

Lecture 1: Introduction and Stylized Facts

Christian Wolf

14.05, Fall 2025

This course: modern macroeconomics

This course will tackle questions that are important and interesting:

1. What drives economic growth? [long-run]

- What explains the income differences across countries? Why are some rich, some poor?
- What explains growing income inequality within countries? What are likely effects of AI?

2. Why do economies undergo business cycles? [short-run]

- Why do they sometimes undergo economic crises? Where does inflation come from?
- What is the role of the government in fighting business cycles? What are the effects of interest rate policy and stimulus checks? What about tariffs?

Methodologically, we will tackle these questions using the tools of modern macroeconomics:

data [time series + cross section] & **models** [micro optimization + general equilibrium]

Administrative

- Lectures Mon/Wed 1:00-2:30pm, Recitations Fri 10:00-11:00am
- Instructor: Christian Wolf
 - My research interests: mainly business cycles, monetary & fiscal policy
- TAs: Keelan Beirne and Raj Mehta

Course prerequisites & resources

- Background: basic microeconomics and macroeconomics (14.01 and 14.02)
- Tools
 - Differential calculus, heavy use of constrained optimization using Lagrangean methods
Why? macro with micro-foundations = optimizing behavior.
 - A few lectures will involve solving difference/differential equations and infinite-horizon problems. We will use a graphical approach and avoid technicalities.
Why? economies unfold dynamically, over time.
 - Some familiarity with statistics or econometrics is important
Why? for your paper + reading relevant literature.
- Class materials
 - Course based primarily on lecture notes + electronic access to a few assigned articles.
 - Optional books: Jones, *Macroeconomics*, & Romer, *Advanced Macroeconomics*

Evaluation

- Participation in class is welcome & will count towards your grade (10%)
- Two in-class exams:
 - Wed October 15, and Wed December 3.
 - 50% of the grade: 30% for your best exam, plus 20% for the other.
 - Based on material covered in lecture notes, recitations, problem sets. Closed book.
- Four problem sets
 - 10% of the grade, will only count the three best problem sets.
 - Essential training for exams.
- One paper. This is a communications-intensive (CI-M) subject.
 - 20 pages ($\approx$ 5000 words) excluding references.
 - 30% of the grade.

AI policy is quite lenient except for the paper. See syllabus for details and rationale.

Evaluation—the paper

- Two paths for the paper:
 1. “Default” option: on growth experiences of two countries; clearer expectations on what you have to do; examples from the past.
 2. “Alternative” option: anything related to the course; after consultation with Keelan.
- Three installments:
 1. Proposal due on October 3 (10% of paper grade).
 2. First draft due on November 7 (50% of paper grade).
 3. Final draft due on December 10 (40% of paper grade).

Note: We will overweight the final draft if it shows substantial improvement relative to the proposal and the first draft.

My class objectives

- My main goal with this class is to train you to critically read and evaluate discussions of macroeconomics and macroeconomic policy in the media
E.g., articles in Financial Times or WSJ, newsletters like Axios Macro, economics podcasts, ...
- Objective is that you can understand and evaluate the quality of the argument:
 - Is the argument internally consistent? What's the assumed model in the background?
 - Is there any empirical evidence? Is it credible?
- I hope that being able to do this will serve you well in whatever you do after

Today's lecture: course overview

- The **how**: interplay of data & models

Today: high-level overview on methodology in macroeconomics.

- Philosophy: stylized and abstract models confronted with real-world data
- Models abstract from detail, allow us to isolate and understand mechanisms. Data used to test the model predictions.
- Why not just data? hard to establish causal links at macro level using real-world data

- The **what**: what are the questions we will address?

Today: sketch of the basic “facts” that we will try to explain.

1. Long run: growth and cross-country/within-country income differences
First midterm and default option for the paper concern this part exclusively.
2. Short run: consumption, investment, business cycles, and crises
Second midterm mostly about this—but cumulative material (in terms of methods and content).

