Chapter 11

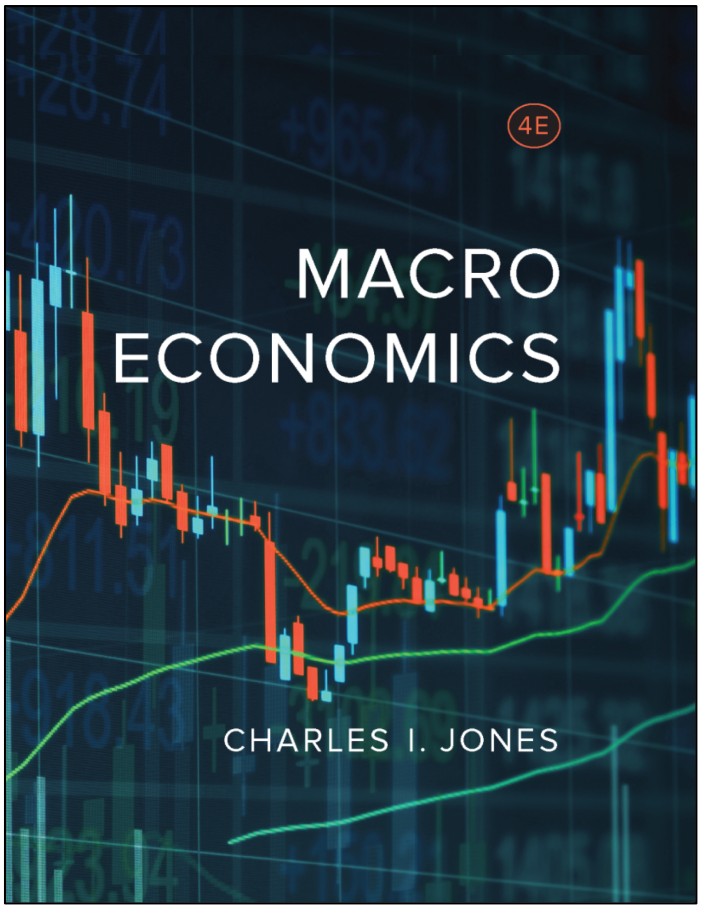
The IS Curve

IS - LM

IS - LP

HICKS

HICKS-JONES



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11.1 Introduction

- In this chapter, we learn:
  - Foundation of the short-run model: **the IS curve** illustrates the **inverse relationship between the real interest rate and short-run output**
  - Aggregate demand shocks (i.e., consumption, investment, government purchases, or net exports) shift the IS curve.
  - Life-cycle/permanent-income hypothesis describes consumption behavior (next lecture).
  - Changes in real interest rates affect short-run output primarily through **investment**.

