The IS Curve

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Structure of the short-run model

- The logic goes roughly like this:
  1. Monetary policy determines the interest rate.
  2. The cost of borrowing determines investment and consumption $\rightarrow$ aggregate demand (IS curve)
  3. Aggregate demand determines output.
  4. Output determines inflation (MP curve).
- There should be a block describing the **supply** of goods (and labor).
  - In our version of the model, there is not.
  - That must be kept in mind when the model is used.

The IS Curve

- The IS curve captures what happens to aggregate demand when the interest rate changes.
- The logic: a higher interest rate implies
  - less borrowing by consumers: $C \downarrow$
  - less investment (higher cost of capital): $I \downarrow$
- This is too simple, but we will not get into the complications...

Why teaching macro is difficult

- The models actually used in economic research are complicated.
- We don't have the tools (math) to talk about them.
- The models use in class are highly simplified versions that try to capture the results obtained from richer models.
- Keep in mind: If the models looks simplistic and arbitrary, there is more in the background which we cannot see.

Deriving the IS curve

- Start from the NIPA identity:

$$Y = C + I + G + EX - IM \tag{1}$$

- In words: total amount of goods available, $Y + IM$, equals total amount of goods used, $C + I + G + EX$.

Behavior: Determinants of demand

- To get aggregate demand, we need to figure out how C, I, G, EX, and IM are determined.
- In reality, there is a long list of variables that determine each demand component.
- We make an extremely simple assumption:
  1. C, G, EX, IM only depend on **long-run** income:

$$\begin{aligned} C_t &= a_c \bar{Y}_t \\ G_t &= a_g \bar{Y}_t \\ EX_t &= a_{ex} \bar{Y}_t \\ IM_t &= a_{im} \bar{Y}_t \end{aligned}$$

  2. I only depends on the gap between the current and the long-run real interest rate:

$$I_t / \bar{Y}_t = a_i - b\,(R_t - \bar{r}) \tag{2}$$

- Think of $\bar{Y}_t$ as determined by the long-run model.

Deriving the IS curve

- We have

$$Y_t / \bar{Y}_t = (a_c + a_g + a_{ex} - a_{im}) + a_i - b\,(R_t - \bar{r}) \tag{3}$$

- Express this in deviations from trend

$$\tilde{Y}_t = \frac{Y_t}{\bar{Y}_t} - 1 = a - b\,(R_t - \bar{r}) \tag{4}$$

with

$$a = a_c + a_g + a_{ex} - a_{im} - 1 \tag{5}$$

The IS curve

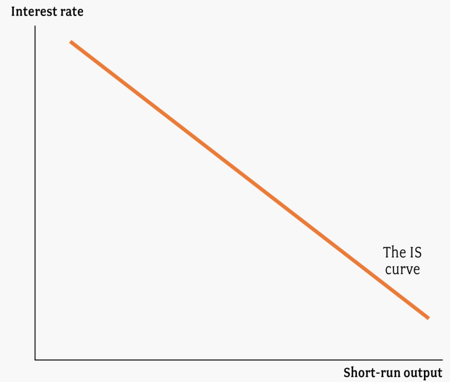


FIGURE 10.1 Introducing the IS Curve

Macroeconomics, Charles I. Jones

Important: the IS curve goes through $\bar{r}, a$.

What does the IS curve mean?

- The IS curve is more than an aggregate demand curve.
- In a more general model:
  - aggregate demand depends on Y (income effect)
  - and Y depends on aggregate demand
- Then the interpretation of IS is:
  - For each Y, the IS curve shows the interest rate that supports aggregate demand Y.
- But: since we assumed that current Y does not affect aggregate demand, the distinction does not matter.
- Exercise: Assume that $C_t = a_c \bar{Y}_t + b_c Y_t$. Solve for the intercept and slope of the IS curve.
  - Now the distinction matters.

What does the IS curve mean?

- The IS curve is not quite goods market clearing
  - We have not talked about the **supply** of Y.
- We are assuming that, in the **short-run**, supply does not matter.
- Note: in the **long-run**, demand does not matter.
- A simplification, that comes at some cost...

