Monetary Economics and the Macroeconomy

Introduction to the Course

Dr. Alessandro Di Nola

University of Birmingham

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General Information

- Lecturer: Alessandro Di Nola
- Office: University House - 2137
- E-mail: a.dinola@bham.ac.uk
- Office hours: Monday 16:00-17:30
- For questions you can write on the Discussion Board on Canvas
    - Good idea to post your questions on the discussion board, since classmates will also benefit—often a question raised by one student is of general interest to many others.

Methods

- An "advanced introduction" to monetary policy
- Greater focus on formal economic models and analytical methods, especially dynamics
- Goal is to build intuition and to learn key concepts and ideally to equip you with the tools needed to work in a central bank
- Towards this end, we will make extensive use of math and programming skills (Matlab, but Python/Julia also OK)
- Warning: This module is challenging...as it should as it is a master-level module. If you plan to just learn by heart it will be very difficult, but if you put the effort in to understand the discussed topics in detail you will be successful.

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Course material

- No required textbook, but useful resources:
    - David Romer (2018): Advanced Macroeconomics. 5th Edition
    - Carl Walsh (2018): Monetary theory and Policy. 4th Edition
    - Jordi Gali (2015): Monetary Policy, Inflation and the Business Cycle. 2nd Edition.
- **Slides** for each lecture, posted on Canvas
- **Problem sets** with solutions, posted on Canvas
- Additional journal articles or working papers, posted on Canvas

Seminar Classes

- Seminar classes will be taught by Yuteng Zhang
- 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 and second-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*

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Coding Background?

- Introduction to Matlab in Seminar classes
- I will assume basic familiarity with programming concepts such as `for/do` loops, arrays, functions, etc.
    - Don't be scared if you don't have previous experience with programming: one of the goal of this course is to teach you the basics in the context of monetary economics
- We will learn together more advanced concepts and methods
- Final goal: being able to **solve and simulate a dynamic economic model on the computer** (central banks...)

▸ How to Install MATLAB

Assessment

- Take-home assignment (25% + 25%)
- In class written exam, closed-book (50%)

Take-home Assignment

- The assignment includes a mix of questions:
  - Some can be solved with pen and paper.
  - Others require writing a short MATLAB script.
- Handout: 15 November 2025
- Submission deadline: 19 December 2025, 12:00 noon

Take-home assignment

- Example of an exercise that can be solved by "paper-and-pencil"

9. The basic Calvo model assumes that in each period a fraction ω of all firms do not change price. Suppose instead that these firms index their price to last period's inflation, so that for such firms the log price is given by $p_{it} = p_{it-1} + \pi_{t-1}$.

a. What is the first-order condition for $\hat{p}_t$, the price chosen by firms that do adjust optimally in period t?

b. How does this compare to (6.34)?

c. The log aggregate price level becomes

$$p_t = (1 - \omega)\hat{p}_t + \omega(p_{t-1} + \pi_{t-1}).$$

Use this equation with the first-order condition for $\hat{p}_t$ obtained in part (a) to find an expression for the aggregate inflation rate. How is current inflation affected by lagged inflation?

Take-home assignment

- Example of a computer-based exercise

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \kappa \widetilde{ln(y_t)}$$
$$\widetilde{ln(y_t)} = E_t\{\widetilde{ln(y_{t+1})}\} - \frac{1}{\gamma_c}(i_t - E_t\{\pi_{t+1}\} - r_t^n)$$
$$ln(y_t^n) = \phi_{yz}^n z_t + \vartheta_y^n$$
$$r_t^n = -\gamma_c \phi_{yz}^n (1-\rho_z) z_t$$
$$z_t = \rho_z z_{t-1} + \epsilon_{z,t}$$

where $\kappa \equiv (\gamma_c + \frac{\gamma_l+\alpha}{1-\alpha})\frac{(1-\theta)(1-\beta\theta)}{\theta}\Theta$, $\Theta \equiv \frac{1-\alpha}{1-\alpha+\alpha\epsilon} \leq 1$, $\vartheta_y^n = -\frac{(1-\alpha)(\mu - log(1-\alpha))}{\gamma_c(1-\alpha)+\gamma_l+\alpha} > 0$ and $\phi_{yz}^n = \frac{1+\gamma_l}{\gamma_c(1-\alpha)+\gamma_l+\alpha}$, and $\mu = log(\frac{\epsilon}{\epsilon-1})$. And $\epsilon_{z,t} \sim N(0, \sigma_{\epsilon,z}^2)$.

