, x_1 + p_{2,t}\, x_2 + \cdots + p_{N,t}\, x_N = \sum_{i=1}^{N} p_{i,t} x_i$$

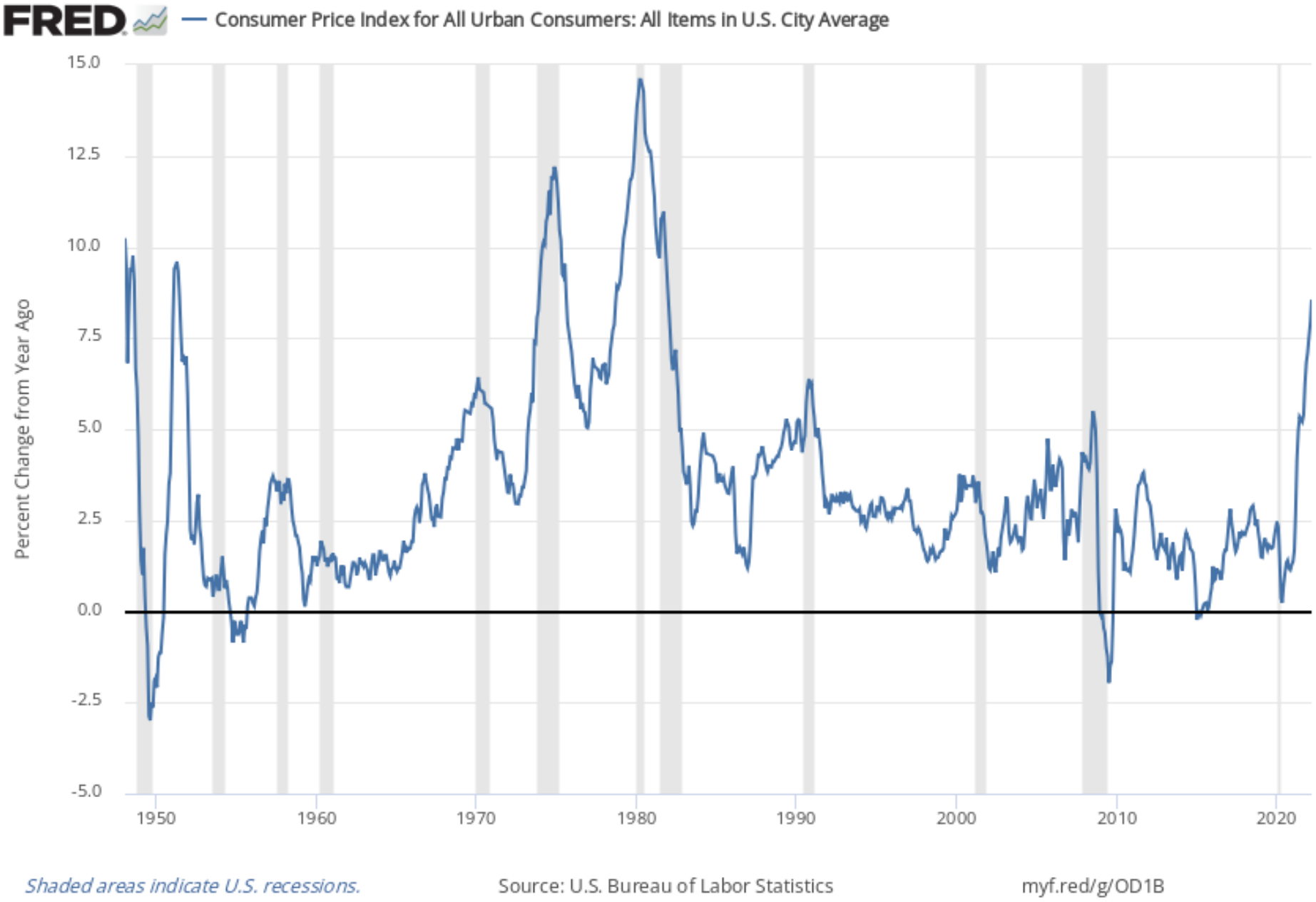
- Define an arbitrary base year for which the price level is normalized to 1 and compute the value of the basket relative to this base year:

$$P_t^{CPI} = \frac{Value_t}{Value_0} = \frac{\sum_{i=1}^{N} p_{i,t} x_i}{\sum_{i=1}^{N} p_{i,0} x_i}$$

- Inflation: Percentage change of CPI Index

Difference to GDP deflator:

- Goods relevant for consumer including imports rather than all goods produced within the economy.
- Holdings fixed quantities (basket is only adjusted every couple of years) rather than holding fixed prices.


