Macroeconomics III - Lecture 1

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University of Copenhagen

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Heilmann Scholarship: One year of studies at Cornell University 2022-2023

Established by Flemming and Judy Heilmann, the scholarship is awarded once a year to a visiting student from Denmark who is enrolled at Cornell University. The scholarship sponsors one year of graduate studies in economics at Cornell University (currently $20.000) starting in the Fall 2022. You can follow courses at Cornell's Department of Economics, Johnson School of Management or School of Industrial and Labor Relations.

Camilla Ringsted, the 15th recipient says "Enrolling at Cornell makes it possible to increase my focus, as the statistics department, the Department of Economics, and the engineering school all offer related seminars as well as courses which can be combined in a way that would not be possible at Copenhagen University"

Please contact Michael.Bergman@econ.ku.dk if you have any questions.

Deadline: September 30, 2021.

Send your application to Michael.Bergman@econ.ku.dk

More information (only in Danish) can be found here.

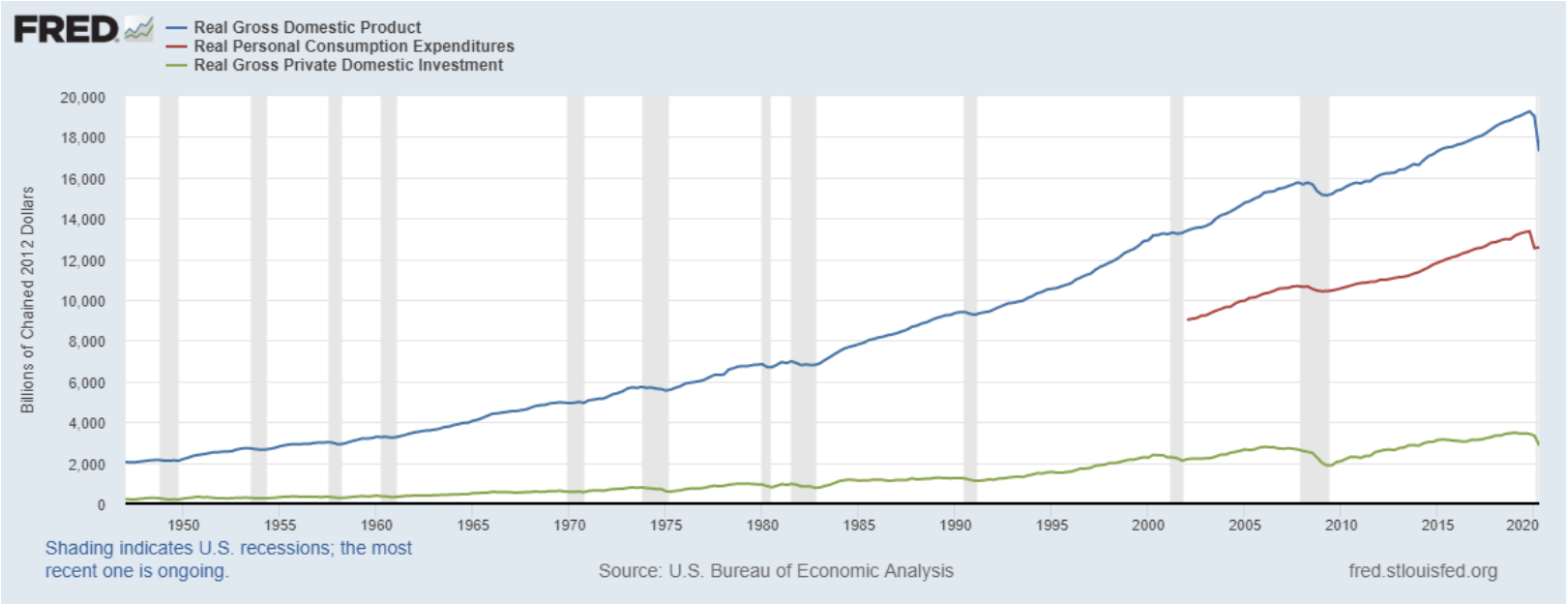
Course and exam

- Course material are on Absalon
- Syllabus
- Assignments: Pass 2 out of 3
- Classes cover weekly problem sets
- Exam is a 3 hour closed book, no aids. English only