Outline

1. The how: interplay of data & models
2. The what
 - Stylized facts about economic growth
 - A primer on business cycles

Data vs. modeling in macroeconomics

- Want to understand macroeconomic relationships. Why not just study data?
 - We have observational data, not experimental data. Can't run large-scale experiments. E.g., can't clone the U.S. economy, and hike interest rates in one economy, and not in the other.
 - Observational data alone just give correlations, no statements about causation.
 - Lots of economics is about teasing causation from observational data (the “credibility revolution”, “quasi-experiments”). But that's much harder in macro than in micro.
- That's why we instead try to model the macro-economy
 - Real-world interactions highly rich and complex, we build stylized models to understand specific forces/mechanisms. Descriptive realism is **not** the objective.
 - We will assume optimizing behavior. Provides some discipline of what is likely to happen when policy gets changed [“Lucas critique”]

“The map is not the territory”



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Back to data

- Of course modeling without connection to data is also not satisfactory
 - Can the model rationalize actual observational data?
 - Is the model consistent with the bits and pieces of actual evidence on causality—either at the micro or macro level—that we do have?
- If the answers are yes, then we may trust the model to extrapolate to other, harder questions that we can't answer from data
- This is how modern macro proceeds: constant back-and-forth between data and models, use structure to fill in the “gaps” of empirical work
- In particular we will rely on data to check our model's *crucial* assumptions ...

Crucial assumptions

A CONTRIBUTION TO THE THEORY OF ECONOMIC GROWTH

By ROBERT M. SOLOW

I. Introduction, 65. — II. A model of long-run growth, 66. — III. Possible growth patterns, 68. — IV. Examples, 73. — V. Behavior of interest and wage rates, 78. — VI. Extensions, 85. — VII. Qualifications, 91.

I. INTRODUCTION

All theory depends on assumptions which are not quite true. That is what makes it theory. The art of successful theorizing is to make the inevitable simplifying assumptions in such a way that the final results are not very sensitive.¹ A “crucial” assumption is one on which the conclusions do depend sensitively, and it is important that crucial assumptions be reasonably realistic. When the results of a theory seem to flow specifically from a special crucial assumption, then if the assumption is dubious, the results are suspect.

Outline

1. The how: interplay of data & models

2. The what

Stylized facts about economic growth

A primer on business cycles

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A measure of economic activity: GDP

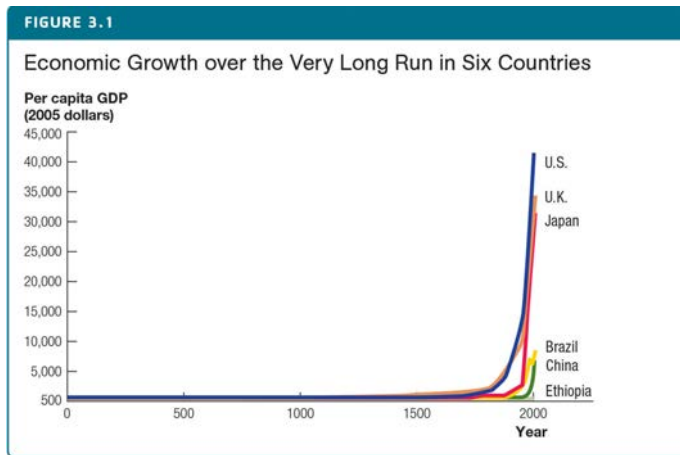
- Definition: GDP (gross domestic product) is the market value of final goods and services produced within a country during a period of time (year)
 - Invented in 1930s-40s by Simon Kuznets at the NBER (here!), first published in 1942
 - Because every expenditure creates income for someone else, we have

$$\text{expenditure} = \text{income} = \text{production}$$

This is the circular flow of the economy. Remember 14.02.

