Macroeconomics

(Math Intensive)

Econon 101B

Professor: Jón Steinsson

Lecture 9

Announcements

- Problem Set 2 has been posted
  - Due Tuesday Oct 5st
- Readings:
  - Today: Jones ch 16
  - Thursday: Jones ch 3, Levitt-Dubner, Mankiw, Thompson, Dell'Antonia, Hodgekiss.

Efficiency of Markets

- Competition promotes efficiency
  - Competitive markets lead goods and services to be priced at marginal cost and factors to be paid their marginal product
  - In this sense, competition limits exploitation
- Perfect competition (or costless negotiation):
  - Yields a Pareto efficient outcome (i.e., maximal efficiency)
- Flip side:
  - If markets are imperfect / incomplete / non-existent (and negotiation costly) market outcomes will not be efficient
  - We call this market failures

The Proper Role of Government

- Efficiency viewpoint:
  - Fix market failures
- Whenever we contemplate a government policy we should ask:
  - What market failure is this policy meant to address?
  - Why does the government have an ability to fix this market failure?

Typical Argument about Economic Policy

- Issue: Should government do X?
- Free market advocate:
  - Markets can take care of X
  - Voluntary exchange can take care of X
- Very powerful argument rhetorically
- One way a skeptic of laissez faire can win argument is by pointing out a market failure and explaining how government can resolve the market failure

New Topic

- We have studied:
  - Production (labor demand and capital demand)
  - Household Labor-Leisure (labor supply)
  - Efficiency of private property/free market setting
- Next topic:
  - Household Consumption-Savings decision

The Consumption-Savings Model

- Suppose Robinson Crusoe lives for two periods
- Let's simplify by ignoring both production and labor-leisure decision
- Instead: Robinson Crusoe gets a set endowment of coconuts in each of the two periods
  - Denote them as Y_1 and Y_2
- Robinson Crusoe knows values of both Y_1 and Y_2 in period 1

A Storage Technology

- In addition, Robinson Crusoe has access to a "savings technology" (safe investment opportunity)
- He can choose to save some of Y_1
- If he saves B coconuts at time 1, the savings technology yields $(1 + R)B$ coconuts at time 2
  - We say that the savings technology has a gross return of $(1 + R)$ and a net return of R
  - R is the "interest rate" in the economy

Saving and Borrowing

- Suppose that the “savings technology” is such that Robinson Crusoe can either “save” coconuts or “borrow” coconuts
- We can think of the savings technology as borrowing and lending with a neighboring islander (i.e., Friday)
- If Robinson Crusoe borrows, $B < 0$
- In both cases, the return is R (for simplicity)

The Consumption-Savings Model

- Robinson Crusoe's resource constraints (budget constraints) are then:
- In period 1?

$$C_1 + B = Y_1$$

- In period 2?

$$C_2 = Y_2 + (1 + R)B$$

Limits on Saving and Borrowing

- What is the most Robinson Crusoe can save?

$$B < Y_1$$

- What is the most Robinson Crusoe can borrow?
  - As much as he can pay off in period 2:

$$(1 + R)B > -Y_2 \text{ which implies } B > -\frac{Y_2}{(1+R)}$$

Utility Function

- In general, Robinson Crusoe's utility function can be written $U(C_1, C_2)$
- We will, however, specialize and consider the utility function
$$U(C_1) + \beta U(C_2)$$
- Here, β is called Robinson Crusoe's subjective discount factor

Interpretation of β

$$U(C_1) + \beta U(C_2)$$

- What is the interpretation of β?
  - β is the weight Robinson puts on future consumption relative to current consumption
  - β governs Robinson Crusoe's degree of patience
  - If $\beta < 1$, Robinson Crusoe down-weights (discounts) future consumption
  - If period length is one year, a typical value used is something like $\beta = 0.98$

Consumption-Savings Model

- Robinson Crusoe maximizes

$$U(C_1) + \beta U(C_2)$$

- Subject to:

$$C_1 + B = Y_1$$
$$C_2 = Y_2 + (1 + R)B$$

(and limits on borrowing and saving)

- What are the endogenous variables? C_1, C_2, B
- Exogenous variables: Y_1, Y_2, R
- Parameters: β

Solving Model: Plug and Chug

1. Combine budget constraints into one "intertemporal" budget constraint:

$$C_1 + \frac{1}{1+R} C_2 = Y_1 + \frac{1}{1+R} Y_2$$

- "Present value" of consumption must equal "present value" of income
- What does "present value" mean?