Consider the following calibration

Discount rate	β	0.99
Curvature of utility in consumption	γ_c	1
Curvature of utility in leisure	γ_l	2
Decreasing returns to labour	α	0.36
(Calvo) Probability of changing price	θ	0.66
(Elasticity that gives the) Markup on intermediate goods	ϵ	6/5
Productivity shocks	ρ	0.9
	σ_{ϵ_z}	0.03

To close the model we need to add an interest rate rule. For this use the simple Taylor rule

$$i_t = \phi_\pi \pi_t + \phi_y \widetilde{logy_t} + \epsilon_{i,t} \tag{2}$$

where $\epsilon_{i,t} \sim N(0, \sigma_{\epsilon_i})$, $\sigma_{\epsilon_i} = 0.01$.

(a) Plot the impulse response functions of the inflation rate, output gap, and the interest rate to a one-standard deviation interest rate shock for $\phi_\pi = 1.5$, $\phi_y = 0.6$.

(b) Try a couple of other values for ϕ_π and ϕ_y and describe your findings.

(c) The optimal monetary policy that we derived in Q1 can be implemented as the interest rate rule $i_t = r_t^n + 1.5\pi_t + \widetilde{logy_t}$. Plot the impulse response functions under the optimal monetary policy and compare them to your results using the Taylor rules. What is the difficulty in actually implementing this optimal monetary policy rule in practice?[3]

In-Class Exam

- Mostly based on "paper and pencil" problems, but I may ask something related to computer-based simulations
- Discussion about AI (mostly personal opinions)
  - AI tools are very useful tools that greatly increase productivity (even in learning!)
  - As every tool, use it with care! Sometimes your favorite AI software may give a wrong answer
  - Even if the answer is correct, make sure you understand why it is correct
  - In my experience, AI helps if you already have a basic understanding of the issue at hand
  - Make sure you understand well course material: AI will not help you during the final exam!

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Introduction - Module Content

- Monetary policy is hugely important in current times!
- The module will cover the following topics:

  1 Inflation, Money Growth, Output: Stylized Facts

  2 Classical Monetary Model with Flexible Prices
    - 2a. Perfect Competition
    - 2b. Monopolistic Competition

  3 Price Rigidities and New Keynesian Models
    - 3a. Partial Equilibrium Models with Price Stickiness
    - 3b. General Equilibrium New Keynesian Model
    - 3c. Optimal Monetary Policy

Appendix

Installing MATLAB (Step 1)

1. Go to the University of Birmingham IT Services portal:
   - `https://universityofbirmingham.service-now.com/`
   - Search for `MATLAB` in the Software Catalogue.
   - Or simply type `matlab university of birmingham` in Google search bar
2. Download the installer for your operating system (Windows or macOS).
3. During installation:
   - Select **Log in with a MathWorks Account**.
   - **Very important**: Use your University of Birmingham email (`@student.bham.ac.uk`).
   - Accept the Campus-Wide Licence.

Installing MATLAB (Step 2)

1. Complete the installation by choosing the default options.
2. When prompted to select toolboxes, make sure you include:
   - **Optimization Toolbox**
   - **Symbolic Math Toolbox**
3. Once installed:
   - Open MATLAB to confirm activation.
   - Test by typing `ver` in the Command Window.
   - Check that the Optimization Toolbox and Symbolic Math Toolbox are listed.

Using MATLAB Online

- If you prefer not to install new software, you can use **MATLAB Online**.
- Access via: `https://matlab.mathworks.com`
- Log in with your University of Birmingham MathWorks account (same as for installation).
- Runs entirely in the browser, no setup needed.
- Includes most toolboxes, including:
  - **Optimization Toolbox**
  - **Symbolic Math Toolbox**
- Note: performance may be slower than desktop MATLAB for large simulations but for this course will be OK.