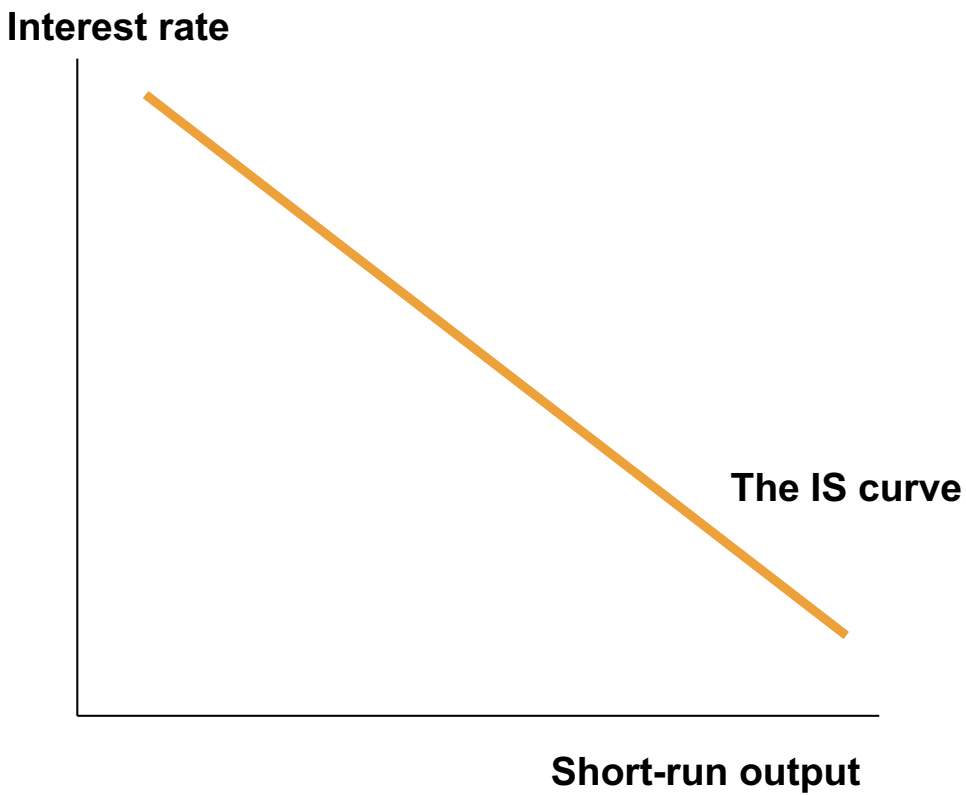
Introduction

- The Federal Reserve influences the level of economic activity in the short run.
  - The Fed targets the federal funds rate.
  - The federal funds rate is highly correlated with the short-term nominal interest rate at which people borrow and lend in financial markets.
  - In-depth look at inner workings of Fed in chapter 12
- The basic story is as follows:

$$\uparrow \text{interest rate} \Rightarrow \downarrow \text{investment} \Rightarrow \downarrow \text{output}$$

- The IS curve:
  - illustrates the **negative** relationship between interest rates and short-run output.

Introducing the IS Curve



11.2 Setting Up the Economy

- The national income accounting identity
  - Implies that the total resources available to the economy equal total uses
  - One equation and six unknown variables

$$Y_t = C_t + I_t + G_t + EX_t - IM_t$$

  - where

Y_t	Output		I_t	Investment
IM_t	Imports		G_t	Government Purchases
C_t	Consumption		EX_t	Exports

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Y_t	Output		I_t	Investment
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Setting Up the Economy

- Five additional equations to solve the model:

$$C_t = \bar{a}_c \bar{Y}_t$$

$$G_t = \bar{a}_g \bar{Y}_t$$

$$EX_t = \bar{a}_{ex} \bar{Y}_t$$

$$IM_t = \bar{a}_{im} \bar{Y}_t$$

$$\frac{I_t}{\bar{Y}_t} = \bar{a}_i - \bar{b}(R_t - \bar{r})$$

where a bar denotes an exogenous variable

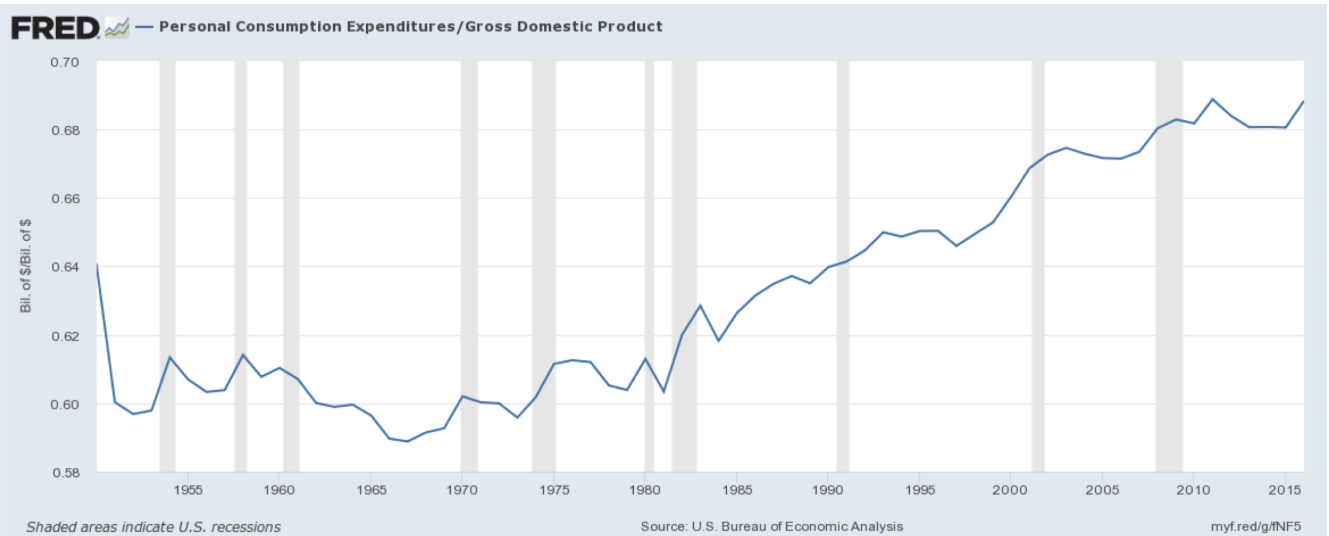
The Model—1

- Assume C_t, G_t, IM_t, and EX_t are given exogenously (i.e. they are functions of *potential* output).
- Example: C_t is a constant fraction of potential output given by $\bar{a}_c$
  - $\bar{a}_c$ is empirically estimated to be approximately 2/3

Consumption

  - About 2 out of every 3 dollars of GDP is attributed to consumption

The Model—2



The Model—3

- Now, we use our national income accounting identity:

$$Y_t + IM_t = C_t + I_t + G_t + EX_t$$

- and substitute in the four equations that contain only parameters:

$$Y_t + \boxed{IM_t} = \boxed{C_t} + I_t + \boxed{G_t} + \boxed{EX_t}$$

$$\boxed{\bar{a}_{im}\bar{Y}_t} \quad \boxed{\bar{a}_c\bar{Y}_t} \qquad \boxed{\bar{a}_g\bar{Y}_t} \quad \boxed{\bar{a}_{ex}\bar{Y}_t}$$

- such that

$$Y_t + \bar{a}_{im}\bar{Y}_t = \bar{a}_c\bar{Y}_t + I_t + \bar{a}_g\bar{Y}_t + \bar{a}_{ex}\bar{Y}_t$$

The Investment Equation

- Investment is given by:

$$\frac{I_t}{\bar{Y}_t} = \bar{a}_i - \bar{b}(R_t - \bar{r})$$

$\bar{a}_i$	Share of potential output that goes to investment
$\bar{b}$	Parameter weighting the difference between the real interest rate and the MPK
R_t	Real interest rate
$\bar{r}$	Marginal product of capital (MPK)

Marginal Product of Capital (MPK)—1

- Amount of additional output the firm can produce by investing in one more unit of capital
- In the long run, MPK= $\bar{r}$, and $\bar{r}$ is:
  - Exogenous
  - Time invariant
- Recall the equation for investment:

$$\frac{I_t}{\bar{Y}_t} = \bar{a}_i - \bar{b}(R_t - \bar{r})$$

- Multiply each side by $\bar{Y}_t$:

$$I_t = \bar{a}_i \bar{Y}_t - \bar{b}\bar{Y}_t R_t + \bar{b}\bar{Y}_t \bar{r}$$

Marginal Product of Capital (MPK)—2

- Now, we can use the following equation for investment to understand how the gap between MPK and the real interest rate helps determine investment:

$$I_t = \bar{a}_i \bar{Y}_t - \bar{b}\bar{Y}_t R_t + \bar{b}\bar{Y}_t \bar{r}$$

- In the short run, MPK= $\bar{r}$ and R_t can be different
- If MPK= $\bar{r} < R_t$
  - Firms should **save** and **not invest** in capital
  - Investment will decline
- If MPK= $\bar{r} > R_t$
  - Firms should **borrow** and **invest** in capital
  - Investment will increase