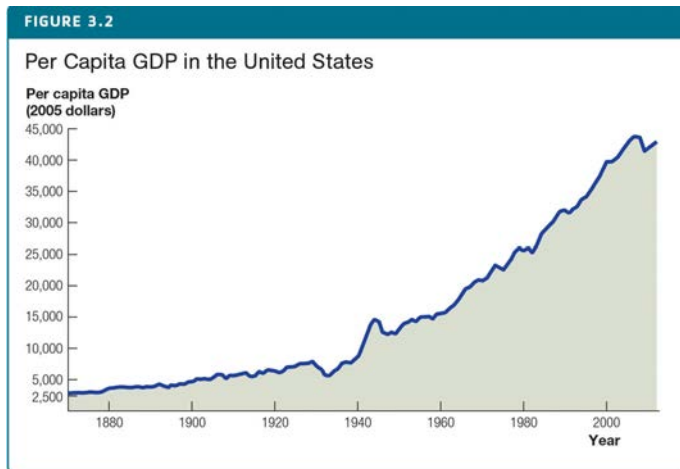
- The next part of this slide deck will present some stylized facts about GDP over time and across countries
- At the end: why do we care about GDP? what about direct measures of well-being?

Rapid economic growth is a recent phenomenon



Income per person roughly stagnated for much of human history, but started a huge take-off about 250 years ago.

Rapid economic growth is a recent phenomenon



U.S. GDP per capita has risen by a factor of 15 since 1870.

Constant growth leads to an exponential path

- Define the growth rate between years t and $t + 1$ as

$$g_t \equiv \frac{y_{t+1} - y_t}{y_t}.$$

- Rewriting this expression, we obtain

$$y_{t+1} = y_t (1 + g_t).$$

- If g_t were constant over time, $g_t \equiv g$ for some g , we could roll this forward to get

$$y_t = y_0 (1 + g)^t. \tag{1}$$

This leads to an exponential path as in the figures.

Exponential growth implies large gains in short time

At a constant growth rate g , how long would it take for an economy to double its output?

- We set $y_t = 2y_0$ and find t that solves (1).
- After taking logs, we obtain,

$$t^{double} \log(1 + g) = \log 2 \simeq 0.7.$$

When g is close to 0, we have $\log(1 + g) \simeq g$. So we can approximately solve,

$$t^{double} \simeq \frac{0.7}{g} = \frac{70}{100 \times g}.$$

- This leads to the Rule of 70: If the economy grows at 2% per year, then it takes ≈ 35 years to double.
- At 5% per year, it takes only 14 years to double.

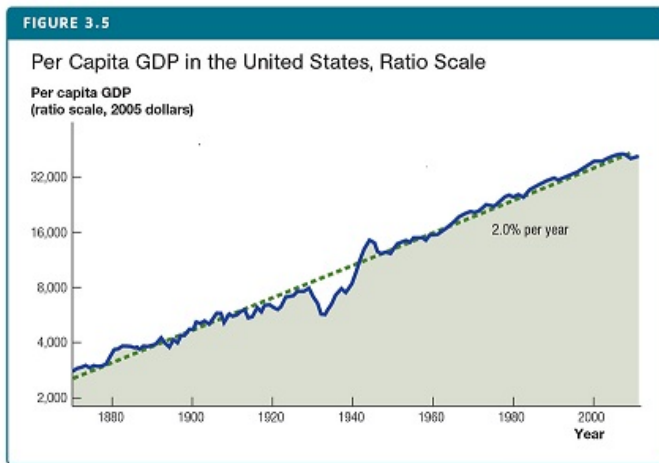
Exponential growth: use log scale

- One implication is that GDP and other growing macroeconomic variables (consumption, investment, capital stock, productivity, wages, ...) are easier to measure on log scale.
- t^{double} is independent of y_0 , which means output is linear when plotted on a log scale.
- More generally, note that $y_t = y_0 (1 + g)^t$ implies

$$\log y_t = \log y_0 + \underbrace{t \log(1 + g)}_{\simeq g}.$$

- So log scale will be a line with slope approximately equal to g .