FRED
Consumer Price Index for All Urban Consumers: All Items in U.S. City Average
Percent Change from Year Ago
15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
1950
1960
1970
1980
1990
2000
2010
2020
Shaded areas indicate U.S. recessions.
Source: U.S. Bureau of Labor Statistics
myf.red/g/OD1B

Measuring the Labor Market

Key statistic: The unemployment rate

$$u = \frac{U}{U+E} = \frac{U}{LF}$$

u: unemployment rate, U: Unemployed, E: number of people employed,
$LF = E + U$: labor force

Labor input in an economy:

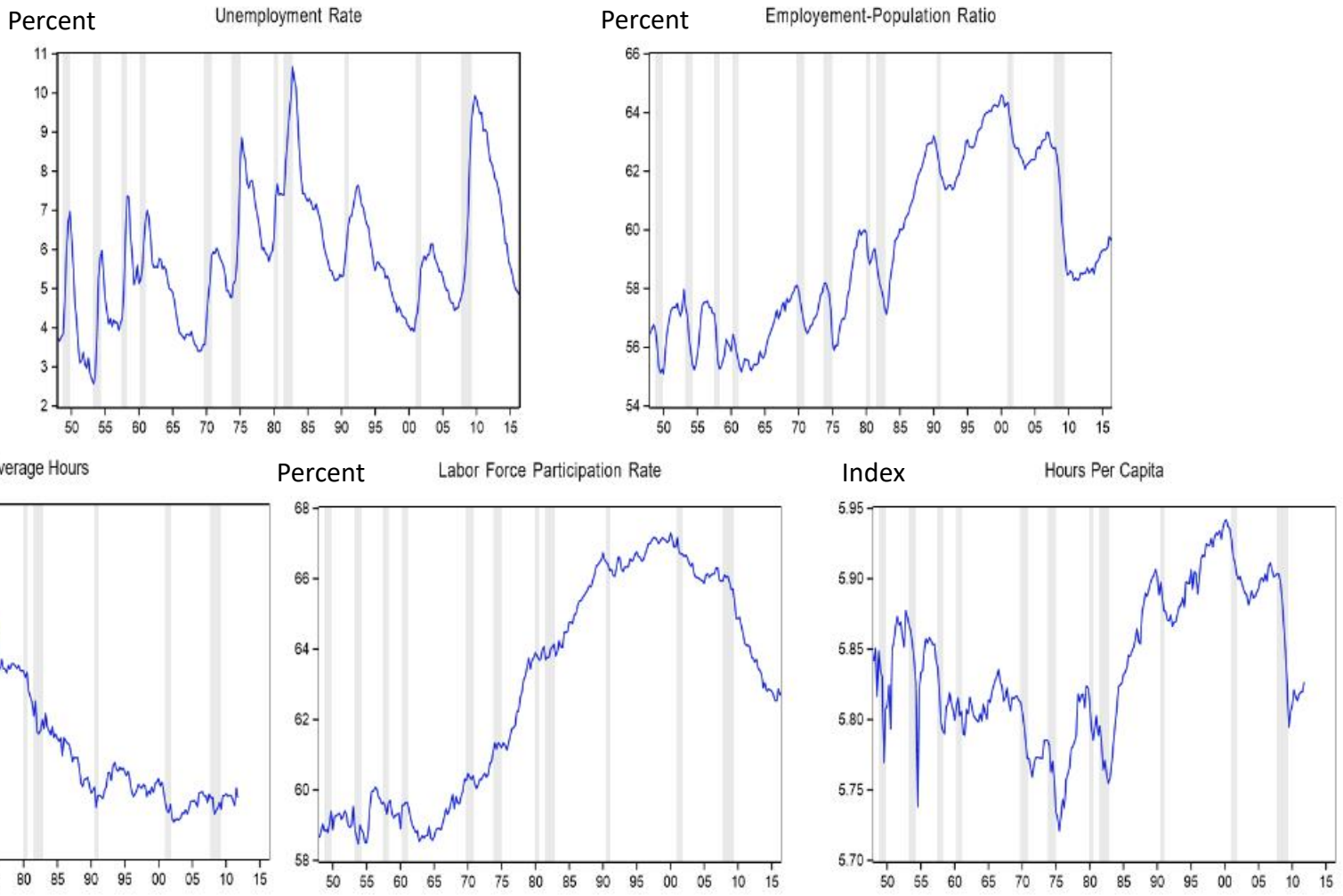
- Total hours worked: $N = h \times E$, h: average number of hours each working person works
- Hours per capita: $n = \frac{h \times E}{L}$ (L: total population)
- Extensive margin: how many people work (E)
- Intensive margin: amout of time spent working per person (h)