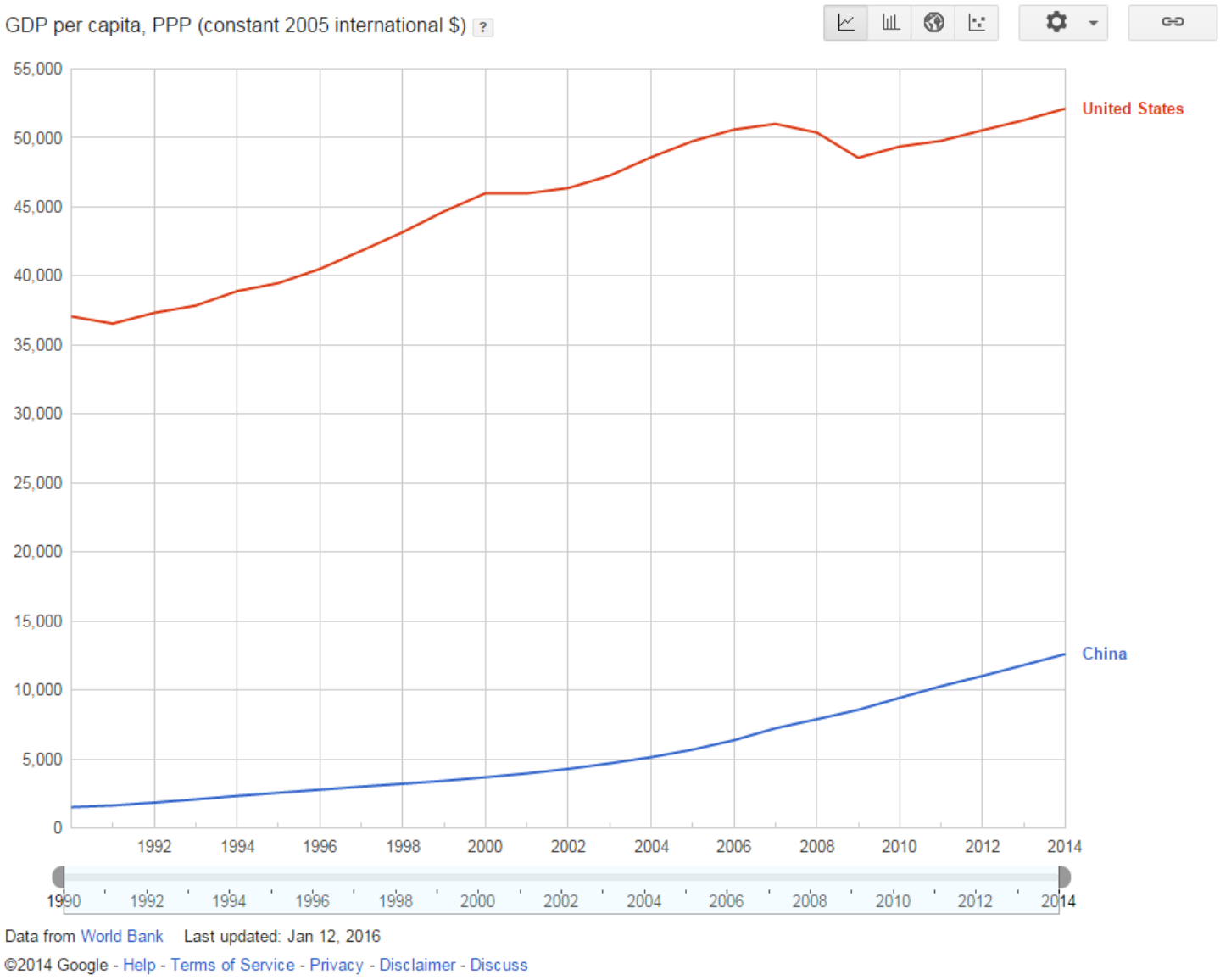
Introduction

- What do we do in this course?
- Macroeconomists are interested in aggregate variables - GDP, consumption, investment, inflation, etc.
- These exhibit patterns, either in the cross-section of in the time-series dimension
- Goal: Understand these patterns