Exponential growth: use log scale



⇒ linear in log space

Small differences in growth matter

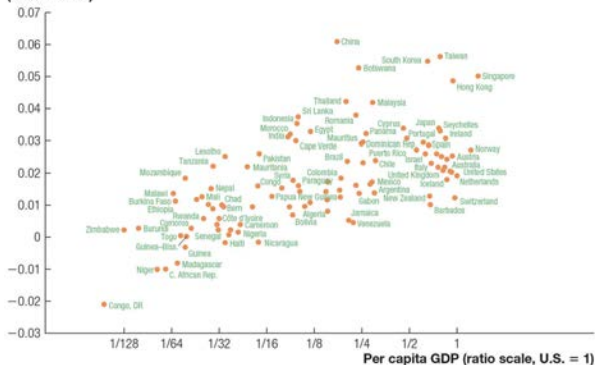
- U.S. GDP per capita growth was roughly 2% per year on average. Seems small, but created $1.02^{140}=16$ -fold difference over 140 years.
- If the growth rate was 1% instead of 2%, then GDP per capita would rise by only $1.01^{140}=4$ times since 1870 (similar to Mexico).
- Some East Asian countries grew by 6% over 1960-1990; this is a factor of 5.75 ($= 1.06^{30}$) within just one generation.
- But growth miracles didn't happen in all countries ...

Large income differences across countries

FIGURE 3.7

Levels and Growth Rates of Per Capita GDP

Per capita GDP growth
(1960 to 2010)



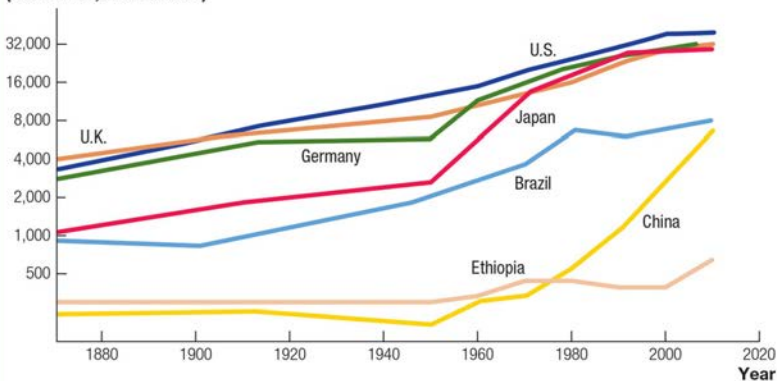
- x-axis: GDP per capita varies by a factor of 128 across countries
- Why such large differences? consider the y-axis

Income differences from growth differences

FIGURE 3.6

Per Capita GDP in Seven Countries

Per capita GDP
(ratio scale, 2005 dollars)



Income differences from growth differences

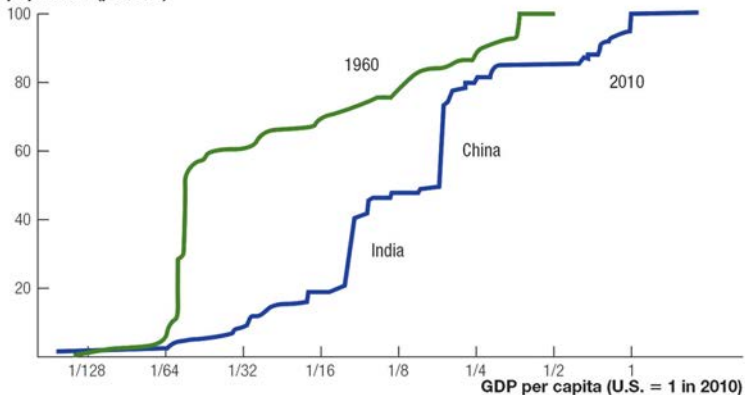
- We see quite heterogeneous growth experiences:
 - Rich countries are rich because they grow at a steady rate.
 - Middle income countries are doing ok but fail to catch up.
 - Sub-Saharan countries are poor because they grow very slowly.
Remember: small differences in growth rates create big effects over centuries.
 - Some countries like China are closing the gap in recent years.
- Growth everywhere (+ catch-up growth in some places) implies that world poverty has been trending down ...

