Econ 204A: Organization

- Class Page: **www.econ.ucsb.edu/~bohn/204A/204Aindex.html**
  - Information is updated throughout the quarter.
  - Check for announcements. Class page announcements are assumed known.

- Open door policy for graduate students. NH3016.
  - Official office hours posted on the class pages.

- E-mail: bohn@econ.ucsb.edu. Put “Econ 204A” in the subject line.

- Grading: Weekly problem sets, midterm (in class), final exam.

Introduction to Macroeconomics

- Objectives of macroeconomics:

  To analyze the economy as a whole, to explain economic growth and economic fluctuations, and to assess economic policy.

- Outline of Econ 204A:

1. Introduction: Intertemporal choice problems.
   - Tools: Constrained optimization. Graphical analysis.
2. The Solow Model: The Mechanics of Capital, Production, and Economic Growth.
   - Tools: Differential equations. Comparative statics. Linear approximations.
   - If time: Introduction to New Growth.
3. The Ramsey Model: Optimal Consumption and Savings/Investment over Time.
   - Tools: Optimal control. Systems of differential equations. Phase diagrams.
   - Applications to Fiscal Policy and to Money. Digression to discrete time.
4. The Diamond model: Modeling Overlapping Generations.
   - Fiscal policy applications. Dynamic inefficiency. Bequests and Ricardian Neutrality.

Intertemporal Choice: Consumption

- Individual decision problem:
  - Given a series of wage incomes w_t. Given real interest rate r_t=r (constant).
  - Individuals choose consumption c_t and asset holdings a_t subject to

    Budget equations: $a_t = (1+r)a_{t-1} + w_t - c_t$

- Building intuition: Two-period version with graphical analysis. Then generalize.
  - Consumption now (c_1) vs. consumption later (c_2).
  - Assume given initial wealth $A = (1+r)a_0$.

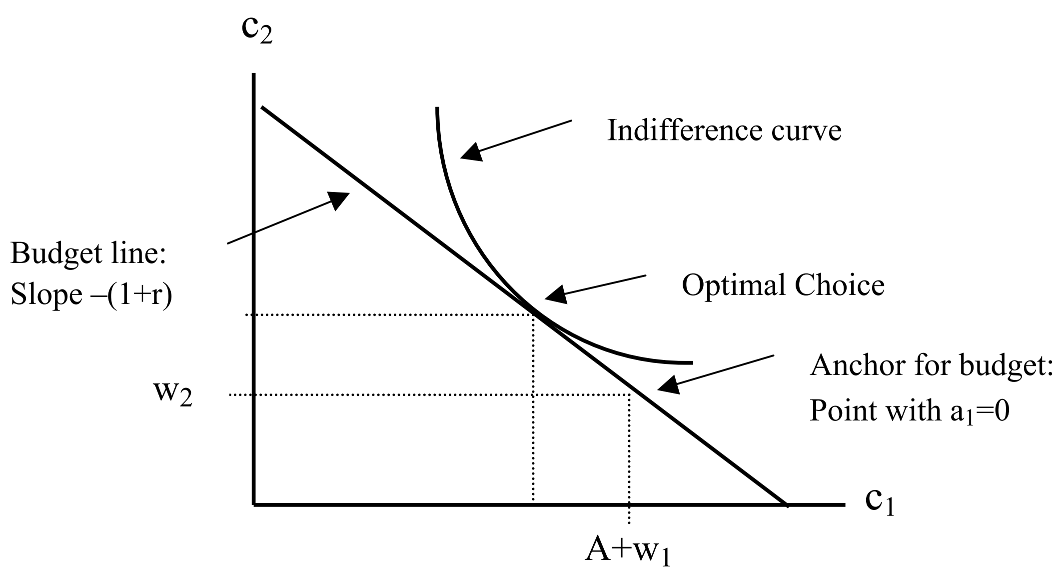
- Budget equations imply an intertemporal budget constraint (IBC):
  - use $a_1 = (1+r)a_0 + w_1 - c_1 = A + w_1 - c_1$ and

    $a_2 = (1+r)a_1 + w_2 - c_2$
  - impose the terminal condition $a_2 = 0$:

    => $a_1 = -\frac{1}{1+r}[w_2 - c_2]$ => $0 = A + w_1 - c_1 + \frac{1}{1+r}[w_2 - c_2]$

    => IBC: $c_1 + \frac{1}{1+r}c_2 = w_1 + \frac{1}{1+r}w_2 + A$.
  - Means: Present value of consumption = Present value of income plus initial wealth.