Present Value

- How much does it “cost” at time 1 to “purchase” the right to one coconut in period 2?
- Price must be equal to the number of coconuts you need to store in period 1 to get one coconut in period 2. Which is?

$$\frac{1}{1+R}$$

- We therefore say that the present value in period 1 of the right to one coconut in period 2 is $1/(1+R)$ coconuts

Solving Model

2. Plug intertemporal budget constraint into objective function:

$$U(C_1) + \beta U(C_2)$$

$$U(C_1) + \beta U\big((1+R)Y_1 + Y_2 - (1+R)C_1\big)$$

- Now we have a simple optimization problem with one choice variable
- How is this solved?

Solving Model

$$U(C_1) + \beta U\big((1+R)Y_1 + Y_2 - (1+R)C_1\big)$$

- Differentiate and set to zero:

$$U'(C_1) - \beta(1+R)U'(C_2) = 0$$

$$U'(C_1) = \beta(1+R)U'(C_2)$$

- This equation is called the "consumption Euler equation"
- Here we use the notation

$$U'(C) = \partial U(C)/\partial C$$

Euler Equation by Variational Argument

- We can alternatively derive the consumption Euler equation using a "variational argument" (and as usual this yields more insight)
- What variation should we consider?
- Starting from (C_1^*, C_2^*), contemplate the following variation:
  - Consume a little less in period 1 (ε coconuts), save these, and increase consumption in period 2 by the proceeds ($(1+R)\varepsilon$ coconuts)

Euler Equation by Calculus of Variations

- Utility function: $U(C_1^*) + \beta U(C_2^*)$
- Marginal benefit? $\beta U'(C_2^*)(1 + R)$
- Marginal cost? $U'(C_1^*)$
- Optimality: $U'(C_1^*) = \beta(1 + R)U'(C_2^*)$
- Intuition: Robinson Crusoe sets marginal cost of forgone consumption in period 1 equal to marginal benefit of addition consumption in period 2

Log Utility

- To gain further insight, we assume
$$U(C) = \log C$$
- This implies
$$U'(C) = \frac{1}{C}$$
- Consumption Euler equation becomes
$$\frac{C_2}{C_1} = \beta(1 + R)$$

Consumption Growth

$$\frac{C_2}{C_1} = \beta(1 + R)$$

- How does growth in income (Y_2/Y_1) affect Robinson Crusoe's consumption growth?
- It doesn't!!!
- Consumption growth is the same whether bulk of income is received in period 1 or period 2

Consumption-Savings

- Suppose most of income is in period 2
  - Robinson Crusoe could have consumption track income
  - Why is this not the “optimal” thing to do?
- Because of diminishing marginal utility
  - Marginal utility will be much lower in period 2 than in period 1
  - Last coconut in period 2 yields much less utility than next coconut in period 1
  - So, Robinson Crusoe should transfer consumption to period 1 and increase utility

Consumption Smoothing

$$\frac{C_2}{C_1} = \beta(1 + R)$$

- Suppose for simplicity that $\beta(1 + R) = 1$
- This implies that:

$$C_1 = C_2$$

  - Irrespective of relative size of Y_1 and Y_2
- Robinson Crusoe wants to smooth his consumption over time because marginal utility is diminishing