Growth is reducing poverty over time

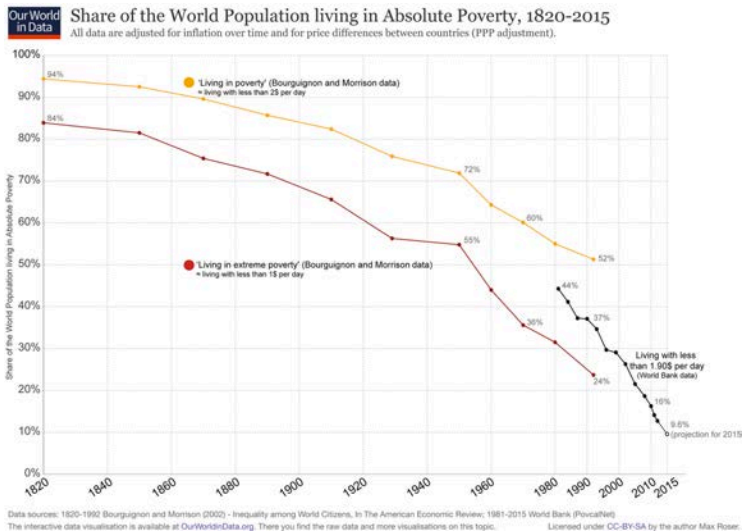
FIGURE 3.8

The Distribution of World Population by Per Capita GDP,
1960 and 2010

Share of world
population (percent)



Growth is reducing poverty over time

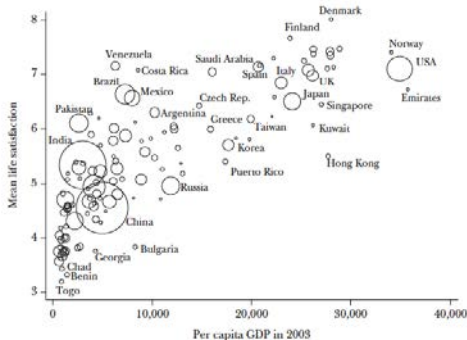


Growth is reducing poverty over time

- The median person is much richer now than in 1960.
- The fraction of people living in poverty also dramatically declined, largely thanks to growth in China and India in recent years.
- But why do we focus on GDP per person? Shouldn't we care about other dimensions of well-being, e.g., health?

GDP vs. well-being

Figure 1
Life Satisfaction and Per Capita GDP around the World



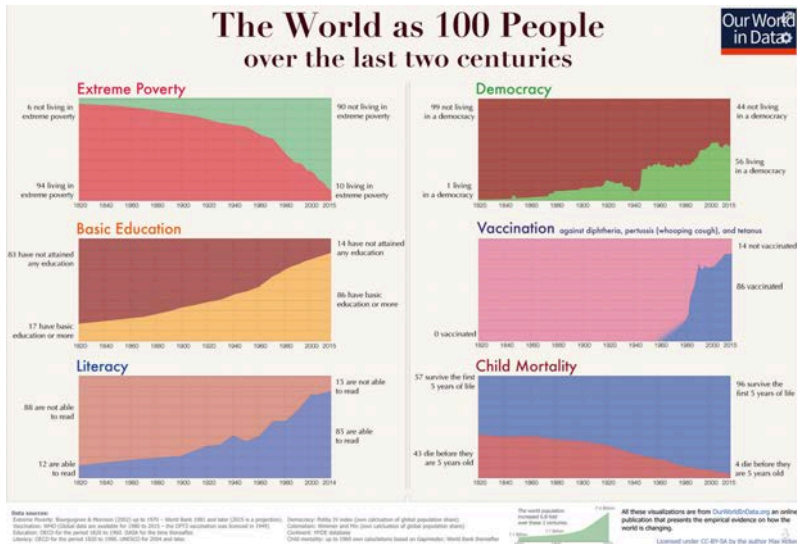
Source: Penn World Tables 6.2.

Note: Each circle is a country, with diameter proportional to population. GDP per capita in 2003 is measured in purchasing power parity chained dollars at 2000 prices.

Other aspects of well-being are typically correlated with GDP. We focus on GDP because it is easier to measure and analyze.