The slope (b)

- Reduce R by a little (ΔR).
- I rises by $b \times \Delta R$.
- The new level of Y that clears the goods market rises by $b \ \Delta R$.
- More generally: other demand components rise as well – that just raises b.
- A movement **along** IS.

The intercept (a)

- Recall that $a = a_c + a_g + a_{ex} - a_{im} - 1$.
- What happens in the long-run?
- $\tilde{Y} = 0$ and $R = \bar{r}$ (by definition).
- Then the IS equation becomes $\tilde{Y} = a - b \times 0 = 0$.
- This restates that $C + G + I + EX - IM = \bar{Y}$ in the long-run.
- In normal times (without shocks): $a = 0$.

The intercept (a)

- We think about the short-run value of a as determined by **demand shocks**.
- Example:
  - Foreigners demand an unusual amount of U.S. goods: $a_{im} \uparrow$.
  - Consumers are temporarily optimistic: $a_c \uparrow$.

The intercept (a)

- Something is fishy here - what happens if a_c rises permanently?
- In the model we have written down that looks like a logical error.
- If $a \neq 0$ then long-run demand $\neq$ long-run supply.
- What ensures that $a = 0$ in the long run?
- The economy's budget constraint.
- The details ... complicated.
- That's why a modern macro model would derive the consumption function from the behavior of individual households (who are not allowed to violate their budget constraints).

Using the IS curve

- To figure out Y_t we still need a way of determining R_t.
- So far, all we can do is ask: how does the IS curve change when the economy is hit by certain shocks?
- Let's consider:
  - a positive demand shock
  - a higher interest sensitivity of investment
  - a shock to potential output

Justifying the behavioral rules

Justifying the behavioral rules

- We made strong assumptions:
  1. C, G, $EX - IM$ all depend only on $\bar{Y}$.
  2. I only depends on $R - \bar{r}$.
- Questions:
  1. Do these assumptions make sense?
  2. What happens if we relax them?

Justifying the behavioral rules

- Note that nothing changes when we generalize the behavioral rules:
  - All demand components could depend on the interest rate and on current output.
  - That would change the values of a and b, but not the form of the IS curve.
- Exercise: Derive the IS curve for that case. Convince yourself that it is still linear and downward sloping.
- The assumptions we made are not as restrictive as they seem.

Justifying the consumption rule

- Intuitively, consumption should rise with income
- Current or long-run income?
- Intuition suggests current income
- This is the "**old**" IS curve (ca. 1970).
- But there are 2 reasons why it should be long-run income:
  1. Data: consumption is smooth relative to income.
  2. Theory ...

Justifying the consumption rule

- Why is consumption smooth relative to income?
- Let's solve a simple (micro) consumption problem.
- The household lives for 2 periods (innocuous).
- She receives incomes y_1 and y_2 (given).
- She can save or borrow at interest rate r.

Household problem

Choose c_1 and c_2 to

$$\max u(c_1) + \beta u(c_2) \tag{6}$$

subject to the budget constraints

$$b = y_1 - c_1 \tag{7}$$

$$c_2 = b(1+r) + y_2 \tag{8}$$

b is saving in the form of a bond with interest rate r.

Household problem

- Substitute *b* out of the budget constraints.
- Obtain one **present value budget constraint**:

$$y_1 - c_1 = \frac{c_2 - y_2}{1 + r} \tag{9}$$

- Or

$$W = y_1 + \frac{y_2}{1 + r} = c_1 + \frac{c_2}{1 + r} \tag{10}$$

- This is very general:

the present value of income must equal the present value of consumption

Household problem

- The new maximization problem:

$$\max u(c_1) + \beta u(c_2) \tag{11}$$

  subject to the present value budget constraint

$$W = y_1 + \frac{y_2}{1+r} = c_1 + \frac{c_2}{1+r} \tag{12}$$

- The household takes the present value of income (W) as given.