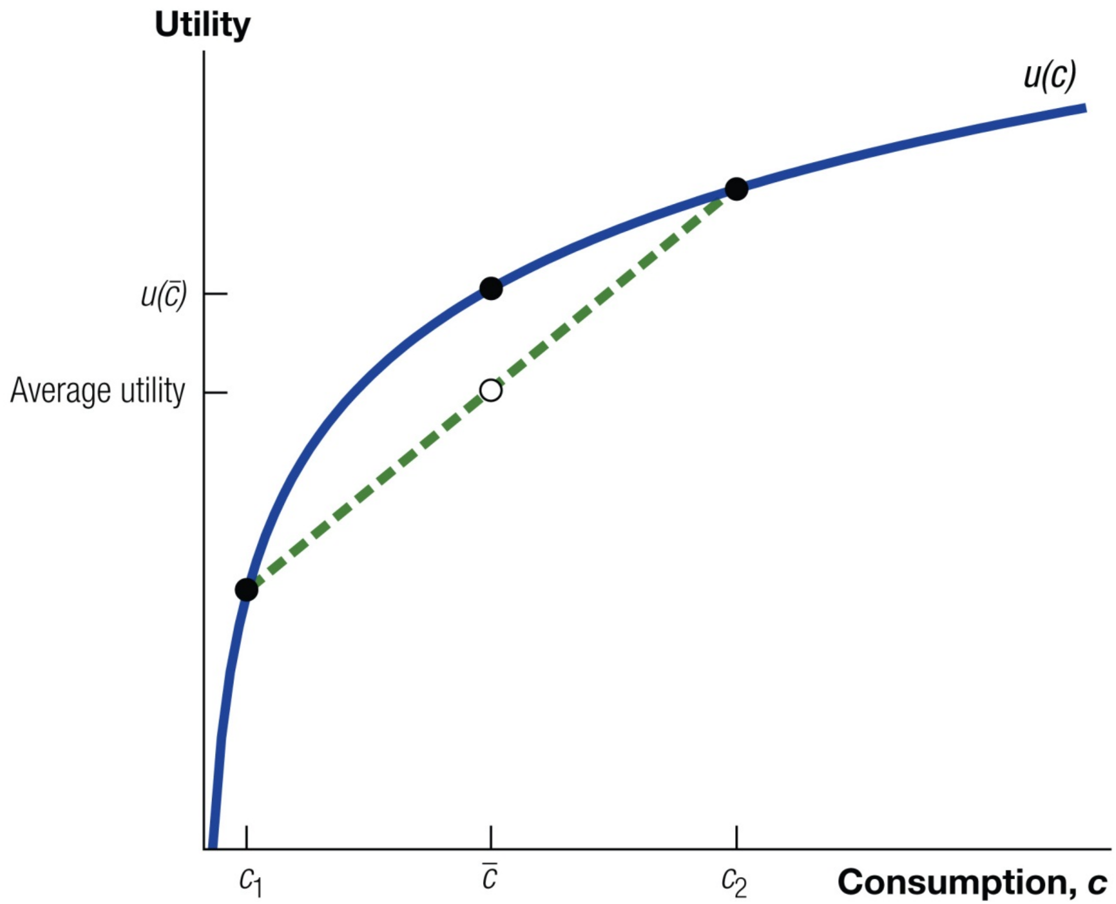

FIGURE 15.2 The Desire to Smooth Consumption

Consumption Growth

$$\frac{C_2}{C_1} = \beta(1 + R)$$

- Holding β fixed, how does consumptions growth vary with R?
  - The higher is the return on saving, the higher is the growth rate of consumption
- If the return to saving is high, Robinson Crusoe decides to save a lot
- This implies that he consumes little in period 1 and a lot in period 2. So, C_2/C_1 is big.

Solving for Level of Consumption

- With log utility we have:

$$\frac{C_2}{C_1} = \beta(1 + R)$$

$$C_1 + \frac{1}{1 + R} C_2 = Y_1 + \frac{1}{1 + R} Y_2$$

- This is two equations in two unknown.
- What are the unknowns? C_1 and C_2
- We can therefore solve for C_1 and C_2

Level of Consumption

- Solving the two equations on the previous slide yields:

$$C_1 = \frac{1}{1+\beta}\left(Y_1 + \frac{1}{1+R}Y_2\right)$$

- Consumption at time t is a fraction of the present value of life-time income
- Consumption at time t only depends on current income in so far as it affects the present value of life-time income

