Advanced Macroeconomics

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

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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 model. 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 economic growth and 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, on business cycle theory, growth theory, monetary economics, international economics and seminars on macroeconomics. The course is also important for more methodology oriented courses like empirical macroeconomics and computational economics.
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.
The Role of Math

- Math is a tool for organizing thoughts consistently
  - Math does not create truth
  - The true economic model of the world does not exist
  - Math creates rigorous transparency about model assumptions and thus a model’s implications (and limitations)
  - Such transparency fosters economic intuition and thereby a solid basis for informed discussions (science)
- Also, mathematically formulated models can easier be taken to the data
- “Just talking plausibly about economics is not the same as having a real understanding; for that you need crisp, tightly argued models.” Paul Krugman
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
- Microsoft Excel

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.

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

Part 1: Introduction

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

Part 2: Economic Growth

- Lecture 2: Stylized facts, Solow growth model
- Lecture 3: Augmented Solow growth model, cross-country differences in standards of living

Part 3: Microeconomic Foundations

- Lecture 4: Consumption-savings problem
- Lecture 5: Equilibrium in an endowment economy, fiscal policy
- Lecture 6: Production and labor supply

Part 4: The Real Business Cycle Model

- Lecture 7: The real business cycle model
- Lecture 8: Effects of shocks, taking the model to the data, criticism of the RBC model
Outline

Part 5: The New Keynesian Model
- Lecture 9: Deriving the New Keynesian Model
- Lecture 10: The Effects of Shocks in the New Keynesian Model

Part 6: Financial Crises
- Lecture 11: Monetary Policy and the Zero Lower Bound on Interest Rates
- Lecture 12: The Great Recession

Part 7: Open Economy (if time permits)
- Lecture 13: Modeling open economies

Mock Exam
- Lecture 14: 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):


Other useful macro textbooks:


Academic papers:

- Will be announced during the course.
Literature

More specialized and advanced textbooks:

- **Growth**

- **Business Cycles**

- **International Macroeconomics**
Literature

Research oriented PhD level books (much higher level than in this course):

Information: Tutorial Sessions

- Weekly tutorial sessions:
  - Starting: 21. October 2019
  - Lecturer: Lars Other
  - Time: Mondays 12:00 – 14:00
  - Place: SR 314
  - Note: Be prepared and try to solve the problem sets before class.

- Please register for the course in Friedolin so that we can contact you via E-Mail.
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Lecture 1: Measurement of macroeconomics variables, concept of modern macroeconomic modelling
Learning Objective of Today's 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


- 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
Case with two goods:

\[ \text{Nominal} = p_1 y_1 + p_2 y_2 \]

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

\[ \frac{p_1}{p_2} = \frac{\text{€ good 1}}{\text{€ good 2}} = \frac{\text{good 2}}{\text{good 1}} \]

- 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:

\[ \text{Real}_1 = y_1 + \frac{p_2}{p_1} y_2 \text{ (Units are good 1)} \]

\[ \text{Real}_2 = \frac{p_1}{p_2} y_1 + y_2 \text{ (Units are good 2)} \]
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 actually denominated in units of money, but facilitates comparisons over time.

\[
\text{Real GDP}_t = p_{1,0}y_{1,t} + p_{2,0}y_{2,t} + \cdots + p_{N,0}y_{N,t} = \sum_{i=1}^{N} y_{i,t}
\]

- 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

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

- Inflation: rate of growth of price index
Chain-Weighted Real GDP

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

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

\[ GDP_t = € 5 \times 100 + € 500 \times 10 = € 5500 \]
\[ GDP_{t+1} = € 10 \times 100 + € 300 \times 20 = € 7000 \]

Baseyear $t$:

\[ Real \ GDP_t = € 5 \times 100 + € 500 \times 10 = 5500 \]
\[ Real \ GDP_{t+1} = € 5 \times 100 + € 500 \times 20 = 10500 \]

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

Baseyear $t + 1$:

\[ Real \ GDP_t = € 10 \times 100 + € 300 \times 10 = 4000 \]
\[ Real \ GDP_{t+1} = € 10 \times 100 + € 300 \times 20 = 7000 \]

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.
GDP is an estimate, revisions are large

US real GDP growth, 2015 Q1
Log Real GDP
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.
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: amount of time spent working per person (\( h \))

Other important labor statistics:

- Employment-population rate: \( \frac{E}{L} \)
- Labor force participation rate: \( lfp = \frac{LF}{L} \)
Figure 1.6: Labor Market Variables

- Unemployment Rate
- Employment-Population Ratio
- Average Hours
- Labor Force Participation Rate
- Hours Per Capita
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. $\alpha$, $\beta$), sometimes with lowercase Latin letters without a time subscript.
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

Course 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*

- **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*
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.”


- 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 modeling 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.
- 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.