Two Periods: Graphical Analysis



- Budget line has slope –(1+r). Increase in r => steeper slope.

  Feasible set: Area under the budget line.

- Endowment point is $(A+w_1, w_2)$. Higher A, w_1, w_2 => budget line shifts "out".

Two Periods: Math

- Optimization problem: maximize $U = u(c_1) + \beta u(c_2)$
  - subject to IBC: $c_1 + \frac{1}{1+r} c_2 = A + w_1 + \frac{1}{1+r} w_2$
- Approach #1: substitute constraint into objective. Problem is:

  Max $U = u\left(A + w_1 + \frac{1}{1+r} w_2 - \frac{1}{1+r} c_2\right) + \beta u(c_2)$.

  FOC for c_2: $-\frac{1}{1+r} u'(c_1) + \beta u'(c_2) = 0$ => $\frac{1}{1+r} u'(c_1) = \beta u'(c_2)$
- Approach #2: use Lagrangian. Define shadow value λ. Problem is:

  Max $L = u(c_1) + \beta u(c_2) + \lambda \cdot \left(A + w_1 + \frac{1}{1+r} w_2 - c_1 - \frac{1}{1+r} c_2\right)$

  => FOC for c_1 and c_2: $u'(c_1) = \lambda$ and $\beta u'(c_2) = \lambda \cdot \frac{1}{1+r}$ => $\frac{1}{1+r} u'(c_1) = \beta u'(c_2)$
- Same conditions. If utility is strictly concave, the solution (c_1,c_2) is unique.

Interpretation: Consumption Smoothing

- Consumption Smoothing Intuition:
  - Suppose time preference factor is approximately equal to the discount factor:

$$\beta \approx \tfrac{1}{1+r} \quad => \quad u'(c_1) \approx u'(c_2) \quad => \quad c_1 \approx c_2$$

  - Insight: *Consumption is a "smooth" series*. True even if the income series varies.

- Benchmark: suppose $c_1 \approx c_2$. Then $c_1 + \tfrac{1}{1+r} c_2 = c_1 \cdot (1 + \tfrac{1}{1+r}) = A + w_1 + \tfrac{1}{1+r} w_2$

$$=> \quad c_1 = c_2 = \frac{1}{1+(1+r)^{-1}} \cdot (A + w_1 + \tfrac{1}{1+r} w_2)$$

  - Find: *Consumption is approximately a fraction of total lifetime resources.*
  - Note: If wage income was a constant y, then $\frac{w_1 + \frac{1}{1+r} w_2}{1+(1+r)^{-1}} = \frac{y + \frac{1}{1+r} y}{1+(1+r)^{-1}} = y$.

- Permanent Income = Annuity equivalent of the income actual stream (Friedman 1957)

  Here $y^P = \frac{w_1 + \frac{1}{1+r} w_2}{1+(1+r)^{-1}}$. Then $c_1 = y^P + \frac{1}{1+(1+r)^{-1}} \cdot A$.

  - Find: *Consumption ≈ Permanent Income plus a fraction of initial wealth.*

Interpretation: Savings Incentives

- Savings incentives: High interest rates provide incentives to consume less & save more:
  - If $1+r>1/\beta$, then $u'(c_1)>u'(c_2)$ => $c_2 > c_1$.
  - High interest rates "tilt" the consumption path upwards. Consumption grows over time.
  - Growing consumption must start at a lower level to satisfy the IBC.