45 Year Working Life

- We can extend our model to a setting in which Robinson Crusoe works for 45 years
  - Say from age 22 to 67
- Let’s assume for simplicity that $\beta = 1$
- Then we have:

$$C_1 = \frac{1}{45} \sum_{t=1}^{45} \left(\frac{1}{1+R} \right)^{t-1} Y_t$$

- For simplicity: No initial wealth/debt and no retirement period

Consumption and Income

$$C_1 = \frac{1}{45} \sum_{t=1}^{45} \left(\frac{1}{1+R} \right)^{t-1} Y_t$$

- Again, consumption is a fraction of present value of life-time income
- Does not depend on shape of income profile
- This idea is often called the permanent income hypothesis

Permanent Income Hypothesis

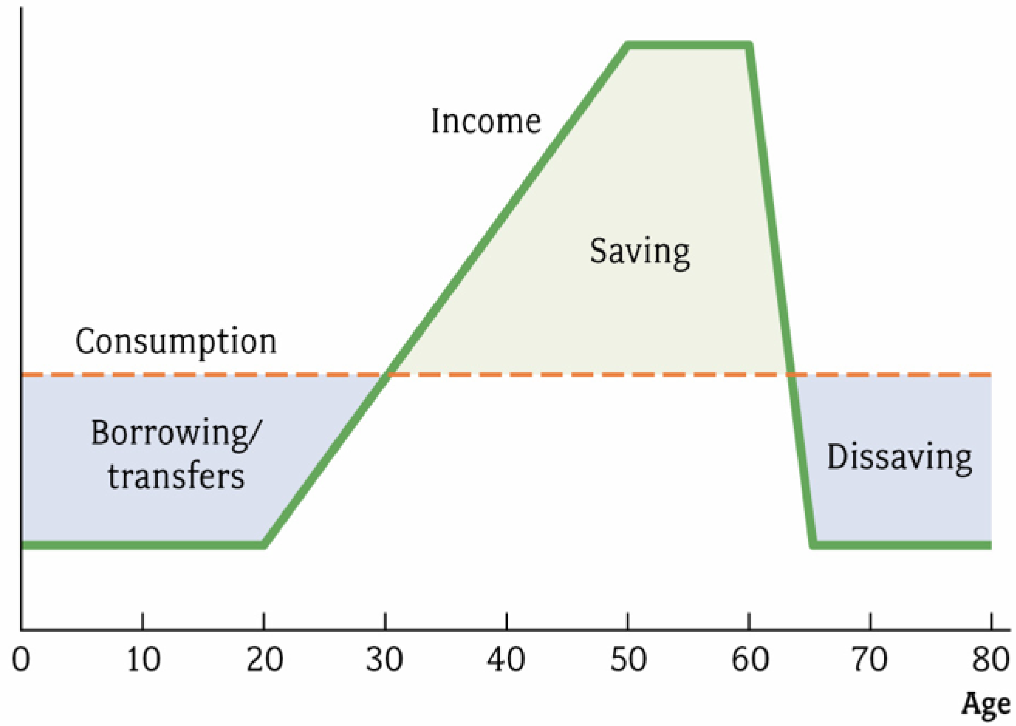

FIGURE 10.5 The Life-Cycle Model of Consumption

Macroeconomics, Charles I. Jones

Consumption and Income

$$C_1 = \frac{1}{45}\sum_{t=1}^{45}\left(\frac{1}{1+R}\right)^{t-1} Y_t$$

- Say you unexpectedly get a large bonus in your first year of working life (very high Y_1)
- But this doesn't change your beliefs about income in future years
- How large a fraction should you consume of this windfall and how much should you save?

