Intermediate Macroeconomics

Introduction

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Textbook Readings

- Romer, (Today: Introduction)
- Chiang and Wainwright, Chapters 1-5 (selective).
- Mankiw, (Today: Chapter 1)
Introduction

Aims and Objectives: Object of Inquiry

• Broadly speaking, macroeconomics is interested in the aggregate economy of a nation
  • Described by a series of aggregate variables such as GDP, Consumption, Investment, Interest Rates, Inflation etc.
  • These variables are typically catalogued for a nation in their National Income and Product Accounts (NIPA)
  • An excellent data source for the U.S. is the FRED database, free online, at the Federal Reserve Bank (St. Louis)’s website
  • For cross-country the best are the Penn-World Tables: https://pwt.sas.upenn.edu/
  • The object of inquiry, the aggregate economy, described by aggregate variables, demonstrates certain empirical regularities, motivating the study of the macroeconomics
The main **aims** of macroeconomics have to do with (i) economic growth and (ii) cycles, as measured by various statistical representations of the variables that describe the economy.

- **Economic Growth**: challenges are to identify economic processes that allow nations to exhibit long run growth in per-capita income (GDP), and why GDP growth rates across nations vary.
- **Business Cycles**: challenges are to explain and predict the myriad fluctuations exhibited in the short run by a large number of aggregate variables around a given growth rate.
However, there is a unifying *methodological theme* for analyses of growth and cycles.
The explanation of necessarily dynamic phenomena with Dynamic (Deterministic or Stochastic) General Equilibrium models.
The models are then evaluated using statistical techniques to determine the extent to which they match data and thereby could be employed in policy making and/or forecasting.
No model is perfect, the idea is to examine the extent to which a model can be used.
A Brief Modern History of Macroeconomic Thought

The Traditional Approach for studying empirical regularities

- Began with the specification of a (static or dynamic) system of equations consisting of accounting identities, ad-hoc behavioral equations (e.g., the consumption function) and 'forcing processes' for exogenous variables
- Two main theoretical paradigms that each gave a system for analysis: Classical and Keynesian
- Classical: markets comprising an aggregate economy equilibrated through smooth relative price adjustments and posited a real-nominal dichotomy
- Keynesian: did away with market clearing assumptions (especially in the short-run), and explained why nominal and real variables influenced one another
- Regardless of paradigm, the method of analysis, theoretical or empirical, was the same: specification of a system of equations reflecting views on the interaction of aggregate variables.
Introduction
Aims and Objectives

- The Modern Approach for studying empirical regularities
  - Requires construction of explicit dynamic (possibly stochastic) optimization problems facing agents interacting in a general equilibrium
  - Dynamic: because macroeconomic variables time series exhibit ‘persistence’ (e.g. yesterday’s value of GDP is related to today’s value) we must account for the notion that economic decisions made today will affect at the very least the set of choices tomorrow.
  - Optimization problems consistent with microeconomic principles, endogenous variables clearly identified relative to exogenous and pre-determined ones
  - Expectations of variables consistent with the model at hand
  - Result: a system of equations with no ad-hoc behavioral equations, but equations that explicitly reflect economic behavior of agents within and across time
Change in methods applied to all paradigms, giving birth to New Classical and New Keynesian schools of thought operating under new methodological principles: clear specification of preferences, constraints, policies and external factors that yield a system of equations with a direct link to optimization problems facing agents.
Modern macroeconomics employs economic models to achieve mostly one of three **major goals**

- Account for (often via replication), recurrent patterns of aggregate economic activity known as stylized facts
  - These facts pertain to long run growth rates of macroeconomic aggregates as well as characteristics of their short run (often defined as quarterly) cyclical fluctuations
- Interpret and analyze specific aggregate socioeconomic episodes, e.g. the worldwide Great Depression of the 1930’s
- Conduct policy analyses that cannot be conducted in reality
  - E.g., what would be the societal welfare implications of the U.S. economy eschewing income taxes in favor of only sales taxes?
  - Such a question cannot be experimented with in reality but can be analyzed using a model of aggregate economic behavior.
Time Series Data: in growth and cycle models, macroeconomists employ time series data

- A time series represents the value of a variable (e.g. real GDP, say $y$) over time
- Thus denote a time series as a function of time, e.g. $y(t) = y_t$ because as time changes the value of real GDP changes
- Next, work with logged versions of a time series represented in levels
- This is because changes in the log of a variable $y_t$ over time represent the growth rate of the variable

\[
\frac{d \log y(t)}{dt} = \frac{d \log y_t}{dt} = \frac{\dot{y}_t}{y_t} = \frac{dy_t}{dt} = \frac{y_t}{y_t} \equiv \frac{\dot{y}_t}{y_t} = g_{y_t} \tag{1}
\]

where $\dot{y}_t = \frac{dy_t}{dt}$. 