Household: Optimality

Even without any derivations, we find that:

The optimal consumption choices, c_1 and c_2, do not depend on the timing of income of the life-cycle, y_1 and y_2.
They only depend on the present value W.

This insight is known as

The Permanent Income Hypothesis

Household: Optimality

- Let's derive optimal consumption to verify the Permanent Income Hypothesis.
- Substitute the budget constraint into the utility function:

$$\max_{c_2} u\left(W - \frac{c_2}{1+r}\right) + \beta u\left(c_2\right) \tag{13}$$

- First-order condition for c_2:

$$u'\left(W - \frac{c_2}{1+r}\right)\frac{-1}{1+r} + \beta u'\left(c_2\right) = 0 \tag{14}$$

- Combining them yields the **Euler equation**

$$u'(c_1) = \beta(1+r)u'(c_2) \tag{15}$$

- Solution: (c_1, c_2) that satisfy the Euler equation and the lifetime budget constraint.

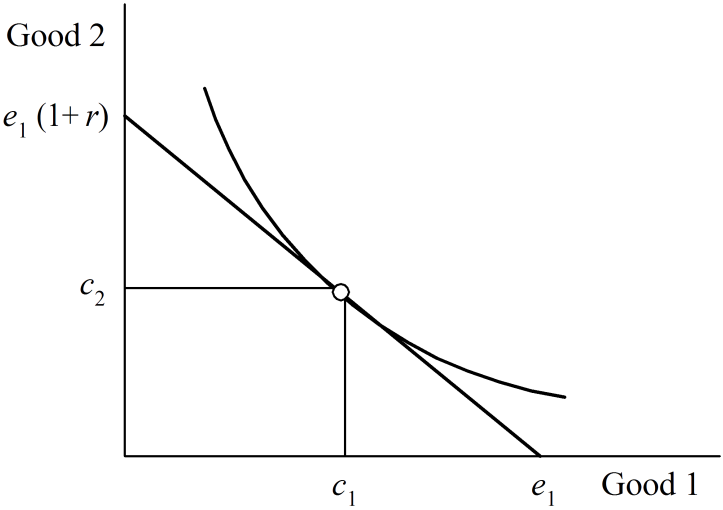
Household: Optimality

Interpretation of the Euler equation: a small change along the budget constraint does not change utility.

- Giving up ε units of consumption today costs $u'(c_1)\ \varepsilon$.
- Next period, gain $1+r$ units of consumption, valued at $\beta u'(c_2)\ \varepsilon\ (1+r)$.
- The Euler equation states: marginal benefit = marginal cost.

An Euler equation very similar to this one appears in most macro models.

Graphical illustration



Empirical implications

- Let's think about a household who lives for many periods (e.g. 70 years).
- Assume $u(c) = \ln(c)$.
- Therefore, $u'(c) =$
- For each pair of years, an Euler equation holds:

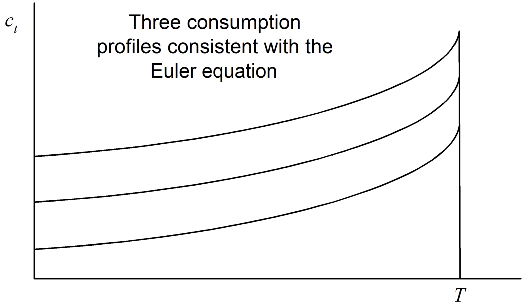
$$u'(c_t) = \beta(1+r)\,u'(c_{t+1}) \tag{16}$$

$$1/c_t = \beta(1+r)/c_{t+1} \tag{17}$$

$$c_{t+1}/c_t = \beta(1+r) \tag{18}$$

- Consumption grows at rate $\beta(1+r)$ from t to $t+1$.
- Assume for now that r is constant over time.
- Plot the consumption paths for a set of households that differ in their y_1 and y_2.

