# ECON 7010 - Macroeconomics I

Fall 2015

Notes for Lecture #1

<u>A View of Economics (applies to basically all fields):</u>

- Circle with three nodes:
  1. Theory
  2. Facts (data)
  3. Policy
- Each feeds to and from one another:
  - Theory
    * It is: Optimization, Equilibrium Analysis (i.e. a consistency requirement, how do all the individual decisions fit together?)
    * It is influenced by the facts: they shape theories we come up with
    * It influences Policy Design
  - Facts
    * It is: Statistics/Econometrics
    * It is influenced by Policy, which affects economic actions and outcomes measured in data
    * It influences Theory and Policy through evaluation of models and policy (i.e. test theory and policy efficiency with data)
  - Policy
    * It is: Evaluation and Design of economic policy
    * It is influenced by data via it's evaluation with data
    * It influences Theory since Policy affects data from which we form theory

<u>Facts:</u>

1. Economies Fluctuate
   - Draw GDP since 1900 or so - upward trend with small movements, larger movement in 1929, 1981, 2008
   - Constant (or just about) growth over time (very close to the 3% per year average)
   - Business cycle fluctuations around this constant trend growth
   - Why?
     - shocks to technology, tastes/preferences (Real business cycle theory (RBC))
     - beliefs (i.e. animal spirits) (Keynesian business cycle theory)
     - natural cycle (Austrian business cycle theory)
   - *very* hard to know the timing of turning points in cycles
   - Macroeconomists not sure of the "whys"
     - Best modern models mix elements of RBC and Keynesian models
     - Modern macroeconomists focus on "micro-foundations"
   - What can (should) we do?

- Leading economic models differ on both normative and positive points here
- Real business cycle models often suggested that we should not do anything to counter business cycles - that they represent economic agents making optimal decisions given changes in productivity
- It's hard to believe that business cycles are optimal, and many, including neoclassical economists propose models where business cycles are not optimal.
  * However, many neoclassical models (since they rely on microeconomic behavior) can have a hard time supporting active policy making (i.e. they say we should do something, but that we cannot do something about business cycles)

2. Co-movement: Positive correlation between macroeconomic variables and Y (GDP)
   - Notation
     - Y = output (GDP)
     - C = consumption
     - I = Investment
     - N = employment
     - w = real wage
     - r = real interest rate
     - all variables measured in real terms (not nominal)
   - Correlations:
     - $corr(C, Y) > 0$
     - $corr(I, Y) > 0$
     - $corr(N, Y) > 0$
     - $corr(\frac{Y}{N}, Y) > 0$
     - $corr(w, Y) \approx 0$ - this and next are real challenge for model builders - it's difficult to create a model with near zero elasticities in equilibrium
     - $corr(r, Y) \approx 0$
3. Standard Deviations
   - std(I)>std(Y)>std(C)
   - this is because of consumption smoothing (i.e., risk averse agents prefer to spread consumption across periods in an even manner)
   - investment series is extremely volatile, consumption is less so (w/ durables more volatile than non-durables because durables are more like an investment)
4. Serial Correlation
   - Positive serial correlations (Persistence $\rightarrow$ good yesterday, likely good today)
   - $corr(x_t, x_{t-1}) > 0$
   - $x$ could be Y, C, I, N, w, r...
5. There are the types of relationships that macroeconomic models hope to capture.
6. A test of how good the model is is how well it captures these (and other) "stylized facts".
7. To reiterate - the challenge is to build up a model from individual optimization that captures the movements we see in the macroeconomy.
   - There are big hurdles to doing this kind of economics - you need some "tools".
   - It is the learning of these tools that is the real goal of this course.
   - In particular, we will learn dynamic optimization and general equilibrium modeling.

- These tools will serve you well outside of macroeconomics.