The Setup of the Economy for the IS Curve

The Setup of the Economy for the IS Curve

Endogenous variables: $Y_t,\ C_t,\ I_t,\ G_t,\ EX_t,\ IM_t$

National income identity: $$Y_t = C_t + I_t + G_t + EX_t - IM_t$$

Consumption: $$C_t = \bar{a}_c \bar{Y}_t$$

Government purchases: $$G_t = \bar{a}_g \bar{Y}_t$$

Exports: $$EX_t = \bar{a}_{ex} \bar{Y}_t$$

Imports: $$IM_t = \bar{a}_{im} \bar{Y}_t$$

Investment: $$\frac{I_t}{\bar{Y}_t} = \bar{a}_i - \bar{b}(R_t - \bar{r})$$

Exogenous variables/parameters: $Y_t,\ \bar{r},\ \bar{a}_c,\ \bar{a}_i,\ \bar{a}_g,\ \bar{a}_{ex},\ \bar{a}_{im},\ \bar{b}$

Exogenous for now (until next chapter): R_t

11.3 Deriving the IS Curve

- Begin with the national income accounting identity:

$$Y_t + IM_t = C_t + I_t + G_t + EX_t$$

- Divide both sides by potential output:

$$\frac{Y_t}{\overline{Y}_t} = \frac{C_t}{\overline{Y}_t} + \frac{I_t}{\overline{Y}_t} + \frac{G_t}{\overline{Y}_t} + \frac{EX_t}{\overline{Y}_t} - \frac{IM_t}{\overline{Y}_t}$$

- Substitute the five remaining equations into the equation above:

$$\frac{Y_t}{\overline{Y}_t} = \frac{\bar{a}_c \overline{Y}_t}{\overline{Y}_t} + \frac{\bar{a}_i \overline{Y}_t - \bar{b}\overline{Y}_t R_t + \bar{b}\overline{Y}_t \bar{r}}{\overline{Y}_t} + \frac{\bar{a}_g \overline{Y}_t}{\overline{Y}_t} + \frac{\bar{a}_{ex} \overline{Y}_t}{\overline{Y}_t} - \frac{\bar{a}_{im} \overline{Y}_t}{\overline{Y}_t}$$

- Simplifying yields:

$$\frac{Y_t}{\overline{Y}_t} = \bar{a}_c + \bar{a}_i - \bar{b}(R_t - \bar{r}) + \bar{a}_g + \bar{a}_{ex} - \bar{a}_{im}$$

Deriving the IS Curve—1

- Recall the definition of short-run output:

$$\tilde{Y}_t \equiv \frac{Y_t - \bar{Y}_t}{\bar{Y}_t} = \frac{Y_t}{\bar{Y}_t} - 1$$

- Subtract 1 from both sides of the equation:

$$\frac{Y_t}{\bar{Y}_t} - 1 = \bar{a}_c + \bar{a}_i + \bar{a}_g + \bar{a}_{ex} - \bar{a}_{im} - 1 - \bar{b}(R_t - \bar{r})$$