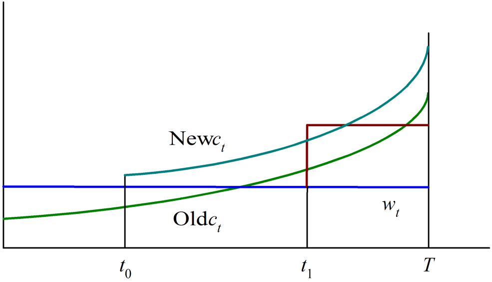
Empirical implications



Rich and poor households have the same consumption profiles, just shifted up or down.

How does the household respond to shocks?

Let's think about an anticipated increase in future earnings.



Empirical implications

1. Over time, consumption growth should not depend on income growth.
   - Carroll & Summers (1997) have tested this. It fails in the data.
   - Divide people into occupation or education groups.
   - Those with predictably steeper wage profiles have steeper consumption profiles.
   - This is consistent with the model, if one accounts for the fact that wages are not perfectly predictable.
2. Households should consume only small fractions of temporary income shocks (lotteries, tax refunds).
   - The data support this (with some minor exceptions).
3. Households should consume more, if they expect faster future wage growth.
   - This is difficult to test, but seems to hold up.

Empirical implications

- Consider a given reduction in income taxes.
- How much will it increase demand?
- What does the answer depend on?

Empirical implications

Young people (you!) should borrow. Old people should dissave.

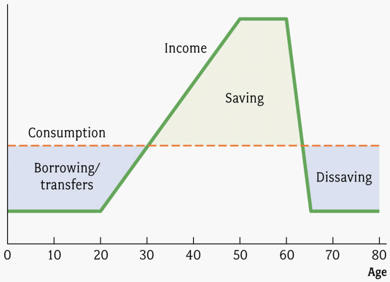


FIGURE 10.5 The Life-Cycle Model of Consumption

Macroeconomics, Charles I. Jones

Intuition: Permanent Income Hypothesis

- What is the intuition for the PIH?
- What are the key assumptions?
- What have we abstracted from that could overturn the PIH?
- Is the PIH relevant for your consumption choice?

Implications for the IS curve

- Consumption should depend on lifetime income $(\bar{Y})$, not on current income (Y).
- More precisely, the marginal propensity to consume out of Y should be much smaller than out of $\bar{Y}$.
- This is what motivates our consumption rule

$$C_t = a_c \bar{Y}_t \tag{19}$$

- Now we also understand that a_c is not fixed.
- It depends on expectations about future income growth.

The Investment Rule

What determines a company's investment?

1. The cost of capital relative to the marginal product of capital: $R - \bar{r}$.
2. Current demand Y_t.
3. Expected future demand.
4. The capital stock.
5. Cash flow.

The Investment Rule

- The rule

$$I_t / \bar{Y}_t = a_i - b\,(R_t - \bar{r})$$

  captures the cost of capital and something like cash flow (through $\bar{Y}$).
- We can add current demand Y_t without changing the IS curve (see above).

The Investment Rule

- Critical omissions from the investment rule:
  1. Capital stock
  2. Expectations
- We have to treat them in an ad hoc way as shifting a_i.
- If we had the tools, we would include both in the model.

Government Spending

- We assume $G_t = a_g \bar{Y}_t$.
- This captures that G is smooth relative to Y.
- In reality, G does depend on Y (because tax revenues vary with Y).
  - We can add that without changing the IS curve.
- What is missing?
  - The **government budget constraint**.
  - Higher G requires higher taxes or more debt.
  - Both affect private spending (**crowding out**). [Why?]
- If we had the tools, we would include this in the model.

Government Spending

- This is a really important omission!
- In our model,
  1. higher G unambiguously raises demand.
  2. the effect of G on demand is fixed (one for one).
- Both are not true in the data.
- It matters how G is financed (debt vs. various types of taxes).
- How G crowds out private spending depends on expectations.

Net Exports

- We look at those in more detail later.

Examples

Assume that the Fed controls R_t and holds it constant. What are the effects of:

1. consumers expect lower future income growth
2. the marginal product of capital increases due to technical innovations
3. a housing bubble bursts
4. the government increases spending (financed how?)

Reading

- Jones, Macroeconomics, ch. 10.