Other important labor statistics:

- Employment-population rate: $\frac{E}{L}$
- Labor force participation rate: $lfp = \frac{LF}{L}$

Labor Market Variables

Figure 1.6: Labor Market Variables



Definition of Business Cycles and Recessions

Business Cycles

"Business cycles are a type of fluctuation in the aggregate economic activity of nations that organize their work mainly in business enterprises. A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic."

(Burns and Mitchell, "Measuring Business Cycles", National Bureau of Economic Research, 1946, p.3, https://www.nber.org/chapters/c2980.pdf)

- Standard business cycle length 2-8 years, recent work emphasis the increasing importance of longer cycle up to 10 years (Beaudry et al., 2020, American Economic Review) and of medium-term cycles up to 30 years.

Recession

- Definition often used in the press: two consecutive quarters of negative growth
- NBER: Significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales.
- Depression: a particularly severe and prolonged downturn in economic activity

Potential Output and the Output Gap

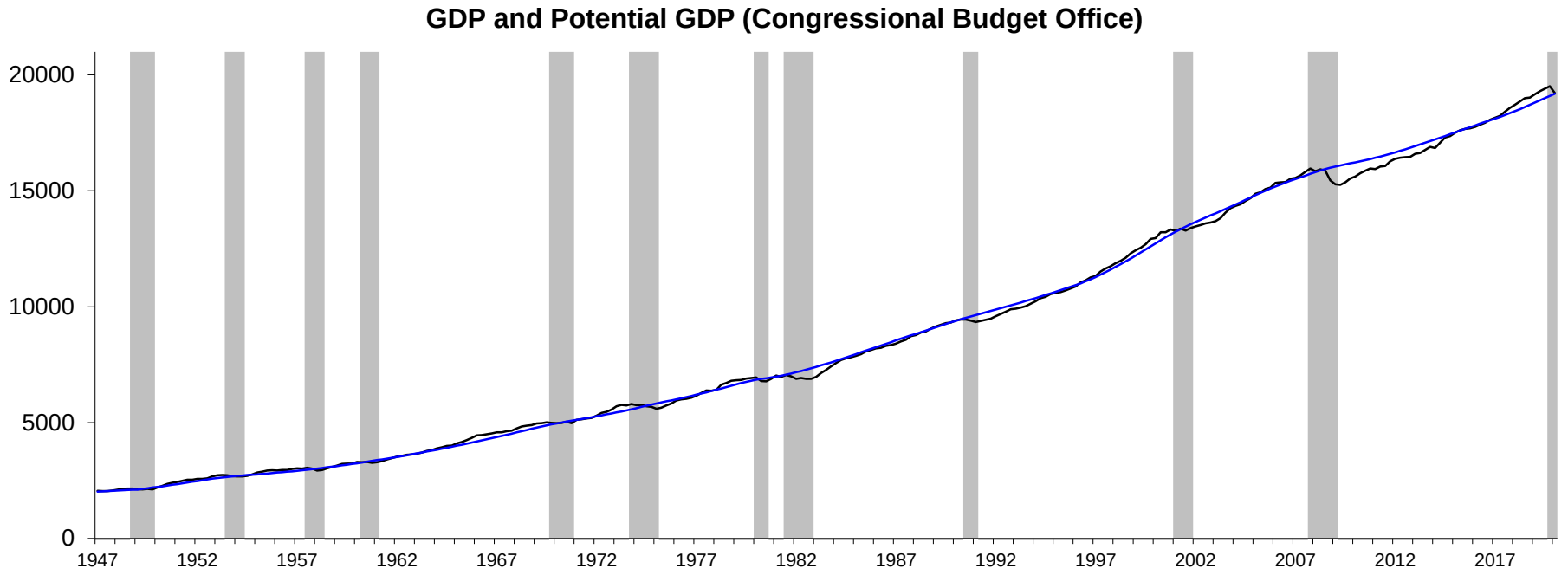
Potential Output – definition by the Congressional Budget Office