$\tilde{Y}_t$

$\bar{a}$

long run $\bar{a} = 0$

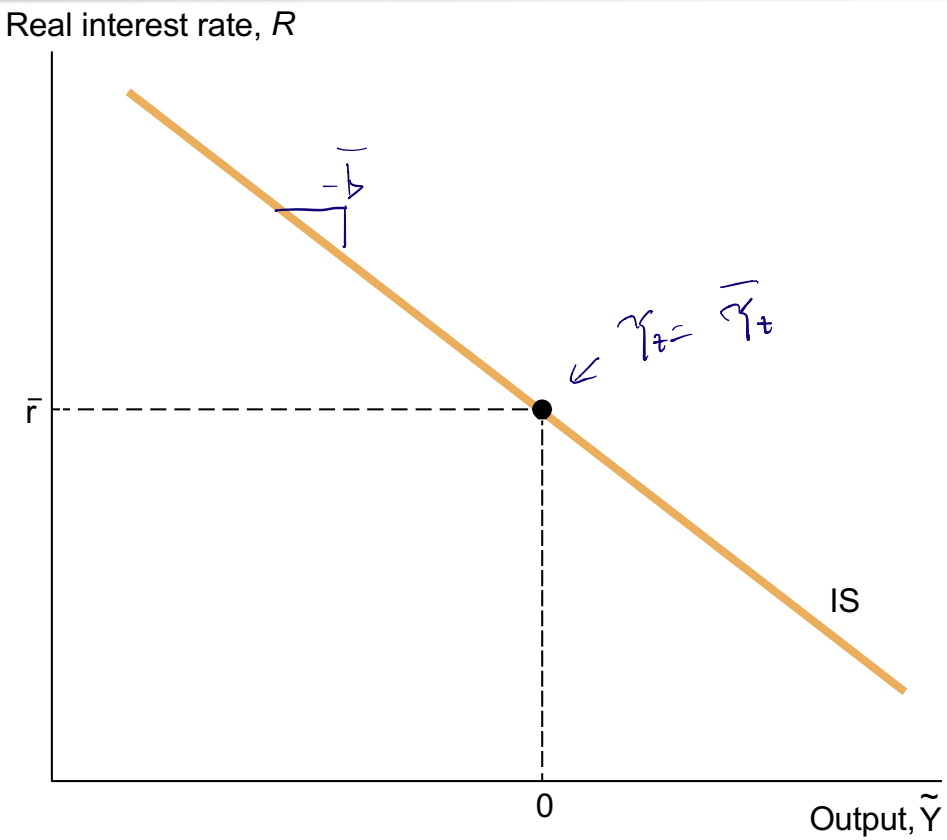
Deriving the IS Curve—2

- After simplifying:

$$\tilde{Y}_t = \bar{a} - \bar{b}(R_t - \bar{r})$$

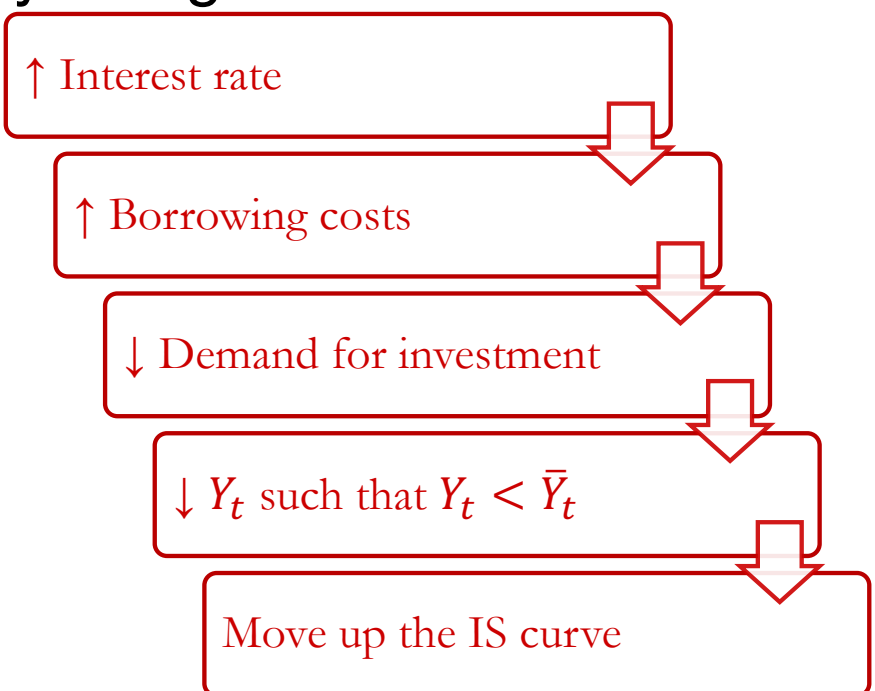
  - The gap between the real interest rate and the MPK is what determines output fluctuations
  - The parameter $\bar{a}$ is called the aggregate demand shock a recession, $\bar{a}\downarrow$, shift IS curve.
  - Note: when $Y_t = \bar{Y}_t$ then $\bar{a} = 0$ and $R_t = \bar{r}$