Marginal Propensity to Consume

$$C_1 = \frac{1}{45}\sum_{t=1}^{45}\left(\frac{1}{1+R}\right)^{t-1} Y_t$$

- An extra dollar of income today only raises consumption today by about ≈2% (1/45)
- Marginal propensity to consume (MPC) is said to be 2%
- MPC should be higher later in life

Forward-Looking Behavior

- Consumption-savings model embodies forward-looking behavior on the part of Robinson Crusoe
  - Nothing special about current period income
  - Current consumption depends on current and future income, NOT past consumption
- Forward-looking behavior unique to economics (nothing like this in physics)

Forward-Looking Behavior

- Suppose you are hiking and are about to go down the mountain.
  - You don’t take the easiest first step and then the easiest second step, …, and then fall off a cliff
  - You look ahead and plot a route that overall is best. This is forward-looking behavior
- Water does not look down the hillside and decide on the “best” way down
- Water is not forward-looking

Forward-Looking Behavior

- 60 years ago, economists modeled people as behaving much like water (today's consumption depending on yesterday's consumption and current income)
- The idea that people display forward-looking behavior is one of the most important ideas of 20th century macroeconomics
  - Pioneered by Milton Friedman and Robert Lucas among others

Rational Expectations

- Today, most economists model people as forming "rational expectations" about the future and acting optimally given these expectations.
- Rational expectations: People should form optimal forecasts given there information
  - They should not make systematic mistakes (mistakes they should have been able to avoid given their information)
- Very strong form of forward looking behavior

Rational Expectations

- Do people have rational expectations?
  - Think of a wide-receiver in football.
    Where does he run?
  - In contrast, think of a squirrel (or an infant).
- Needless to say, rational expectations is very controversial
- Real world probably somewhere in between:
  - People are forward-looking
  - But perhaps not fully rational
- Much current research focuses on this

Consumption-Savings

- Consumption Euler Equation:
$$U'(C_1) = \beta(1+R)U'(C_2)$$
  - Marginal benefit of saving an extra dollar equal to marginal cost
- With $U(C) = \log C$:
$$\frac{C_2}{C_1} = \beta(1+R)$$
  - Consumption growth unrelated to income growth
  - Determined by interest rate and discount factor

Consumption-Savings

- Level of consumption if Robinson Crusoe lives for two periods:

$$C_1 = \frac{1}{1+\beta}\left(Y_1 + \frac{1}{1+R}Y_2\right)$$

- Consumption at time t is a fraction of the present value of life-time income
- Consumption at time t only depends on current income in so far as it affects the present value of life-time income

Does the Model Fit the Data?