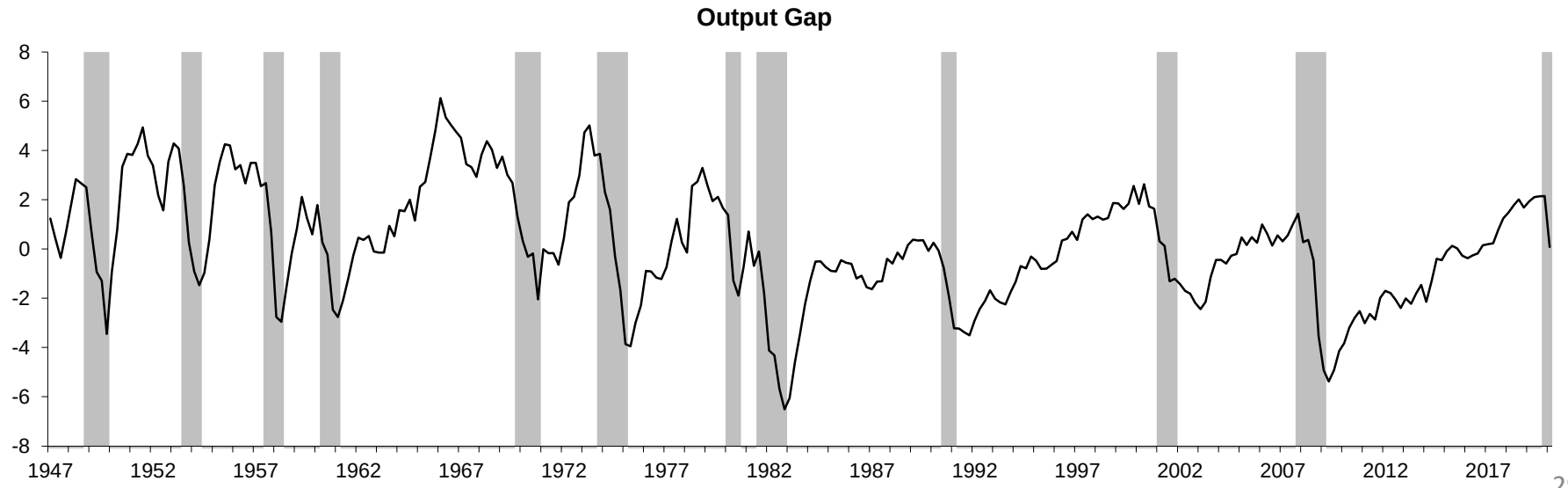
- Trend growth in the productive capacity of the economy. Estimate of the level of GDP attainable when the economy is operating at a high rate of resource use
- It is not a technical ceiling on output that cannot be exceeded. Rather, it is a measure of maximum sustainable output – the level of real GDP in a given year that is consistent with a stable rate of inflation.

The Output Gap

- The output gap measures the difference between actual and potential output
- If actual output rises above its potential level, then constraints on capacity begin to bind and inflationary pressures build. If output falls below potential, then resources are lying idle and inflationary pressures abate.
- Economic activity above or below the normal capacity is typically viewed as being inefficient, so that the output gap is an important target for policy makers.
- During an expansion the output gap typically turns positive, during a recession negative
- The output gap can be negative during a low growth episode leading to GDP being below trend without a recession, i.e. a negative output gap does not necessarily imply declining GDP.

