Monetary Policy and Dynamic Macroeconomics: Introduction

University of Birmingham

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Course 2024-2025

This course

- An "advanced introduction" to dynamic macroeconomics and monetary policy
- Core topics in macro — general equilibrium models, from simple one period model to neoclassical growth model, fiscal policy, monetary frictions, new-Keynesian model
- But greater focus on formal economic models and analytical methods, especially dynamics
- Goal is to build intuition and to learn key macro tools, concepts and to make better sense of on-going macro policy debates

Course structure

1. **First half**: essentially "frictionless" macro: perfect competition and prices are fully flexible in all markets.
   - Intro to general equilibrium models
   - Neoclassical growth model and dynamic optimization
   - Fiscal policy: What are the effects of increasing government spending? Should government tax capital or labor?
2. **Second half**: macroeconomics with frictions
   - monetary economics, nominal rigidities, new Keynesian models, monetary policy

Course material

- No required text, but useful resources:
  - David Romer (2018): Advanced Macroeconomics. 5th Edition
  - Marina Azzimonti et al. (2024): Macroeconomics (preliminary draft available on Canvas)
- Slides for each lecture, posted on Canvas
- Problem sets with solutions, posted on Canvas
- Additional journal articles or working papers, posted on Canvas

Course schedule

Lectures		
Mondays	09 : 00 – 11 : 00	Watson - WATN-LT B (101)
Fridays	14 : 00 – 16 : 00	University House - UNIH-110

Seminars (2 groups)		
Thursday	11 : 00 – 12 : 00	University House - UNIH-106
Thursday	12 : 00 – 13 : 00	University House - UNIH-106

Seminar Classes

- Seminar classes will be taught by Dr. Liang Shi
- Seminar class exercises
  - In-depth analysis of topics covered in lectures
  - Offer a means of self-assessment
- You are advised to complete the exercises in advance
- Contribute to the discussion facilitated by the class teacher
- Study the solutions posted to Canvas after the class

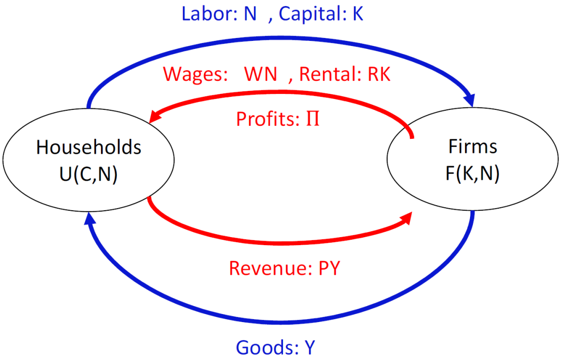
Math Background

- This is an advanced course
- You should be familiar with standard "math for economists"
  - Multivariable calculus
  - Constrained optimization (e.g. method of Lagrange multipliers)
  - Taylor series (in particular, first-order approximations)
- If any of the above topic does not sound familiar, please review it
  - M. Pemberton and N. Rau (2001), *Mathematics for Economists: an Introductory Textbook*
  - Simon, C.P. and Blume, L. (1994) *Mathematics for Economists*

Introduction

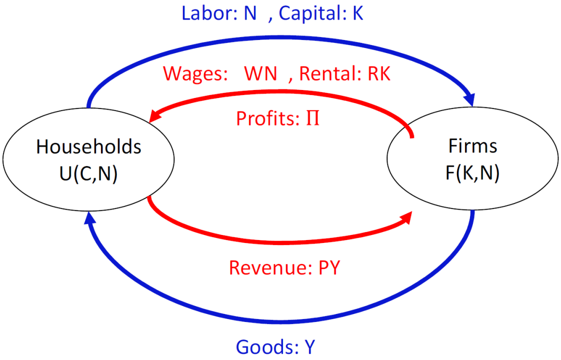
Structure of the macroeconomy

- Households rent labor services N and capital K to firms
- Households buy consumption goods Y from firms