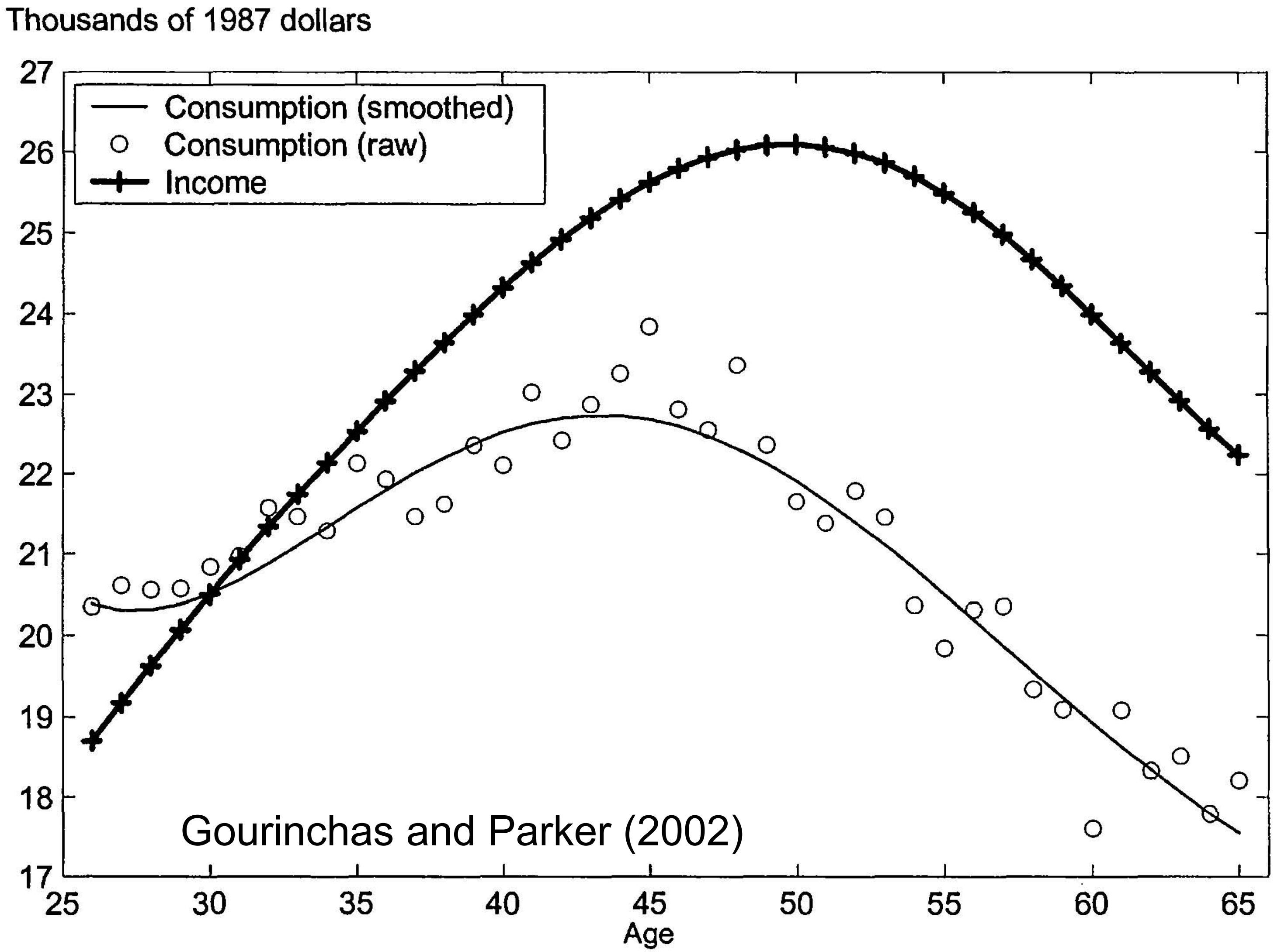

FIGURE 2.—Household consumption and income over the life cycle.

Does the Model Fit the Data?

- No
- What does it miss?
  - Model implies a constant growth rate of consumption (Euler equation)
  - Data show a hump shaped pattern of consumption over the life cycle
  - Consumption profile seems to mimic income profile, while model says it shouldn’t

What Is Wrong with the Model?

- People are not forward looking?
  - Well, they do save for retirement
- People's preferences change over time?
  - Need more consumption when have young children (Gourinchas-Parker try to take this into account)
- People can't borrow against future income?
- Young people want to build up buffer stock of savings ("rainy day fund")?

How to Make Sense of Evidence?

Gourinchas and Parker (2002):

- People are impatient
  $$\beta < 1 + R$$
- Want downward sloping consumption profile
- But are borrowing constrained earlier in life
- Engage in precautionary savings early in life
- Save for retirement late in life