Time series: GDP and components in the US



Cross-section: Per capita, PPP-adjusted GDP



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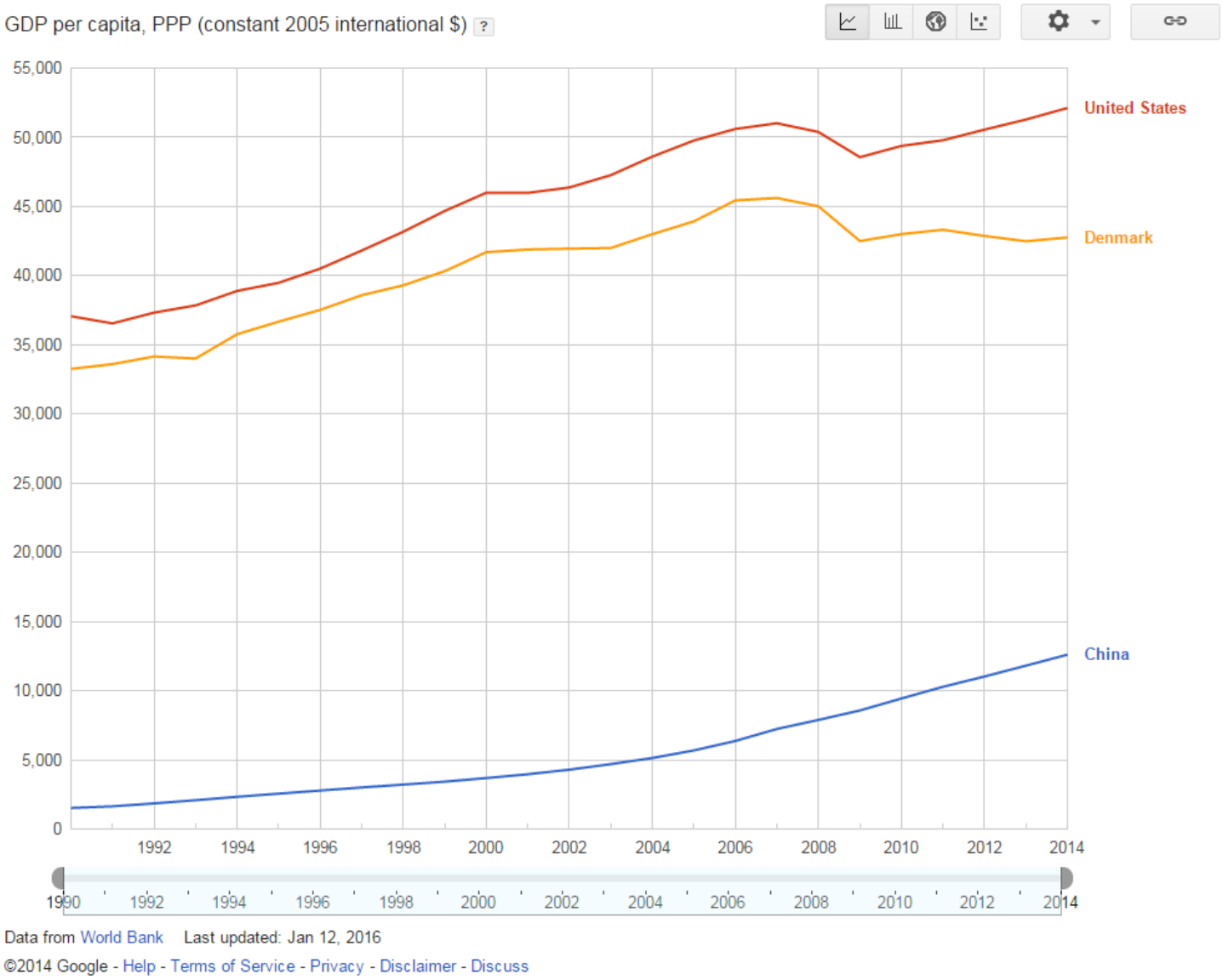
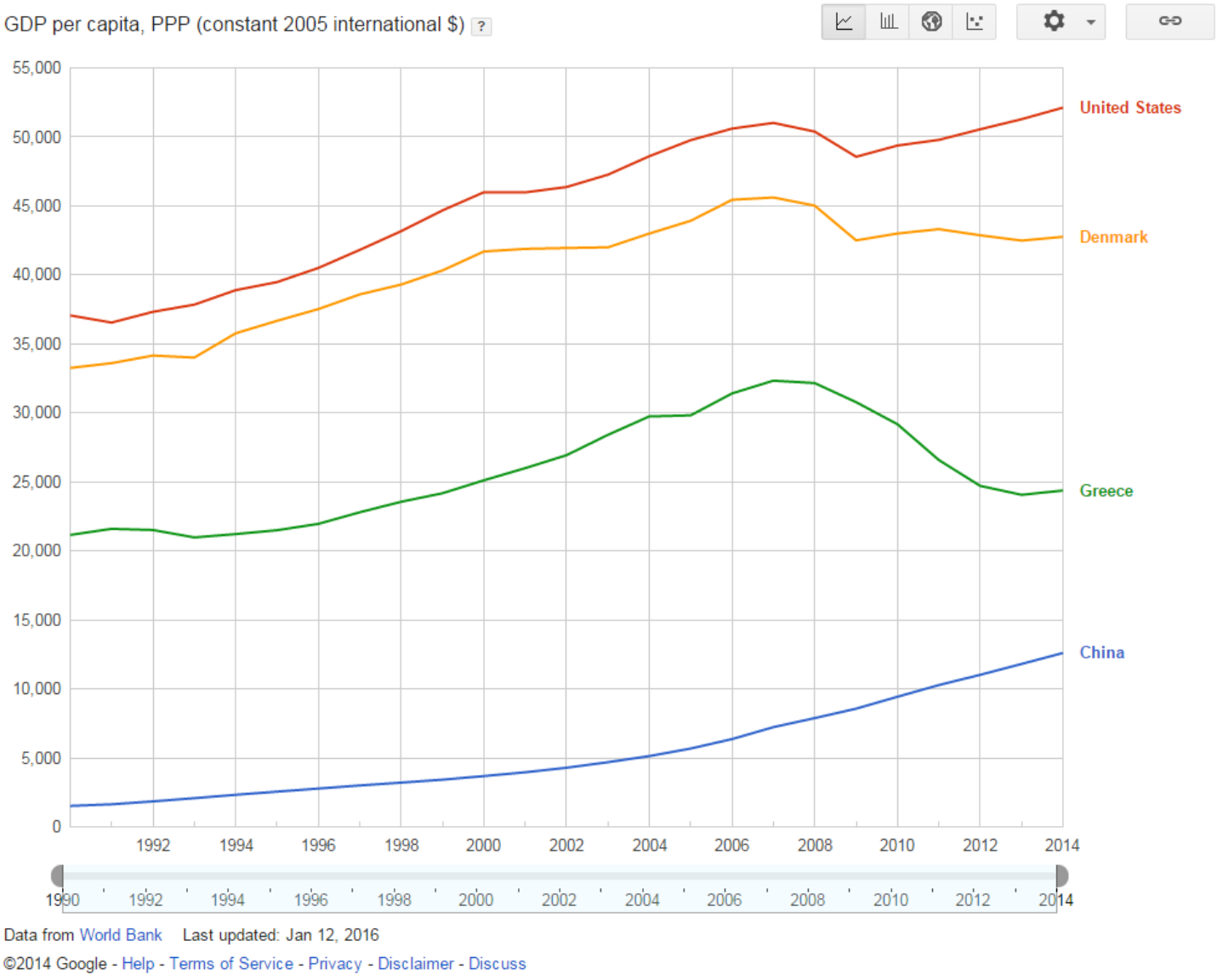
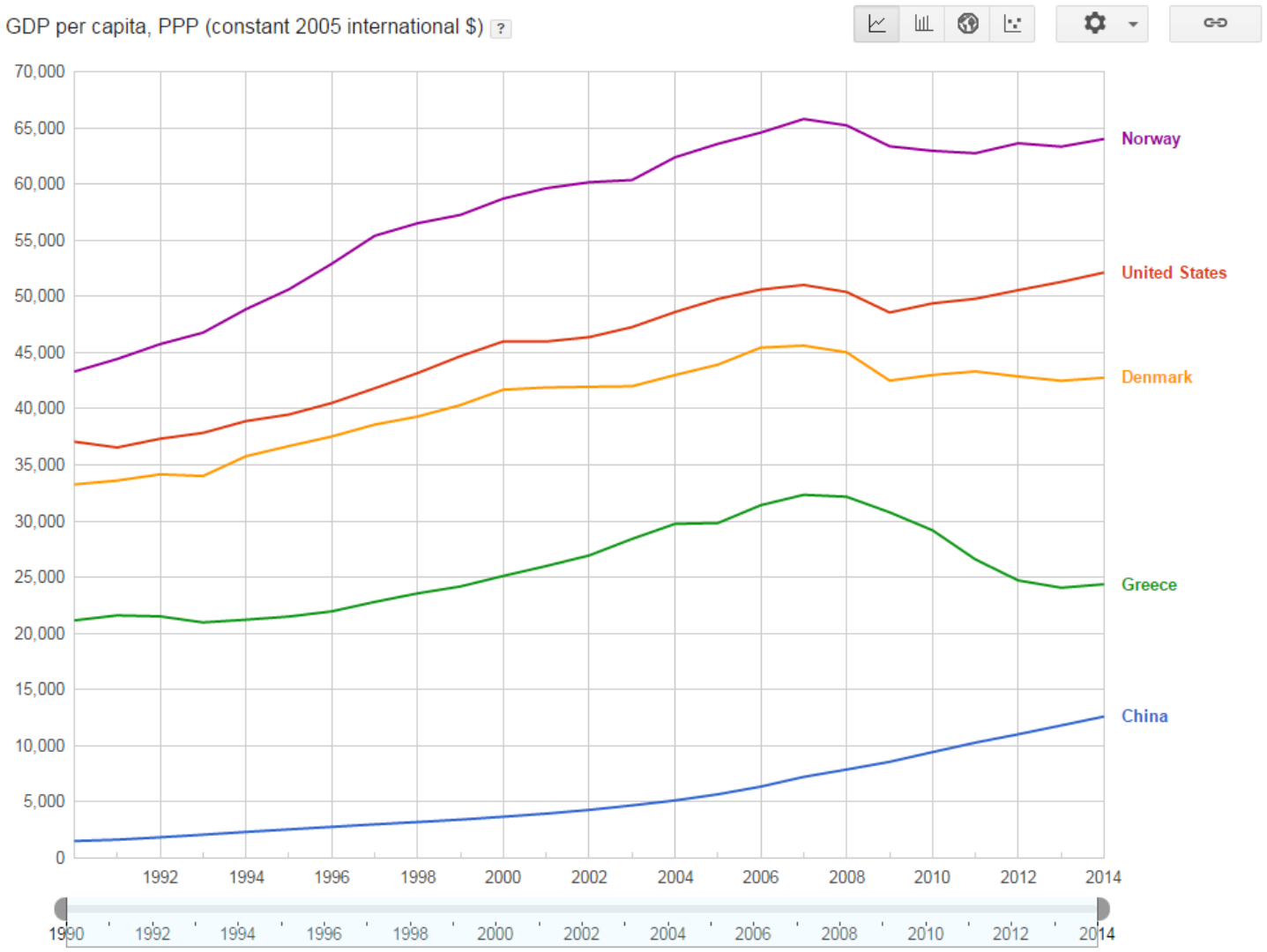