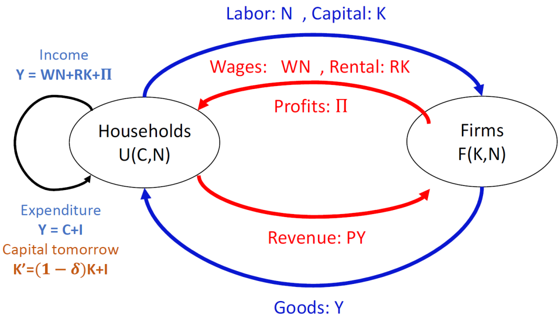
Structure of the macroeconomy, cont'd

- Households receive wages, rental income and profits from firms
- Firms receive revenues PY from selling goods to households



Structure of the macroeconomy, cont'd

- Households use their income to finance consumption C and investment $I = K' - (1 - \delta)K$



Stylized Facts

Stylized Facts

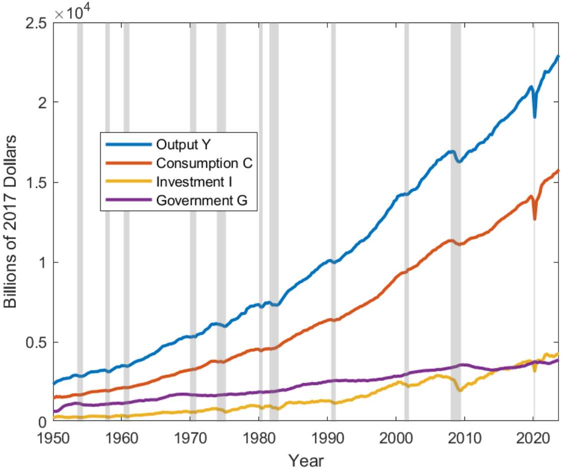
- Relative stability of growth in real GDP per person
- Benchmark models are organized around *balanced growth* paths.
- These growth paths set up to capture certain 'stylized facts' (Kaldor 1963)
    - Trend growth in output and real wages
    - No trend in composition of output, i.e. consumption/output and investment/output ratios are roughly constant over time
    - No trend in capital/output ratio, or factor shares
    - How well do these "stylized facts" hold up?

Stylized Facts

- We observe data on
  - Output, Y_t
  - Consumption, C_t
  - Investment, I_t
  - Government expenditures, G_t
- How do we organize these time series into a consistent framework?
- Most dynamic models are built around these equations (feasibility and technological constraints)

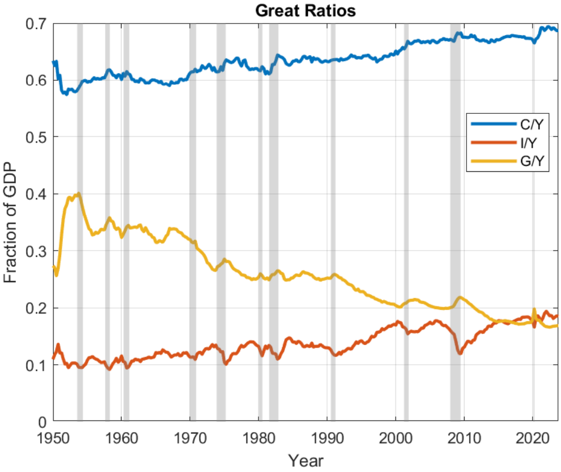
$$
\begin{aligned}
Y_t &= C_t + I_t + G_t, \\
K_{t+1} &= (1-\delta)K_t + I_t, \\
Y_t &= F(K_t, N_t).
\end{aligned}
$$

Stylized Facts: Real GDP and its components over time



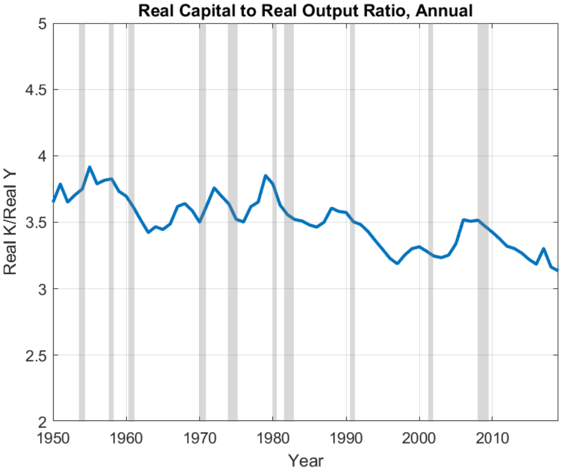
- Output Y, consumption C, investment I and government expenditures G: $Y = C + I + G$