Introduction
A Tour of Topics and Tools
• Growth models try to explain pattern of $g_{yt}$ within and across countries
• Across countries: Penn World Tables, or World Development Indicators (a bit less complete)
• Public Data on Google
Nearest GDP equivalents, 2009 or latest, $bn

[Map showing GDP equivalents for various countries with different color codes for GDP ranges: Less than 50, 50 - 200, 200 - 500, 500 - 1 trillion, 1 trillion or more.]
Each dot represents one country.

The line around the dot shows how satisfaction relates to income within that country:

- Higher-income people are more satisfied
- Higher-income and lower-income people are equally satisfied

Average life satisfaction (on a 10-point scale)

G.D.P. per capita, converted to dollars at prices that equalize purchasing power

Source: Betsey Stevenson and Justin Wolfers, Wharton School at the University of Pennsylvania
Introduction
U.S. Real GDP

- As an example of growth for one country, consider U.S. Real Gross Domestic Product
- GDPC96 in FRED database
- Time series plots:
- In trillions of 2000 dollars \((y_t)\)
- In natural logarithms \((\log y_t)\)
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Natural Logarithm of U.S. Real GDP
• Business cycle models try to explain fluctuations in time series variables around their trends.

• As an example, nominal GDP ($Y_t$) for the U.S. can be thought of as the real GDP ($y_t$) multiplied by some measure of the aggregate price level ($p_t$)

$$Y_t = p_t \times y_t \tag{2}$$

• Let us look at those two components separately (i.e., fluctuations in real GDP and a measure of inflation).

• Consider the GDP implicit price deflator as a measure of the aggregate price level ($p_t$), GDPDEF in FRED database.
• Time series plots of cycles:
  
  • Consider fluctuations around the growth rate in terms of annualized percentage change in $y_t$

$$\hat{y}_t = \left\{ \left[ \left( \frac{y_t}{y_{t-1}} \right)^4 \right] - 1 \right\} \times 100 \quad (3)$$

• And consider inflation ($\hat{\pi}_t$) measured as the annualized percentage change in $p_t$

$$\hat{\pi}_t = \left\{ \left[ \left( \frac{p_t}{p_{t-1}} \right)^4 \right] - 1 \right\} \times 100 \quad (4)$$
Introduction

Annualized Percentage Change in U.S. Real GDP

[Diagram showing annualized percentage change in U.S. Real GDP from 1950Q1 to 2000Q4, with shaded areas indicating NBER dates.]
Introduction

Annualized Percentage Change in U.S. Real GDP Deflator (‘Inflation’)

![Graph showing annualized percentage change in U.S. Real GDP Deflator from 1950Q1 to 2000Q1. The graph illustrates fluctuations in inflation rates over time, with shaded areas indicating NBER recession dates.]
• Select Stylized Facts for Macroeconomic Environments: Growth

• Balanced Growth:
  • In the long run (measured on a five-year basis) output and physical capital per worker grow at almost constant rates that show no diminishing
  • Physical capital to output ratio and the rate of return to capital are almost constant quantities
  • Return to labor (wages) grows at the same rate as output; output shares of capital and labor are almost constant

• Cross-country differences in levels and growth rates of GDP:
  • Persistent Differences: unconditional convergence of poor countries to rich ones is non-existent
  • But, groups of countries that share characteristics show convergence, called conditional convergence
Select Stylized Facts for Macroeconomic Environments: Cycles

- Business cycles are defined as the deviation of real GDP from its' trend. Business cycle facts are reported in terms of:
  - Volatility: the standard deviation of a variable relative to the standard deviation of real GDP.
  - Co-movement: correlation of the variable with other variables.
  - Persistence: correlation of the variable with its’ own past lagged values.

- These facts can be:
  - Pro-cyclical, Counter-cyclical or A-cyclical
  - Leading, Coincident or Lagging
Introduction
Real Stylized Facts

- Consumption of non-durables and services is less volatile than real output.
- Investment is three times as volatile than real output.
- Hours worked are much less volatile than output.
Growth rates of real GDP, consumption, investment

Percent change from 4 quarters earlier

Investment growth rate

Real GDP growth rate

Consumption growth rate

Index of Leading Economic Indicators

- Published monthly by the Conference Board.
- Aims to forecast changes in economic activity 6-9 months into the future.
- Used in planning by businesses and govt, despite not being a perfect predictor.
Components of the LEI index

- Average workweek in manufacturing
- Initial weekly claims for unemployment insurance
- New orders for consumer goods and materials
- New orders, nondefense capital goods
- Vendor performance
- New building permits issued
- Index of stock prices
- M2
- Yield spread (10-year minus 3-month) on Treasuries
- Index of consumer expectations
Money growth is leading and procyclical.
Inflation is leading and procyclical.
Nominal interest rates are lagging and procyclical.
Stock prices are leading and procyclical.
Introduction
Elements of General Equilibrium