Actual Output, Potential Output and the Output Gap





Source: FRED (St. Louis Fed), own computations

What Economists Do

Basically three related modes of inquiry:

1. Retrospective: trying to understand what happened in the past and why it happened
2. Counterfactuals: trying to understand what would have happened under some alternative scenario or policy regime
3. Policy advice: trying to advise policymakers on what to do in the future

Ultimately our objective is to give sound policy advice, but to do so need to conquer retrospective and counterfactual analysis

Models

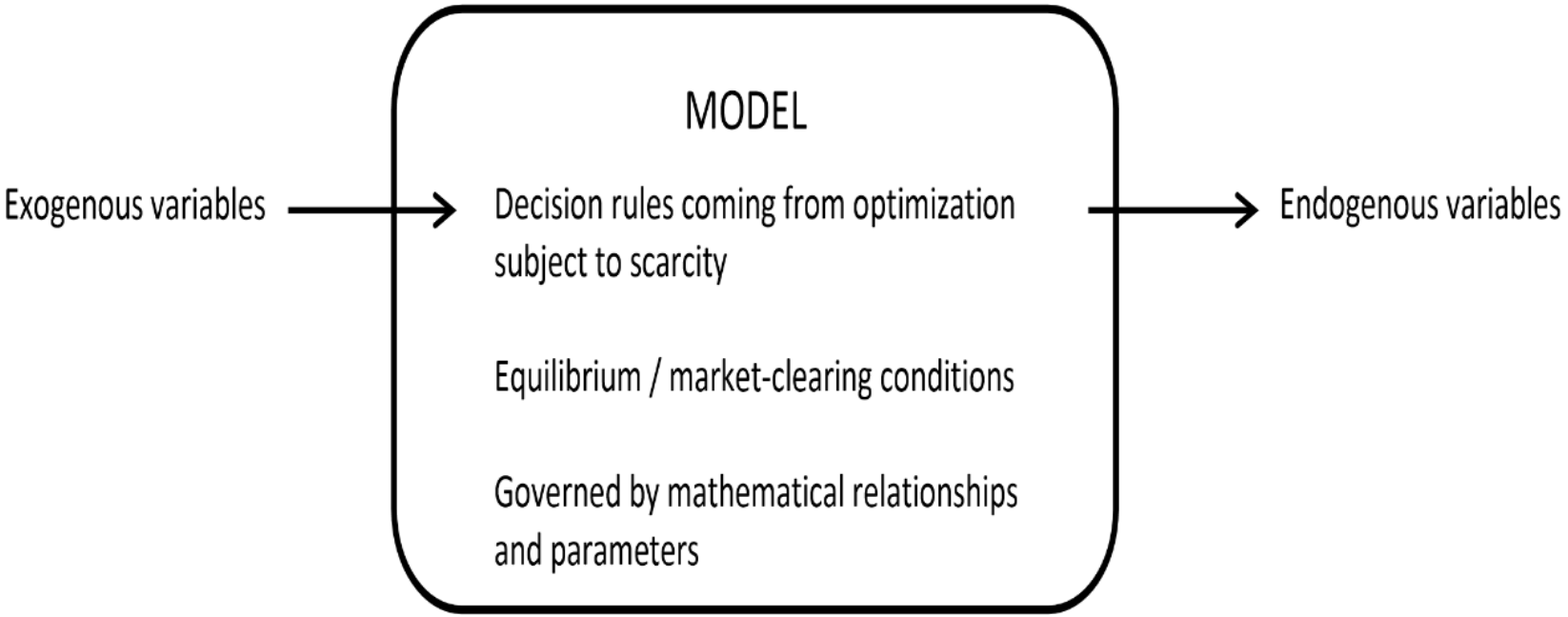
- For better or worse, the real world is messy
- It isn't always easy to do retrospective analysis (e.g. why did the Great Recession happen?), it's hard to do counterfactual analysis (e.g. what would have happened had the Fed not done Quantitative Easing?), it's even harder to give policy advice about the future (e.g. should the Fed raise interest rates?)
- Economics tries to be scientific. In an ideal world, we would like to run experiments
  - What happens when the Fed raises or lowers interest rates?
  - Run an experiment: have a bunch of economies otherwise subject to the same conditions. Change interest rates for one group of economies (the treatment group) and don't for the other group (the control group). Compare differences across groups to get the "treatment effect"
  - For most macro questions, this kind of experiment is impossible
- Because experiments aren't in play, economists use models
- Given a model, we try do "real science": run experiments, and use the outcomes from those experiments to inform policy

Variable Types and Timing Notation

Two kinds of variables: exogenous and endogenous

- Exogenous: taken as given, determined outside of a model
- Endogenous: determined inside of a model
- Will denote variables with Latin letters
- Timing notation: time is discreet. t is the present. $t-1$ is one period in the past. $t+1$ is one period in the future
  - e.g. X_t is the value of variable X observed at date t
- Parameter: fixed value governing mathematical relationships in a model
- Will typically denote parameters with lowercase Greek letters (e.g. α, β), sometimes with lowercase Latin letters without a time subscript.