Stylized Facts: Shares



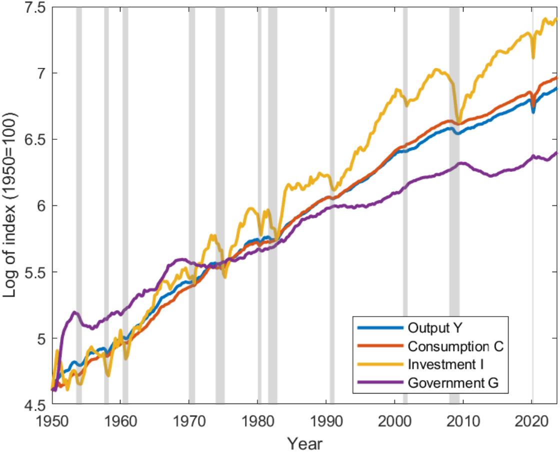
- Shares: C/Y, I/Y and G/Y

Stylized Facts: Capital-to-Output Ratio



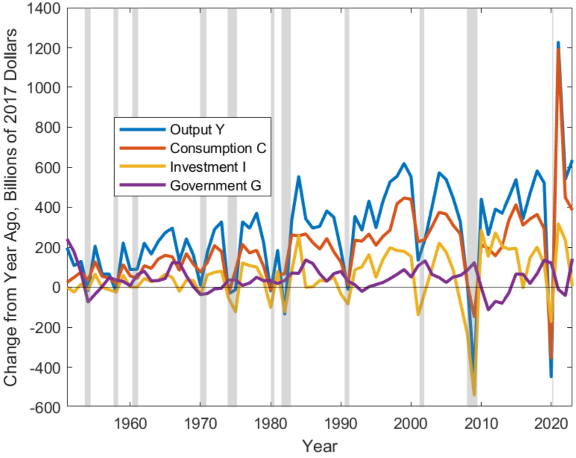
- Note: K is a stock, while Y is a flow

Stylized Facts: Growth rates



- $\log(y_t) - \log(y_{t-1}) \approx g_t$, where $g_t = (y_t - y_{t-1})/y_{t-1}$

Stylized Facts: Short-run changes



- Magnitude of the Covid recession stands out

Terminology

- Course will focus on macroeconomic dynamics
- Consider a function $F : \mathbb{R}_+ \rightarrow \mathbb{R}_+ \ldots$ this is our 'model'

$$X_{t+1} = F\left(X_t\right)$$

- We will be interested in the properties of the time-series $\{X_t\}_{t=0}^{\infty}$
- We will call X_0 the initial condition
- We will say that the steady-state value of X_t is $\bar{X}$ that satisfies

$$\bar{X} = F(\bar{X})$$

- We will refer to X_t as an endogenous variable
- Suppose $F\left(X_t\right) = \widetilde{A}X_t^{\alpha}$, we will refer to α as a parameter, we will refer to $\widetilde{A}$ as an exogenous variable.