    => Initial consumption is (slightly) less than permanent income intuition would suggest.
  - Caveat: High r also reduces y^P => income and substitution effect.

- Example (Power utility): $u(c)=\frac{1}{1-\theta}c^{1-\theta}$ with $\theta > 0, \theta \neq 1$
  - Then: $\frac{1}{1+r}u'(c_1)=\beta u'(c_2) \Leftrightarrow \frac{1}{1+r}c_1^{-\theta} = \beta c_2^{-\theta} \Leftrightarrow \frac{c_2}{c_1} = [(1+r)\beta]^{1/\theta}$ increasing in r.
  - Elasticity of (c_2/c_1) with respect to $(1+r)$ is $1/\theta$ = Elasticity of intertemporal substitution.

Permanent Income Model with many periods

- Generalize to arbitrary number of periods n. Terminal condition $a_n = 0$.

  - Intertemporal budget constraint: $\sum_{t=1}^{n} \frac{1}{(1+r)^{t-1}} c_t = A + \sum_{t=1}^{n} \frac{1}{(1+r)^{t-1}} w_t$

  - Benchmark: If β≈1/(1+r), so consumption is constant, the budget constraint implies

$$c_1 = (A + \sum_{t=1}^{n} \frac{1}{(1+r)^{t-1}} w_t) / (\sum_{t=1}^{n} \frac{1}{(1+r)^{t-1}})$$

  Interpretation: $\sum_{t=1}^{n} \frac{1}{(1+r)^{t-1}} = \frac{1+r}{r} [1-(1+r)^{-n}]$ = present value of a fixed annuity.

  - Simple intuition for large n and small r, $1/\sum_{t=1}^{n} \frac{1}{(1+r)^{t-1}} \approx \frac{r}{1+r} \approx r$

  => *Consumption is approximately a fraction r of lifetime resources.*

- Lessons from permanent income theory:

  1. Distinguish changes in current income (holding future income constant) from changes in permanent income (current and future income): Permanent changes have a much greater impact than temporary changes.
  2. Future income matters => Expectations about future income matter.
  3. Consumption growth depends on interest rates relative to the rate of time preference

Intertemporal Choice with Production

- Output is produced with capital and labor: $Y_t = F(K_t, L_t)$
  - Properties: Increasing; concave; constant returns to scale. (More later.)
  - Firm profits = Output – wage cost – cost of capital. (All in real terms.)
  - Real wage = Marginal product of labor: $w_t = F_L(K, L)$
  - Interest rate = Marginal product of capital – depreciation rate.

- Warm-up: <u>A static model</u>. Given K. No capital investment.
  - Time constraint: available hours = h. Time for work (l) plus leisure (h-l)
  - Households maximize utility from consumption and leisure: $U = u(c, h-l)$

    subject to a budget constraint: $c = w \cdot l + \pi$ [given other funds π]

    FOC: $u_1(c, h-l) \cdot w = u_2(c, h-l)$

    => Consumption-leisure graph with indifference curves and budget line (slope –w).

  - Assume firms are owned by households: $\Pi = F(K, L) - w \cdot L$. Population = N.
  - Market equilibrium with identical households: $l = \frac{1}{N} L,\ \pi = \frac{1}{N} \Pi$

    => $c = w \cdot \frac{L}{N} + \frac{1}{N} \Pi = \frac{1}{N}[w \cdot L + F(K, L) - w \cdot L] = \frac{1}{N} F(K, L) = F(\frac{1}{N} K, l)$

    => Aggregate tradeoff between per-capita consumption and leisure is concave.

- What if a "social planner" (government) made all the decisions?
  - Social planner maximizes household utilities subject to production constraint.

    Maximize $U = u(c, h-l)$ s.t. $c = \frac{1}{N} F(K, N \cdot l)$.

    FOC: $u_1(c,h-l) \cdot \frac{1}{N} F_L \cdot N = u_1(c,h-l) \cdot F_L = u_2(c,h-l)$. Same as household FOC.
  - Note: Planning solutions are Pareto Optimal. (Here simple: all households identical.)