Cross-section: Per capita, PPP-adjusted GDP

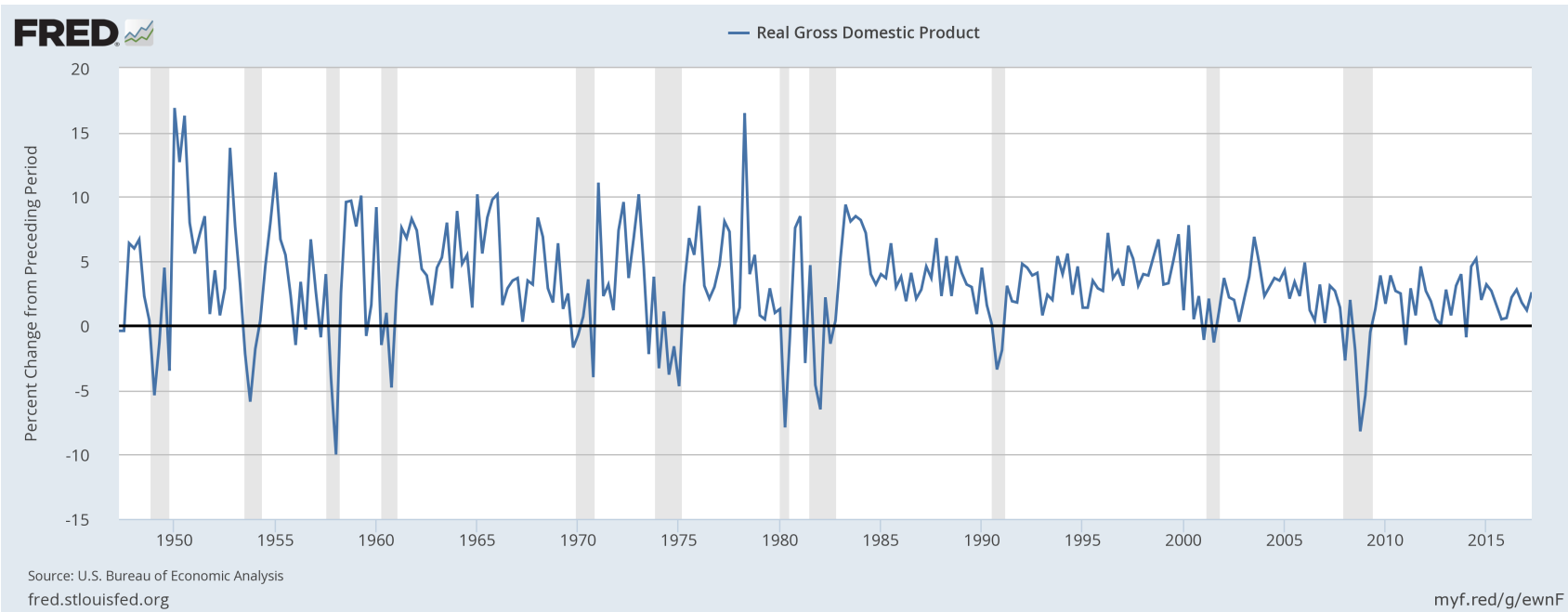


Cross-section: Per capita, PPP-adjusted GDP



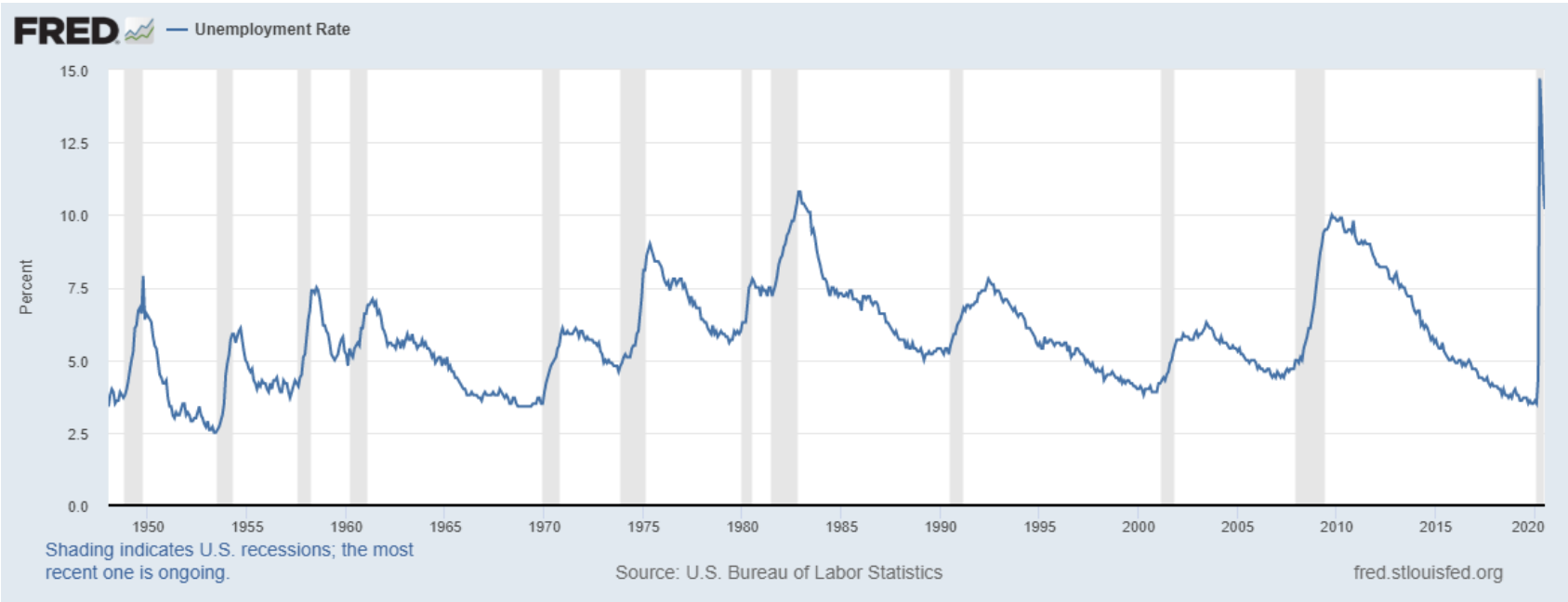
Cycles

- Along with explaining long-run movements and co-movements among main macroeconomic aggregates, we are also interested in their cyclical variation
- We have already seen data that contextualize long-run considerations
- As for a cyclical perspective, take the rate of growth of US real GDP as an example:



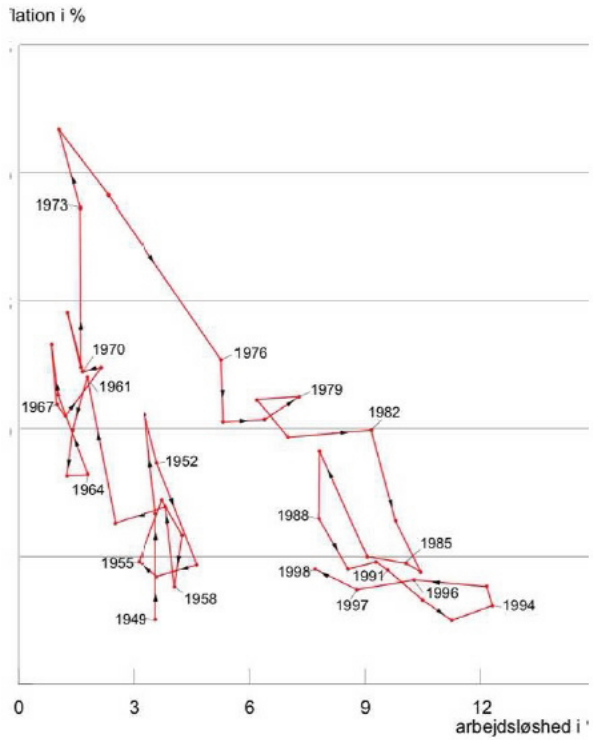
More about cycles

Unemployment rate



Inflation dynamics

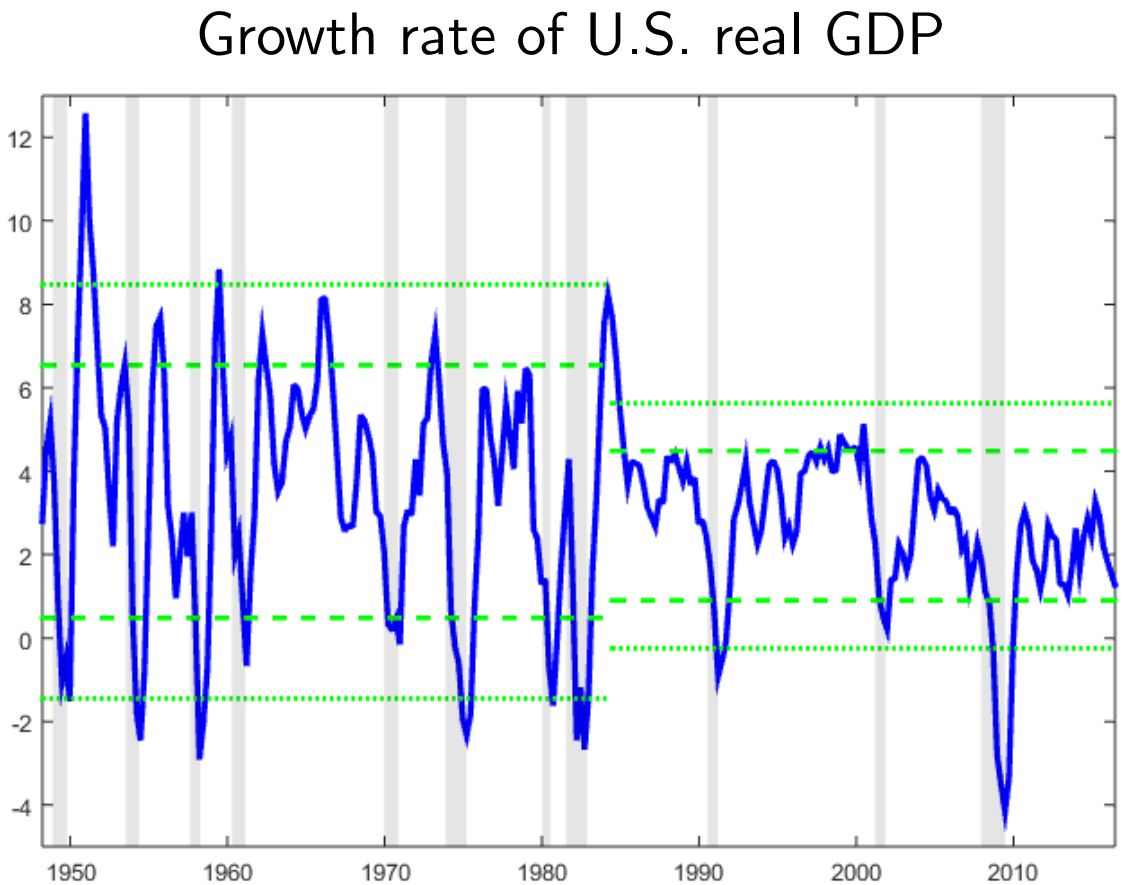
Danish Phillips curve



Danish Phillips curve

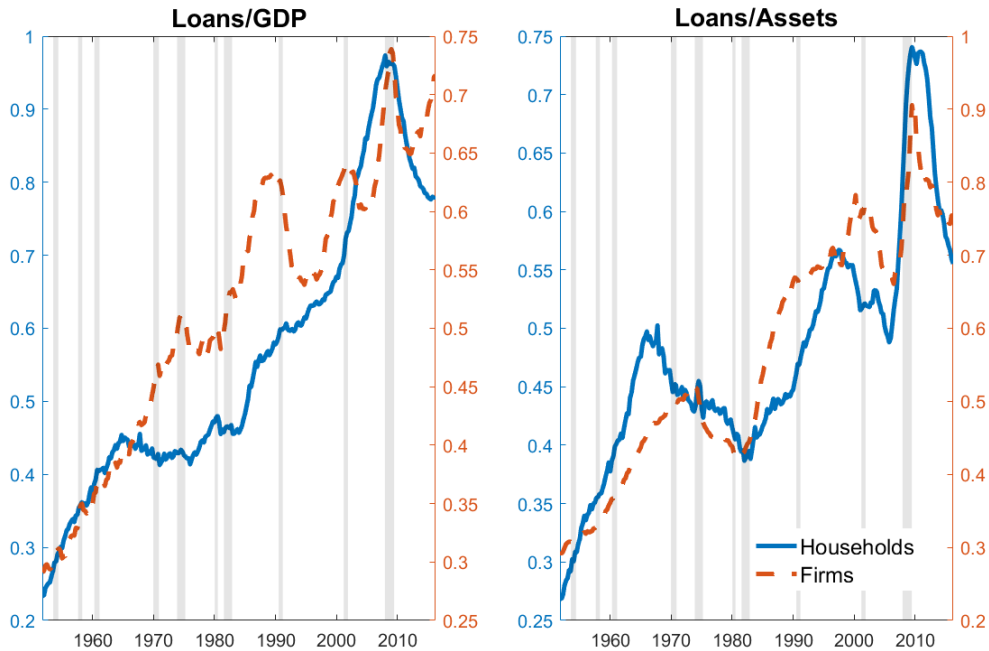
- Three regimes:
  - 1949-1973
  - 1974-1993
  - 1994-1998
- Our aim is to explain these, and other macroeconomic phenomena, rigorously

Structural change and cycles



Structural change and cycles

Household and corporate leverage in the US



Learning objectives

- To achieve the course objectives you need to learn new *analytical tools* to structure macroeconomic phenomena
- Specialization requires specific instruments, which in modern economics are provided by *mathematical models*
- In more advanced courses, we will then provide you with computational/econometric skills (along with more advanced and comprehensive models)

An overview of the main models we will see

- Our goal is to understand why these patterns occur, to be able to tell a coherent, formal story of all relevant patterns
- First half of the course: Two main frameworks within which to tell such stories:
  1. Ramsey model (aka neoclassical growth model)
  2. Overlapping generations model (OLG)
- Second half of the course: Business cycle analysis
  1. Open economy: The intertemporal budget constraint
  2. Real business cycle (RBC) framework
  3. Nominal rigidities
  4. Monetary-policy making

An overview of the main models we will see

Ramsey

- Questions: What drives aggregate capital accumulation, savings, output and consumption?
- Key difference w.r.t. the Solow model: Aggregate dynamics are "microfounded", i.e. derived form decisions taken at the microlevel (households, firms)
- Policy applications: Is there a role for the government, what effects do fiscal spending programs have?