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Growth is reducing poverty in many dimensions



Taking stock from stylized facts about growth

- Rapid growth is a recent phenomenon in human history.
 - There are still vast differences in income levels across countries.
 - These differences largely driven by differences in growth rates. Some countries failed to grow, while others grew at a steady rate.
- Raises the questions that we'll tackle in the first half of the class:
 - Why do countries grow? Why at a more or less steady rate?
 - Why do some countries grow much faster than others? Shouldn't poor countries catch up?
 - Can we do anything to make growth faster? In particular, what role do savings/investment play? How much should an economy save?
 - Does growth benefit everyone? What about new technologies like AI?

“The consequences for human welfare involved in questions like these are simply staggering: once one starts to think about them, it is hard to think about anything else.” — Robert Lucas Jr.

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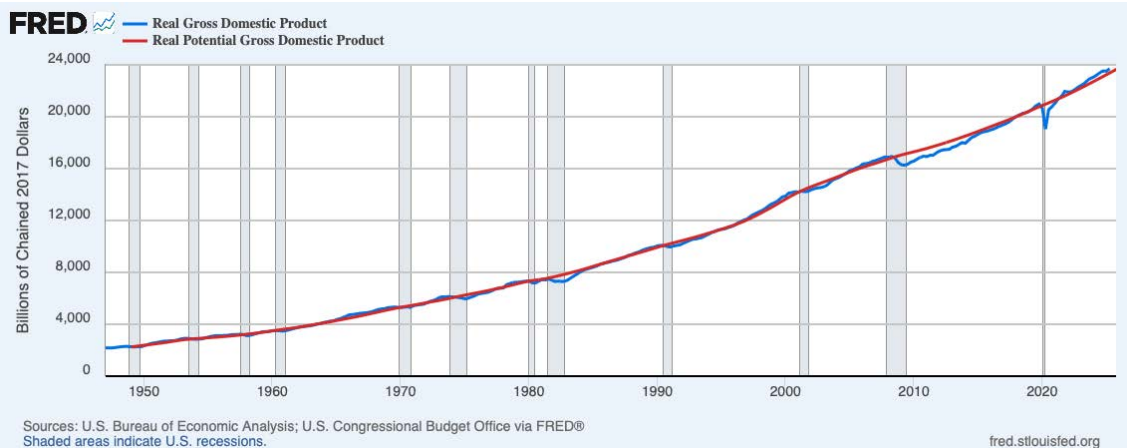
Stylized facts about economic growth

A primer on business cycles

What are business cycles?

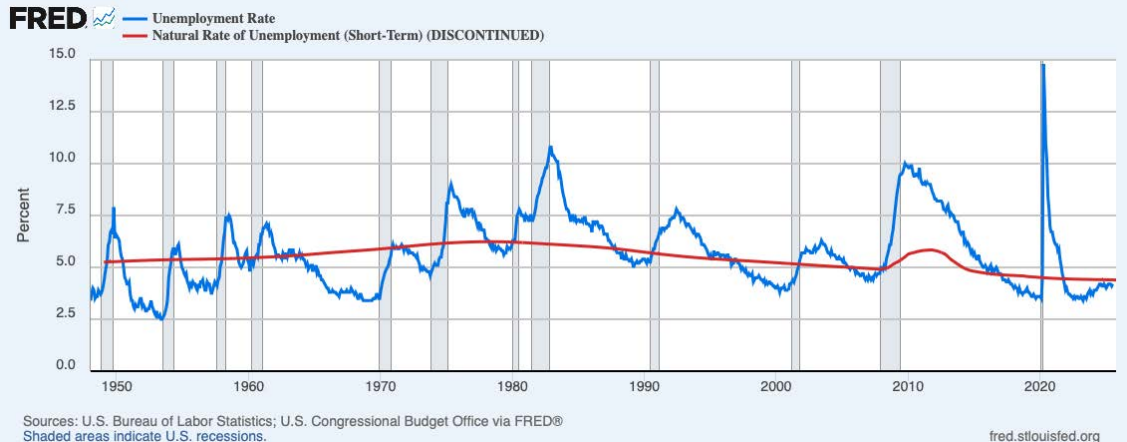
- What are business cycles in the **data**?
 - Recurring short-run fluctuations of macroeconomic aggregates around a smoother long-run trend [i.e., the $\approx 2\%$ growth from before]
 - Co-movement of many quantities at both the aggregate and the industry/regional level
 - GDP, consumption, investment, employment co-move strongly always
 - Inflation and interest rates: a more complicated picture
- What are business cycles in the **theory**?
 - Stochastic variation in the endogenous variables of a model of the economy
 - More simply: the economy is subject to shocks—new technologies, oil shortages, wars, pandemics, policy changes—and responds
- We will elaborate on both fronts (facts and theory) in the second part of the course, but let's get a glimpse now, using the Great Recession and Covid as two examples.