    => Social planner is a useful "device" to compute Pareto-optimal allocations.

  - First fundamental welfare theorem: Competitive equilibrium is Pareto optimal.

    (Assuming price-taking/competitive behavior, increasing utility.)
  - Second fundamental welfare theorem: All Pareto optimal solutions can be implemented as market equilibrium. (In general: with lump sum transfers).

    (Requires a concave production function and a concave utility function. Here no transfers needed because households are identical.)

- Interpret the social planner as a representative household who also operates a firm.
  1. Solving a representative agent problem is a convenient way to obtain market allocations.
  2. Given the optimal allocation, market clearing "prices" follow from the FOC.

     [Here: optimal (c,l) implies unique $w = u_2(c,h-l)/u_1(c,h-l)$.]

General Case: Production Economy with many discrete time periods

(Here a sketch only)

- Resource constraints: $Y_t = F(K_t, L_t) = I_t + C_t$ and $K_{t+1} = I_t + (1-\delta)\cdot K_t$.
  - Household utility: $U = u(c_1, h-l_1) + \beta \cdot u(c_2, h-l_2) + \ldots$
  - Alternative interpretations:
    1. Market allocation with firms and households; markets for labor, goods, capital.
    2. Social planner maximizes U subject to production constraints.
    3. Representative household maximizes U s.t. per-capita resource constraints.
- Observations:
  - Marginal increase in l_t allows a marginal increase in c_t by F_L.
    => $\frac{\partial u}{\partial c_t} F_L(K_t, L_t) = \frac{\partial u}{\partial l_t}$ must apply – as in the static production model; also: $F_L = w_t$.
  - Marginal increase in K/N reduces c_t by same amount & increases c_{t+1} by F_K+(1-δ).
    => $\frac{\partial u}{\partial c_t} = \beta \frac{\partial u}{\partial c_{t+1}} \cdot [F_K(K_{t+1}, L_{t+1}) + 1 - \delta]$; also: $F_K + 1 - \delta = 1 + r$.

    Interpretation: Marginal product of capital = interest + depreciation = cost of capital

    [Note: Concave production => aggregate tradeoff between c_t and c_{t+1} is concave.]
  - Key challenge: Dynamics of capital and output: $K_t \rightarrow Y_t \rightarrow I_t \rightarrow K_{t+1} \rightarrow Y_{t+1} \ldots$

    How does such an economy evolve over time? How does economic growth occur?

Context: A Brief History of Macroeconomics

- Pre-Keynesian ("Classical") Analysis
  - Extension of microeconomics. Quantity theory of money.
- John Maynard Keynes. ISLM interpretation by John Hicks.
  - Missing theory of inflation => The Phillips curve => Neoclassical Synthesis (~1960s)
  - Large "Top-Down" models for business cycles. Solow model for long-run growth.
- Rational expectations and the Lucas Critique (1975).
  - Applications: New-Classical theories; New-Keynesian theories.
- Real Business Cycles: Fluctuations in a stochastic growth model.
  - Production sector = Solow. Behavior = rational. Small models.
- Current consensus: DSGE = Dynamic stochastic general equilibrium models
  - With or without information frictions that yield 'Keynesian' features.
  - With infinitely lived dynasties or with overlapping generations of finite-lived agents.
- Issues: Population; preferences; technology; information; frictions (money).
  - Benchmark: Full information, no frictions.

Learning Objectives

- Conceptual:
  1. Macroeconomics is based on microeconomic principles – optimal choices subject to constraints, market equilibrium, welfare theorems. w
  2. Microeconomic intuition: income and substitution effects.
  3. Macroeconomic intuition from simplied models:
     - Intertemporal consumption choices and permanent income.
     - Static production models and consumption-leisure tradeoff.

- Technical skills:
  1. Optimization – with and without constraints.
  2. Solving and interpreting intertemporal and static choice problems.

  Problem sets for practice.