Cake Eating Problem:

- time, $t = 1, 2$
- $c_t \equiv$ consumption of cake in period $t$
- Preferences: $u(c_1) + \beta u(c_2)$
  - $u'(\cdot) > 0$
  - $u''(\cdot) < 0$ (i.e., strictly concave utility function)
  - $0 \leq \beta \leq 1$ discount factor
  - $u'(0) = \infty$, Inada condition (first derivative approaches infinity as $c$ approaches zero), always keeps you away from boundary conditions/corner solutions
- Endowment:
  - $w_1 > 0$ given (start of period one)
  - No endowment in period 2 (it's important that agent knows this at outset)
- Technology:
  - Storage technology: $w_2 = w_1 - c_1$ (this is called the "transition equation")
    * Storage technology is: "how much of that stuff that I put in today is there tomorrow"
- Markets:
  - None here
- Information:
  - No uncertainty
- The problem:
  - $\max_{c_1,c_2,w_2,w_3} u(c_1) + \beta u(c_2)$
    * subject to:
    * $w_2 = w_1 - c_1$
    * $w_3 = w_2 - c_2$
    * $c_t \geq 0$, $t = 1, 2$ - Inada condition takes care of this condition and ensures interior solution
    * $w_t \geq 0$, $t = 2, 3$
    * Note that there will be 6 Lagrange multipliers for the 6 constraints
    * However, with some substitutions, we can eliminate some constraints
    * As noted, the Inada condition takes care of two constraints
    * Then one can combine the first two constraints into one: $w_3 + c_1 + c_2 = w_1$ and we'll use $\lambda$ as the Lagrangian multiplier on this constraint. Note this also gets rid of $w_2$ as a choice variable
    * Which leaves only one more constraint, $w_3 \geq 0$, we'll use $\phi$ as the Lagrangian multiplier on this constraint (only one more left since $w_2 \geq 0$ is implied by the two remaining constraints)
  - Lagrangian: $L = \max_{c_1,c_2,w_3} u(c_1) + \beta u(c_2) + \lambda(w_1 - c_1 - c2 - w_3) + \phi(w_3)$
  - FOCs:
    * w.r.t. $c_1$: $u'(c_1) = \lambda$
    * w.r.t. $c_2$: $\beta u'(c_2) = \lambda$

- Note that the two conditions above imply the "Euler" equation : $u'(c_1) = \beta u'(c_2)$
- $\rightarrow$ We'll see these Euler equations all the time.
- $\rightarrow$They relate two variables across time.
- $\rightarrow$They are the condition of inter-temporal optimization.
- This condition is necessary, but not sufficient condition for choices along an optimal path in a dynamic optimization problem
- Interpretation: If (discounted) marginal utilities are not equal, then agent can improve utility by rearranging the amounts consumed in different periods
- DRAW inter-temporal budget constraint and indifferent curve (whose slope is the ratio of marginal utilities).

* w.r.t. $w_3$: $\phi = \lambda$
  - If $\phi > 0$, then that means the non-negativity constraint on $w_3$ binds, thus $w_3 = 0$
  - We assumed that the marginal utility of consumption was positive (i.e., $u'(c) > 0$), thus $\lambda > 0$ and so $\phi > 0$
  - Thus we know that $w_3 = 0$ (i.e., we don't leave any cake left over for period in which we get no utility from consuming it)

– Since agents only receive an endowment in period 1 and get no utility from period 3 consumption, we can rewrite this problem in a more simple way:

* $c_1 + c_2 = w_1$
* $w_1 - c_1 = s$, where $s$=savings
* $c_2 = s$
* now the maximization problem becomes: $\max_{s:w_1 \geq s \geq 0} u(w_1 - s) + \beta u(s)$
* the FOC (now just w.r.t. $s$) becomes the Euler equation: $u'(w_1 - s) = \beta u'(s)$
* We can write the optimization problem as a Bellman equation: $V_2 \equiv \max_s u(w_1 - s) + \beta u(s)$
  - $\Rightarrow u'(w_1 - s) = \beta u'(s) \rightarrow$ how agent acts optimally is given by the Euler equation
  - $s(w_1) \rightarrow c_1$ and $c_2$ as a function of $w_1$
  - This is the policy function or decision rule (demand function is a specific example of this)
  - describes how agents chose endogenous variables as a function of exogenous variables and parameters
  - $V_2(w_1) = u(w_1 - s(w_1)) + \beta u(s(w_1))$ (where $V_2$ is the value once I know how the agent will optimize (from policy function above))

We spend weeks extending this simple example - adding periods, changing the "storage technology", adding uncertainty, etc. This will build up our dynamic optimization tools. We'll then apply these tools to real economic questions.