GDP



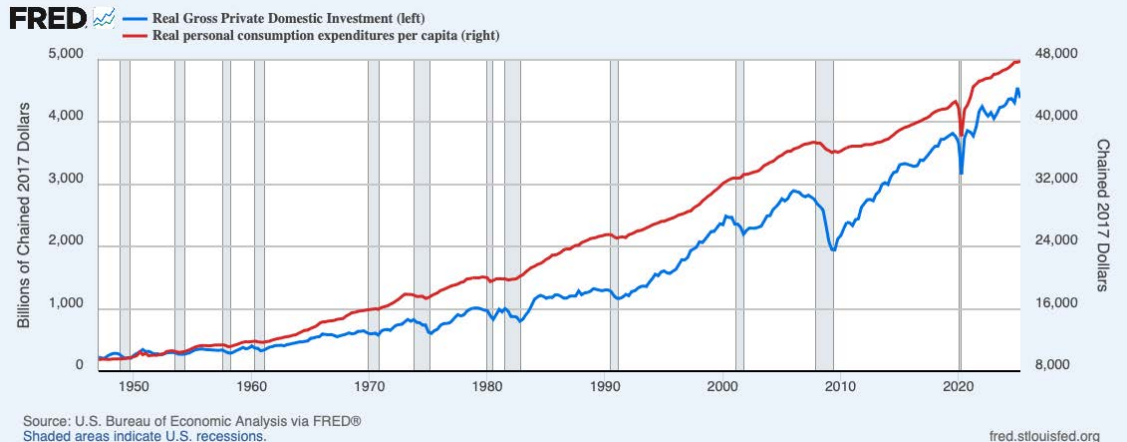
Data from FRED (<https://fred.stlouisfed.org/>). Blue line is actual real GDP [taking out inflation], red line is “potential” real GDP [full employment].

Unemployment



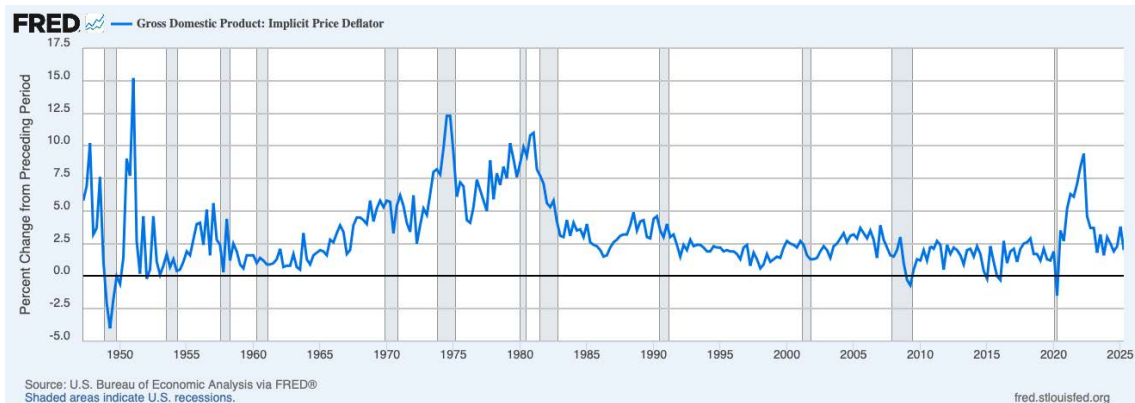
Blue line is the actual unemployment rate, red line is the “natural” rate of unemployment