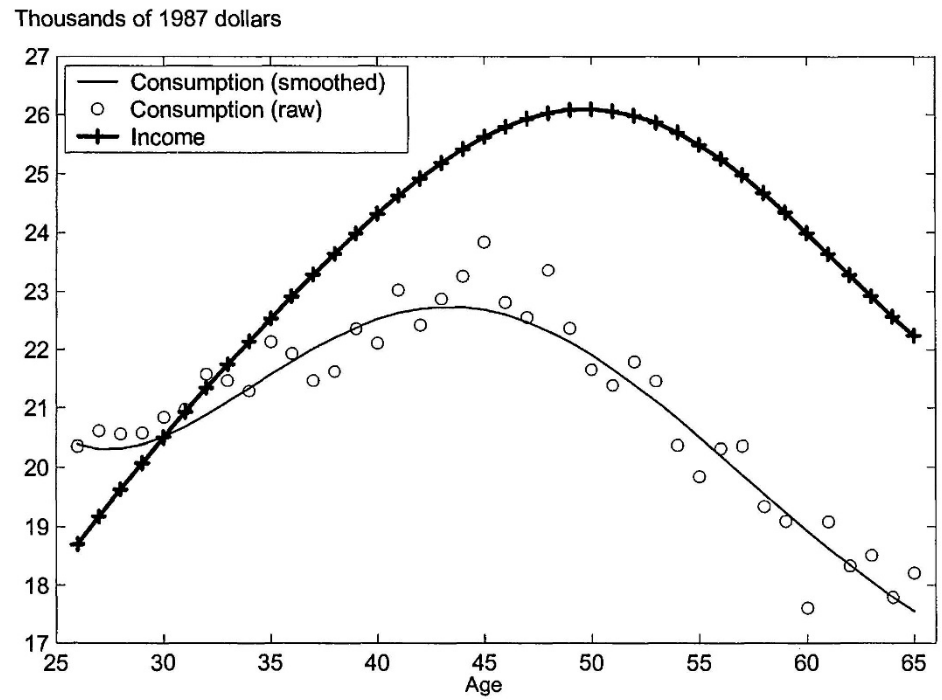

FIGURE 2.—Household consumption and income over the life cycle.

Gourinchas and Parker (2002)

Consumption-Saving

- Three important ideas:
  1. Consumption smoothing
     - Diminishing marginal utility implies that households should borrow when income is low and save when income is high
  2. Borrowing constraints
     - Prevent households from smoothing consumption as much as they would like
  3. Precautionary savings
     - Even when income is low, might want to build up buffer stock of savings as a precaution against future setbacks

History of Thought

- John Maynard Keynes introduced idea of the consumption function in the 1930's
  - Consumption a function of current income
$$C_t = a + bY_t$$
  - b denotes marginal propensity to consume
  - $0 < b < 1$, MPC between zero and one
  - Argued that interest rate was unimportant
- Tryggve Haavelmo and Paul Samuelson provided early estimates of $MPC > 2/3$
  - Correlation vs. causation??

History of Thought

- Keynes' consumption function implied:
  - Savings rate should rise as country gets richer
  - Some economists worried that there wouldn't be enough profitable investment to absorb increase in savings. This would lead to stagnation.
- In 1940's Simon Kuznetz gathered data on GDP and consumption back to 1860's.
  - Consumption turned out to be stable as a share of GDP. Savings rate did not seem to rise as economy grew

History of Thought

- In the 1950's Franco Modigliano (and co-authors) proposed the life-cycle hypothesis:
  - Consumers smooth consumption relative to income (e.g., save for retirement)
  - Consumers are forward-looking
  - Savings rate not related to level of income but rather current income relative to average income over life
  - Savings rate doesn't rise with life-time income

History of Thought

- In 1957, Milton Friedman proposed the permanent income effect
  - Consumption not related to current income but rather "permanent income"
  - MPC out of "windfall" much lower than what Keynesians say, perhaps about 1/3
  - Why 1/3 as oppose to 1/45?
    (Today we use the term permanent income hypothesis over a model that implies MPC = 1/45)

History of Thought

- Empirical Evidence in 1950’s and 1960’s:
  - Spending out of unanticipated payments in 1950 to U.S. veterans holding National Service Life Insurance was between 0.3 and 0.5
  - Spending out of reparations payments by Germany to Israelis in 1957-58 was about 0.2

History of Thought

- In 1978, Robert Hall writes down model much like ours and argues for a MPC of 0.05.
  - Also, consumption should be a random walk (with trend because of interest rate)
  - Only unanticipated changes income should affect consumption (anticipated changes should already be factored into consumption since people are forward-looking)
- In 1982, Hall and Mishkin (1982) estimate MPC to consume of 0.2 and conclude model is wrong because MPC is too high.

History of Thought

- Since 1980:
  - Economists incorporate borrowing constraints and precautionary savings due to uncertainty about the future into model
  - This raises MPC in the model back up to 0.2-0.4
  - Key contributers: Stephen Zeldes, Christopher Carrol, Pierre-Olivier Gourinchas and Jonathan Parker.