An overview of the main models we will see

Overlapping generation models

- Incorporates population turnover (births and deaths)
- Analyze how life-cycle considerations affect aggregate capital accumulation, savings, output and consumption
- Policy applications: Social security

An overview of the main models we will see

Open economy

- A one (two)-lecture detour into open economy
- Intertemporal budget constraint
- Key departures from closed economy in terms of comovement between consumption and investment

An overview of the main models we will see

Real business cycles

- Key question: What drives aggregate fluctuations in main macroeconomic aggregates?
- Microfoundations, rational expectations
- Main driver: Technology shocks

An overview of the main models we will see

Nominal rigidities

- Key question: Under which conditions is money non-neutral?
- Key assumption: Prices/wages do not change istantaneously as aggregate demand changes
- Policy applications: Is there a role for the government (i.e., the Central Bank) in smoothing the business cycle, along with ensuring price stability?

An overview of the main models we will see

Monetary policy-making

- Key question: Can monetary policy stimulate economic activity without harming price stability?
- Policy applications: Different institutional settings for monetary policy-making

Microeconomic foundations

- Modern macroeconomics uses microeconomic general equilibrium theory
- It describes macroeconomic outcomes as the result of optimizing choices by households and firms that interact on different markets
- This contrasts with basic macroeconomic frameworks built on ad-hoc behavioral assumptions, as the IS-LM model
- Thus, we first review important microeconomic concepts and introduce assumptions about primitives
- Prior to get there, a quick historical excursus

Keynes' General Theory (Keynes, 1936) and the Great Depression

- Attempt to come to grips with the economic catastrophe...
- ...find policies for its cure and the prevention of future major recessions
- Revolution in the way economists thought about the economy as a whole
- In many respects the analytical content of the book was incomplete
- Hicks and the IS-LM model

Neoclassical synthesis (or "neoclassical-Keynesian" synthesis)

- Keynes' American followers: Samuelson, Klein, Modigliani, Solow and Tobin
- Pragmatic and policy-oriented
- Main technical novelty: incorporation of a Phillips curve. Otherwise, substantial satisfaction with the basic logic of Keynes' theory
- Keynes' theory relevant for studying the short run (involuntary unemployment)
- Classical (pre-Keynesian) theory: market clearing through flexible prices
- Reconciliation of Keynes and the classics: "neoclassical synthesis" or the "neoclassical-Keynesian" synthesis

Milton Friedman and the Monetarism

- Critique of Keynesians' policy activism
- Agreement on the relevance of nominal rigidities in the short run
- Although there is usually a short-run trade-off between inflation and unemployment stabilization, there is no long-run trade-off
- Endogeneity of inflation expectations – in the long run it is impossible to fool rational people (Phelps, 1967, 1968)

The New Classical counter-revolution

- Initiated by Lucas and Sargent in the early 1970s and later joined by Barro and Prescott
- Substantial rejection of Keynesian thinking (disequilibrium)
- Embracement of the classical or Walrasian line of thinking (equilibrium)
- Emphasis on the role of flexible prices under perfect competition not only as long-run theory, but also in the short-run
- Lucas' epoch-making contribution: Systematic incorporation of *uncertainty* and *rational expectations* into macroeconomics
- Rational expectations + market clearing-induced price adjustment $\rightarrow$ "policy-ineffectiveness proposition" (systematic monetary policy designed to stabilize the economy is doomed to failure)

The New Classical counter-revolution (contd.)

Explanation of business cycle fluctuations:

- Lucas' *monetary misperception theory* (Lucas 1972, 1975): shocks to money supply as the primary driving force
- *Real business cycle theory* of Kydland and Prescott (1982) and Prescott (1986): economic fluctuations primarily caused by shocks to real factors (e.g., productivity shocks)

New Keynesian reconstruction

- In the 1970s and the 1980s economists took a different line of attack
- Extension of the Keynesian approach through an expectations-augmented Phillips curve: good empirical performance
- Money neutrality as a good approximation to long-run issues, but not to short-run issues
- Some refinements were possible: new analytical tools from microeconomic general equilibrium theory and the rational expectations

Limitations of the old Keynesian theory addressed by the New Keynesians

1. It is not clear why nominal prices and wages change only sluggishly
2. The underlying microeconomics is not elucidated:
   - What are the budget constraints faced by economic agents? How are demand and supply determined when some agents have market power and act as price setters?
   - If markets do not clear by instantaneous adjustment of (perfectly flexible) prices, how do they then clear?
   - What kind of general equilibrium arises under these circumstances, taking into account the spillovers across different markets?
3. The integration of forward-looking rational (unbiased) expectations is only halfway

New Keynesian economics

- Main scope of New Keynesian economics:
  - Demonstrate the existence of involuntary unemployment
  - Money non-neutrality (or monetary policy effectiveness)
- From a methodological viewpoint this doctrine accepts:
  - *Microfoundations* (derivation of macroeconomic relationships from first principles)
  - *Rational Expectations*

Microfoundations in practice

Preferences

- In the simplest setting, households consume a single good, and possibly value leisure
- They trade-off current and future consumption, and it is usually assumed that preferences are additively separable across time, such that total utility, U, is given by

$$U = \mathrm{E}_0 \left[\sum_{t=0}^{T} \beta^t u\left(c_t, x_t\right) \right]$$

where E_0 denotes the mathematical expectation conditional on information available at time 0, and β is the discount factor which measures the degree of patience

Microfoundations in practice

Preferences

- The function u, which we assume is continuously differentiable, displays positive, decreasing marginal utility
- Consumption is essential, $\lim_{c \to 0} u_c(c, x) = \lim_{x \to 0} u_x(c, x) = \infty$
- For more tractability we usually assume u separable in consumption of goods (and leisure, whenever this applies) and assume CRRA:

$$u(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}, \ \sigma > 0, \ \sigma \neq 1$$