- **General Equilibrium**
  - Most macroeconomic environments are applied general equilibrium models
  - You will learn the exact meaning of General Equilibrium (GE) as you go through the core microeconomic theory and macroeconomic theory sequence of courses at NYUAD

- Suffice it to say for now that GE effectively refers to accounting simultaneously for all of the optimization objectives of the agents comprising the aggregate economy; clearly specifying the economic environment they operate in (e.g. market clearing) as well as specifying what the researcher is taking as exogenous to the environment (e.g. shocks like subprime or Euro crisis)

- We will basically learn what dynamic GE models are throughout this course, so by the end of this course, you should be well versed in these models
Introduction

A Graphical Example of a GE

[Diagram of the circular flow model with arrows indicating the flow of income, labor, goods (bread), and expenditure between households and firms.]
• Typically in macroeconomic environments agents are:
  • Households who maximize utility from consumption and leisure subject to budget constraints that may be dynamic in nature
  • Firms who maximize profit from selling output subject to the constraint that they can produce only so much given a level of available factors of production (i.e. production function)
  • Governments who (hopefully) maximize some welfare criterion for the good of (hopefully) all citizens

• Economic aspects of the environment typically consist of how households and firms interact and assumptions on the nature of the functioning of markets (e.g. do markets clear? and if so at what relative price sequences?)

• In order for a GE model to be precise and be amenable for empirical evaluation we have to allow for various functional forms for utility and production
Under certain conditions, the economic outcomes of general equilibrium models have certain attractive efficiency properties, captured by the so-called ‘Fundamental Welfare Theorem’.

The first theorem states that if markets are competitive and complete, then equilibrium prices will ensure that the allocation of goods to the households is Pareto efficient.

- This means that, under the current equilibrium allocation, it is not possible to make some household better off without making another worse off.
- A market can be described as competitive if each economic agent, while optimizing her own objective, takes prices as a given.
- We say that markets are complete when a market exists for all possible goods and contingencies.

The first welfare theorem is the most important.
The second theorem implies that any allocation of goods and services that is Pareto efficient can be implemented as a competitive equilibrium.

- For example, suppose that society considers a particular (Pareto efficient) outcome to be socially desirable.
- Then the second welfare theorem says that the government can devise a lump-sum tax and transfer system of endowments that can implement it.

The first welfare theorem is easily the more immediately relevant of the two as it allows macroeconomists to model a theoretical social planner instead of multiple markets.

We will learn intuitively what these welfare theorems mean as we go through the material in this course.
• The textbook will only be followed loosely. That is, these notes are going to be fundamental. But you need to be reading the book as well.
• Exams will cover these notes and the textbook.
• Interactive participation will be critical.
Data Review

- Key time series data we will want to model:
  - Nominal GDP ($P_t Y_t$)
  - Real GDP ($Y_t$) (Value Added)
  - Aggregate Prices ($P_t$) via the GDP Deflator and the CPI
  - Unemployment Rate
• Three definitions:
  • Total expenditure on domestically-produced final goods and services.
  • Total income earned by domestically-located factors of production.
  • Total value added generated across sectors

• Key: Expenditure equals income equals production because every dollar spent by a buyer becomes income to the seller.

• Hence the circular flow of income and expenditure

\[
Y_t = C_t + I_t + G_t + X_t - M_t
\]

• Note: GNP – GDP = factor payments from abroad minus factor payments to abroad.
Three ways to compute GDP

**Sector Level Way:** Value Added at each link of the process

\[ GDP = VA \text{ sector 1} + VA \text{ sector 2} + \ldots \]

**Final Expenditure Way:** Final sales total value

\[ GDP = \text{Consumption} + \text{Investment} + \text{Government purchases} + \text{Exports} - \text{Imports} \]

(Also known as National Accounts)

**National Income Way:** Components of national income

\[ GDP = \text{Labor Income} + \text{Capital Income} \]
# An Example

<table>
<thead>
<tr>
<th>Level</th>
<th>Product</th>
<th>Price</th>
<th>Salaries</th>
<th>Profits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat</td>
<td>5 chairs</td>
<td>@£100 each</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>Chairs Ltd</td>
<td>5 chairs</td>
<td>@£50 each</td>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>Farmer Wood</td>
<td>Wood</td>
<td>£125</td>
<td>100</td>
<td>25</td>
</tr>
</tbody>
</table>

Method 1: GDP = 5*(£100-£50)+(5*£50-125)+125 = 500

Method 2: GDP = 5 * £100 = £500

Method 3: GDP = £275 + £225 = £500

Notice from method 1 that measure is VALUE ADDED. Very wrong to count 500 + 250 + 125!
Data Review
GDP: Expenditure Side