Tool

- We will often use linearization (or, first-order Taylor approxim.) to do some back-of-envelope calculations

$$F\left(X_t\right) \approx F\left(\bar{X}\right) + \left.\frac{\partial F(X)}{\partial X}\right|_{X=\bar{X}} \left(X_t - \bar{X}\right)$$

- This gives

$$X_{t+1} \approx \bar{X} + \left.\frac{\partial F(X)}{\partial X}\right|_{X=\bar{X}} \left(X_t - \bar{X}\right)$$

- Manipulating

$$\frac{X_{t+1} - \bar{X}}{\bar{X}} \approx \left.\frac{\partial F(X)}{\partial X}\right|_{X=\bar{X}} \left(\frac{X_t - \bar{X}}{\bar{X}}\right)$$

Example: Back-of-envelope

- Approximately, what is the effect of a 1 percent increase in C_t on Y_t ?

$$Y_t = C_t + I_t + G_t \quad , \quad Y_t = F\left(C_t, I_t, G_t\right)$$

- Take an approximation around average values: $\bar{X} := \mathbb{E}\left[X_t\right]$

$$F\left(C_t, I_t, G_t\right) \approx F(\bar{C}, \bar{I}, \bar{G}) + 1\left(C_t - \bar{C}\right) + 1\left(I_t - \bar{I}\right) + 1\left(G_t - \bar{G}\right)$$

- Manipulating

$$\frac{Y_t - \bar{Y}}{\bar{Y}} \approx \frac{\bar{C}}{\bar{Y}}\left(\frac{C_t - \bar{C}}{\bar{C}}\right) + \frac{\bar{I}}{\bar{Y}}\left(\frac{I_t - \bar{I}}{\bar{I}}\right) + \frac{\bar{G}}{\bar{Y}}\left(\frac{G_t - \bar{G}}{\bar{G}}\right)$$

- Answer given by average consumption $\bar{C}$ divided by average GDP $\bar{Y}$
- In the U.S. economy $\bar{C}/\bar{Y}$ is about 0.7 (See graph in previous slides).

Constant-returns to scale and factor shares

- Suppose output in the economy is produced by a profit-maximizing firm that operates a constant-returns to scale CRS production function F
- F has CRS if

$$F(\lambda K, \lambda N) = \lambda F(K, N), \text{ for all } \lambda > 0$$

For example, Cobb-Douglas function has CRS property:

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

- Profit-maximizing firm solves

$$\Pi_t = \max_{K_t, N_t} \left\{ P_t K_t^{\alpha} N_t^{1-\alpha} - R_t K_t - W_t N_t \right\}$$

- First-order condition for N_t

$$(1-\alpha) P_t K_t^{\alpha} (N_t)^{-\alpha} - W_t = 0$$

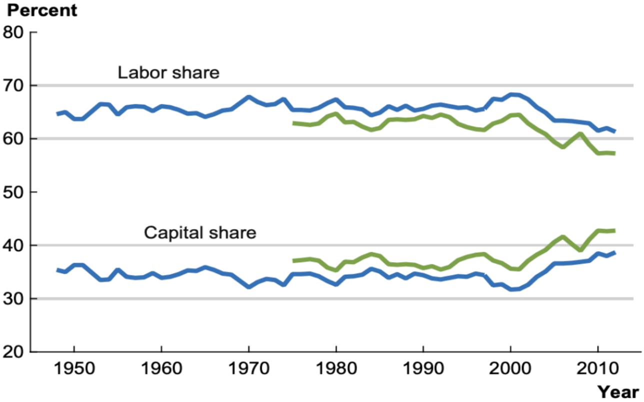
Constant-returns to scale and factor shares

- **Result**. Under constant returns to scale, competitive pricing of inputs implies that factor shares equal output elasticities.
- The labor share, in particular, is equal to

$$\frac{W_t N_t}{P_t Y_t} = 1 - \alpha$$

- This "model" has a testable implication: the labor share is constant over time
- Does this hold approxim. in the data?

US Factor Shares



Source: Jones (2016). Green lines are the factor shares for the corporate sector from Karabarbounis and Neiman (2014).

Appendix

Data Sources

Download data from `https://fred.stlouisfed.org/`

- **Output**. Real Gross Domestic Product (GDPC1)
- **Consumption**. Real Personal Consumption Expenditures (PCECC96)
- **Investment**. Real Gross Private Domestic Investment (GPDIC1)
- **Government expenditures**. Real Government Consumption Expenditures and Gross Investment (GCEC1)
- **Capital stock**. Capital Stock at Constant National Prices for United States (RKNANPUSA666NRUG)