- Note that coefficient of relative risk aversion is σ, and the intertemporal elasticity of substitution (which measures how strongly a change in the interest rate affects the time profile of consumption) is $1/\sigma$

Microfoundations in practice

Log-utility

- For $\sigma \to 1$, $u(c) = \log c$
- *Proof*

$$\lim_{\sigma \to 1} \frac{c^{1-\sigma} - 1}{1-\sigma} = \lim_{\sigma \to 1} \frac{e^{\log c^{1-\sigma}} - 1}{1-\sigma} = \lim_{\sigma \to 1} \frac{e^{(1-\sigma)\log c} - 1}{1-\sigma}$$

- Apply l'Hôpital's rule

$$\lim_{\sigma \to 1} \frac{e^{(1-\sigma)\log c} - 1}{1-\sigma} = \left. \frac{e^{(1-\sigma)\log c}(-\log c)}{-1} \right|_{\sigma=1} = \log c$$

Microfoundations in practice

Technology

- Firms use a production function, f that maps inputs of capital, K, and labor, L, into output
- We assume that f displays positive and diminishing marginal products, has constant returns to scale (CRTS), and satisfies Inada conditions

$$f_K > 0,\ f_L > 0,\ f_{KK} < 0,\ f_{LL} < 0,\ f(\phi K, \phi L) = \phi f(K, L)\ \forall\ \phi > 0$$
$$\lim_{K \to 0} f_K = \lim_{L \to 0} f_L = \infty,\ \lim_{K \to \infty} f_K = \lim_{L \to \infty} f_L = 0$$

- Due to CRTS, output per worker and marginal products only depend on the capital-labor ratio, $k \equiv \frac{K}{L}$
- A common production function is the Cobb-Douglas

$$f(K, L) = K^{\alpha} L^{1-\alpha},\quad \alpha \in (0, 1)$$

Microfoundations in practice

CES production technology

- Constant elasticity of substitution (CES) production function:

$$f(K,L) = \left[\alpha K^{1-\frac{1}{\theta}} + (1-\alpha) L^{1-\frac{1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \qquad \theta > 0$$

- Special cases (try to prove it):
  - Linear ($\theta \to \infty$)

$$f(K,L;\theta \to \infty) = K + L$$

  - Leontief ($\theta \to 0$)

$$f(K,L;\theta \to 0) = \min\left\{\frac{K}{\alpha}, \frac{L}{1-\alpha}\right\}$$

  - Cobb-Douglas ($\theta = 1$)

$$f(K,L;\theta = 1) = \frac{1}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} K^{\alpha} L^{1-\alpha}$$

Microfoundations in practice

Budget constraint

- Consider a household at date t that owns a stock of assets, a_t, from which it receives interest income, $a_t(R_t - 1)$, where $R_t(= 1 + r_t)$ denotes the gross interest rate
- The household also receives wage income, w_t (for the time being, assume inelastic labor supply)
- Finally, must decide how much of income and wealth to consume and how much to carry as assets into the next period, a_{t+1}
- The dynamic budget constraint is

$$\begin{aligned} a_{t+1} &= a_t R_t + w_t - c_t \\ &\text{or} \\ \Delta a_{t+1} &= \underbrace{a_t r_t + w_t}_{\text{total income}} - c_t \end{aligned}$$

A simple two-period example

- With two periods and assuming $a_0 = 0$, the objective function is

$$u(c_0) + \beta u(c_1)$$

and the dynamic budget constraints at the two dates are

$$\begin{aligned} a_1 &= w_0 - c_0 \\ \underbrace{a_2}_{\geq 0} &= a_1 R_1 + w_1 - c_1 \end{aligned}$$

- Since nobody lends resources to a dying household, and saving after one dies is wasteful, it must be the case that $a_2 = 0$
- Using this we can combine the dynamic budget constraints into the intertemporal budget constraint (IBC)

$$c_0 + \frac{c_1}{R_1} = w_0 + \frac{w_1}{R_1}$$

A simple two-period example

Replacing the dynamic budget constraints into the household objective (or constructing a Lagrangian with the intertemporal budget constraint) we find the first-order condition for optimality, or Euler equation (do this)

$$u'(c_0) = \beta R_1 u'(c_1)$$

A simple two-period example

- Alternative representation:

$$\frac{u'(c_0)}{\beta u'(c_1)} = R_1$$

- The interpretation is that the marginal rate of substitution between current and future consumption, $\frac{u'(c_0)}{\beta u'(c_1)}$, is equated to the marginal rate of transformation, the relative price between the two goods, R_1
- Key factors determining the slope of the consumption path (or willingness to substitute intertemporally): β, R_1, and the *curvature* of the utility function

A simple two-period example

- To solve for consumption levels one must combine the Euler equation with the intertemporal budget constraint
- For CRRA preferences we find (do this)

$$c_0 \left(1 + \frac{(\beta R_1)^{1/\sigma}}{R_1}\right) = w_0 + \frac{w_1}{R_1}$$

Note:

- Optimal consumption depends on permanent income
- Income and substitution effects of R_1

A simple two-period example

- A change in R_1:

$$c_0 \left(1 + \frac{(\beta R_1)^{1/\sigma}}{R_1}\right) = w_0 + \frac{w_1}{R_1}$$

- Wealth effect: if $w_1 > 0$, $R_1 \uparrow$ reduces wealth, as it reduces the discounted value of future labor income
- Income effect: for given c_0 and $c_1 > 0$, as $R_1 \uparrow$ the cost of the bundle (c_0, c_1) in terms of the numeraire increases
- Substitution effect: through the Euler, it is optimal to substitute towards the cheaper good (the strength of this effect depends on $1/\sigma$)
- Under which condition do the substitution effect and the income effect neutralize each other?