- Consumption ($C_t$): The value of all durable goods, nondurable goods and services bought by households.
- Investment ($I_t$): Spending on good bought for future use (e.g. capital goods). Includes: Business fixed investment (e.g. equipment), Residential fixed investment, Inventory investment. Basically is spending on new capital that comes online as capital ($K_t$) in the future.
  - $I_t$ is a flow, $K_t$ is a stock so in discrete time

\[
K_{t+1} = I_t + (1 - \delta)K_t, \quad \delta \in (0, 1)
\] (6)
• Government Spending ($G_t$): includes all government spending on goods and services. Excludes transfer payments (e.g., unemployment insurance payments), because they do not represent spending on goods and services.
Investment (I) as % of GDP

2011 (2010 for Japan)

South Africa: 20%
Singapore: 22%
Mexico: 25%
Lebanon: 31%
Japan: 20%
India: 36%
Greece: 15%
France: 21%
China: 48%
Bulgaria: 25%
Brazil: 20%
Australia: 28%
Government Consumption (G) as % of GDP

- South Africa: 21%
- Singapore: 21%
- Mexico: 12%
- Lebanon: 12%
- Japan: 20%
- India: 12%
- Greece: 17%
- France: 25%
- China: 13%
- Bulgaria: 15%
- Brazil: 21%
- Australia: 18%

2011 (2010 for Japan)
C+I+G as % of GDP

- South Africa: 101
- Singapore: 73
- Mexico: 101
- Lebanon: 122
- Japan: 99
- India: 105
- Greece: 107
- France: 103
- China: 96
- Bulgaria: 102
- Brazil: 101
- Australia: 99
GDP vs. GNI

Gross Domestic Product (GDP): Based on activity within national borders.
Gross National Income (GNI): Based on nationality (previously known as GNP)

\[
\text{GNI} = \text{GDP} + \text{Net Factor Payments (NFP)}
\]

Net Factor Payments: Income received from factors of production abroad – Income paid to foreign factors of production

% Difference between GNI and GDP (2011)
• GDP is the value of all final goods and services produced.
• Nominal GDP measures these values using current prices.
• Real GDP measure these values using the prices of a base year.
• So changes in Nominal GDP could because of fluctuations in $P_t$ or $Y_t$
• But, changes in Real GDP can only be due to changes in $Y_t$.
  Hence

$$P_t = \text{GDP Deflator} = 100 \times \frac{\text{Nominal GDP}}{\text{Real GDP}}$$  (7)
• The GDP Deflator at time $t$ for $n$ goods usually measured as

$$P_t = \frac{\text{Nominal GDP}_t}{\text{Real GDP}_t}$$  \hspace{1cm} (8)

$$= \frac{P_{1t}Q_{1t} + \ldots + P_{nt}Q_{nt}}{\text{Real GDP}_t}$$  \hspace{1cm} (9)

$$= \left( \frac{Q_{1t}}{\text{Real GDP}_t} \right) P_{1t} + \ldots + \left( \frac{Q_{nt}}{\text{Real GDP}_t} \right) P_{n}(\text{10})$$
Thus, the GDP deflator is a weighted average of prices. The weight on each price reflects that good’s relative importance in GDP. Note that the weights change over time.

In a CPI computation the weights remain (more or less) fixed over time.

Thus as macroeconomists the GDP Deflator ($P_t$) is a better measure of aggregate prices because the CPI can overstate inflation.
• CPI can overstate inflation because of:
  • Substitution bias: The CPI uses (almost) fixed weights, so it cannot reflect consumers’ ability to substitute toward goods whose relative prices have fallen.
  • Introduction of new goods: The introduction of new goods makes consumers better off and, in effect, increases the real value of the dollar. But it does not reduce the CPI, because the CPI uses (almost) fixed weights.
  • Unmeasured changes in quality: Quality improvements increase the value of the dollar, but are often not fully measured.

• Also, the prices of capital goods are included in the GDP deflator but not in the CPI; the prices of imported goods are included in the CPI but not in the GDP deflator.
Data Review

Measuring Unemployment

- **Categories of Labor:**
  - Employed: working at a paid job
  - Unemployed: not employed but looking for a job
  - Labor force: the amount of labor available for producing goods and services; all employed plus unemployed persons
  - Not in the labor force: not employed, not looking for work

- **Unemployment rate:** percentage of the labor force that is unemployed

- **Labor force participation rate:** the fraction of the adult population that “participates” in the labor force

- **Okun’s Law:** the negative relationship between GDP and unemployment.
Okun’s Law

\[ \frac{\Delta Y}{Y} = 3 - 2 \Delta u \]