A Model



A model makes predictions about endogenous variables

How to Judge / Build a Model

No firm criteria.

Characteristics of a good model:

- Makes good predictions
- Stronger test: makes good predictions about things which it wasn’t designed to explain (“over-identification”)
- Is as simple as possible (Ockham's razor)
  - Abstract from things which are not relevant
  - The simpler it is, the easier it is to understand the mechanisms
- Makes reasonable assumptions

Models in This Course

Economics divided into three "runs" which feature differing levels of abstraction:

- Long run (decades): abstract from endogenous labor input and many sources of shocks, focus on capital accumulation and productivity growth.
  Solow model and other growth models
  We will not cover growth models in this course. There are chapters on the Solow model in the textbook and the course Advanced Macroeconomics focuses on growth models.
- Medium run (several years): abstract from capital accumulation and productivity growth, abstract from nominal price and wage rigidity:
  Neoclassical model or Real Business Cycle (RBC) model
- Short run (months to several years): abstract from capital accumulation and productivity growth, allow for price and wage stickiness:
  New Keynesian model

Models in Modern Macroeconomics

Modern macroeconomics is based on microeconomic foundations and the modeling of expectations plays a central role

- Include deep structural parameters that describe preferences, technology etc. in the model.
- Distinguish these deep structural (policy invariant) parameters from policy parameters to allow for sensible policy simulations.
- Models in which there is no clear definition of the structural meaning of a parameter might mix policy parameters and other parameters. In these models (Cowles commission type) simulations are subject to the *Lucas critique*.

The Lucas Critique

"The 'Lucas critique' is a criticism of econometric policy evaluation procedures that fail to recognize that optimal decision rules of economic agents vary systematically with changes in policy. In particular, it criticizes using estimated statistical relationships from past data to forecast the effects of adopting a new policy, because the estimated regression coefficients are not invariant but will change along with agents' decision rules in response to a new policy. A classic example of this fallacy was the erroneous inference that a regression of inflation on unemployment (the Phillips curve) represented a structural trade-off for policy to exploit."

The New Palgrave Dictionary of Economics, 2008.

- Lucas, Robert E., Jr. (1976), "Econometric Policy Evaluation: A Critique," in Karl Brunner und Alan Meltzer (eds.), The Phillips Curve and Labor Markets. Carnegie-Rochester Conference Series on Public Policy, Vol. 1, pp. 19-46.
- Nobel price in economics 1995.

Microfounded Representative Agent Models

- The Lucas critique let to the development of microfounded models in which there is a clear distinction between policy parameters and deep structural policy invariant parameters.
- Such models are labelled “structural models“ in modern macroeconomics, while simple estimated empirical relationships are labelled as “reduced form equations“.
- The aim of microfounded theories on how macroeconomic policy affect the economy is to develop structural theoretical models that can be used for policy simulation, as they address the Lucas critique.
- Still, you will see that many elements even in microfounded models appear to be rather adhoc and that even state of the art macroeconomic modelling leaves plenty of room for subjectivism.

Summary

- GDP is an imperfect, but still the best measure of aggregate output that we have.
- We distinguish nominal and real GDP and absolute and per capita GDP.
- Two measures of the price level: GDP deflator and the CPI
- The unemployment rate is the best known measure of the labor market, but it is imperfect. There are other measures of total labor input available (hours, employment). Distinguish extensive and intensive margin.
- Two ways to measure business cycles: 1. expansions/recessions, 2. output gap.
- Macroeconomic models are needed to run macroeconomic experiments. They are our laboratories.
- Modern macroeconomics is based on microeconomics because Lucas showed with his critique that the behavior of consumers and firms changes with a change in politics.