Investment and consumption



Blue line is real investment, red line is real consumption

Inflation



Blue line is the annual growth rate in the implicit GDP deflator

The Great Recession and Covid-19

- These two recessions are very different in terms of trigger
Financial/housing shock vs. Covid-19, “demand” vs. “supply” shock.
- Some similarities ...
 - broad co-movement (across sectors/consumption & investment)
 - big spikes in unemployment, no large drop in inflation
 - monetary policy tries to fight, but is constrained
- ... and some features distinguish Covid-19 from previous recessions
 - concentrated on consumer expenditure (services)
 - very heterogeneous across sectors
 - much bigger fiscal policy response
 - inflation spike in recovery

Questions for business cycle theory

- Origins of business cycles
 - Are business cycles driven by “demand” or “supply”? Does the distinction matter? And what does it even mean for there not to be enough demand in the economy as a whole?
 - What explains the similarities across business cycle episodes?
 - How do shocks propagate from one part of the economy to another?
- Monetary policy
 - Why and how does monetary policy matter? Should central banks be independent?
 - How should monetary policy respond to cyclical fluctuations?
 - Should the Fed focus on inflation stabilization or output/unemployment stabilization?
 - Was the Fed's response to Covid-19 appropriate? Should it have done more/less?
 - What can/should monetary policy do when the ZLB (zero lower bound on nominal interest rates) becomes binding?

Questions for business cycle theory

- Fiscal policy
 - When are fiscal stimuli most needed or most effective? How do they work?
 - If I give you free money, will you work more? If not, why should a fiscal transfer stimulate aggregate employment?
 - You may be thinking: “higher gov’t spending or lower rates stimulate aggregate demand.” But what exactly do “demand” and “supply” mean in a general-equilibrium context where demand drives supply and vice versa?
 - Did the recent fiscal stimulus contribute to inflation? If so, how? What about tariffs?
- Financial markets and business cycles [if time permits]
 - What’s the relation between asset markets and the macroeconomy?
 - Why does the stock market appear to be disconnected from the economy now, while the two moved so tightly together in the Great Recession?

What's Next

What's next

- We will focus on long-run growth in the first part of the course, and turn to business cycles and crises in the second part.
- So the topics and the type of policy questions will be very different. But both parts will follow a similar methodological approach.
 - Lecture 2 will lay methodological foundations: we will introduce and solve a simple general equilibrium macro model [“Robinson Crusoe economy”]
 - There will be no single model suitable for all purposes—we will custom-build models for particular questions
 - But all models will rest on identical methodological foundations, which we will introduce with the next lecture

Roadmap for growth part

1. **Capital accumulation** [Solow model]

- Natural candidate to explain growth: savings $\rightarrow$ productive capital
- Can savings sustain growth? Are poor countries poor because they don't save enough?

2. **Optimal consumption-savings choice** [Ramsey model]

- What's the “optimal” level of savings vs. consumption?
- Methodology: infinite-horizon optimization

3. **Growth through productivity & innovation** [endogenous growth]

- How to foster innovation? Are patents a good idea?
- Have technological improvements led to growth at the cost of greater inequality? What are the likely effects of AI on inequality?

Roadmap for business-cycle part

1. Real Business Cycle (RBC) model

- Ramsey + shocks—from long-run growth to short-run fluctuations. Can macroeconomic fluctuations be efficient?
- Supply vs. demand shocks, irrelevance of aggregate demand

2. New Keynesian (NK) model

- Foundations of aggregate demand: better models of consumption and investment
- Aggregate supply revisited: nominal rigidities to get demand to matter
- How does (monetary, fiscal) policy affect the economy? Should we try to stabilize cycles?

3. Recent developments

Tariffs, effects of stimulus checks on inflation, central bank independence, ...

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Fall 2025

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