11.4 Using the IS Curve

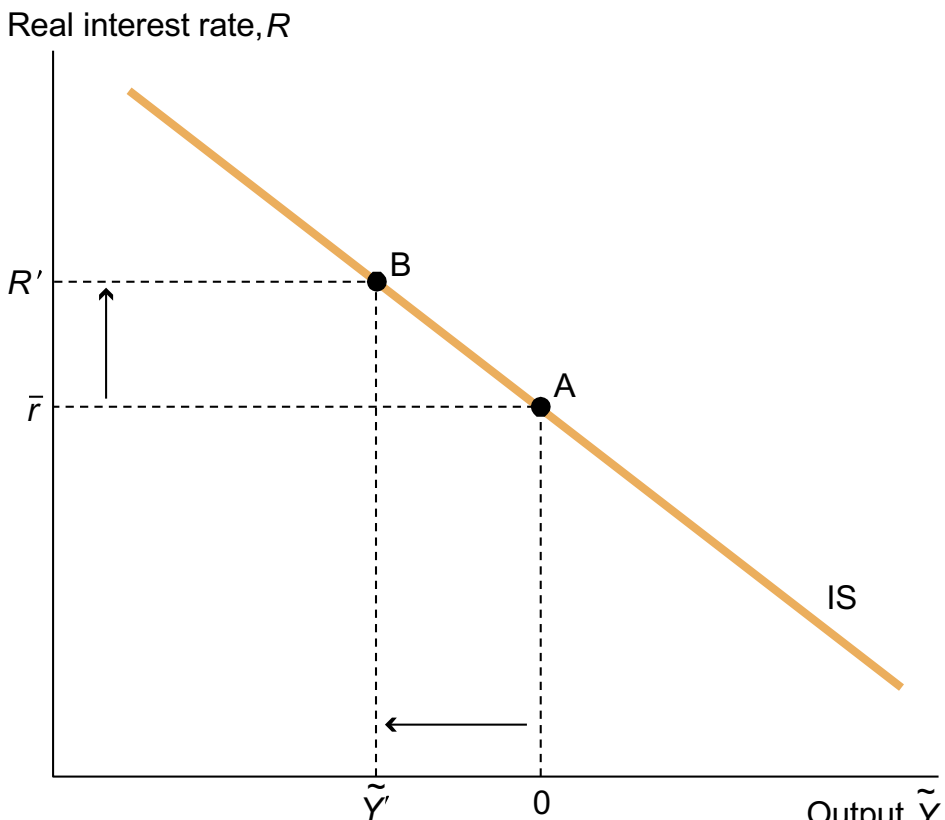


A Change in the Interest Rate—1

- A change in the ***real*** interest rate moves the economy along the IS Curve



An Increase in the Real Interest Rate to R'



A Change in the Interest Rate—2

- If the sensitivity to the interest rate ($\bar{b}$) were **higher**:
  - The IS curve would be **flatter**
  - A change in the interest rate would be associated with larger changes in output

A Change in the Interest Rate—3

- Rearranging the IS equation $\tilde{Y}_t = \bar{a} - \bar{b}(R_t - \bar{r})$ and solving for R_t:
  - $\tilde{Y}_t - \bar{a} + \bar{b}\bar{r} = -\bar{b}R_t$
  - $R_t = \frac{\tilde{Y}_t - \bar{a} + \bar{b}\bar{r}}{-\bar{b}}$
  - $R_t = \frac{\bar{a}}{\bar{b}} + \bar{r} - \left(\frac{1}{\bar{b}}\right)\tilde{Y}_t$
- The **slope** of the IS curve is *negative*
- As $\bar{b}$ **increases**, the **slope decreases**, and the **IS curve becomes flatter**

Shift of the IS Curve—Demand Shocks [1]

- Exogenous change in $R_t \Rightarrow$ **move along** IS curve
- Exogenous change in $\frac{I_t}{Y_t}$ for **given** $R_t \Rightarrow$ **shift of** the IS curve
- Recall the equation for investment:

$$\frac{I_t}{\bar{Y}_t} = \bar{a}_i - \bar{b}(R_t - \bar{r})$$

Shift of the IS Curve—Demand Shocks [2]

- IS curve in this chapter is very stylized
- Important link to Solow model in chapter 5 is left out:
  - $\bar{a}_i$ is long-run investment share in short-run model
  - $\bar{s}$ is investment/saving rate in Solow model
  - What happens to MPK in long run if $\bar{s}$ rises in Solow model?
  - What happens to MPK if $\bar{a}_i$ rises in short-run model?

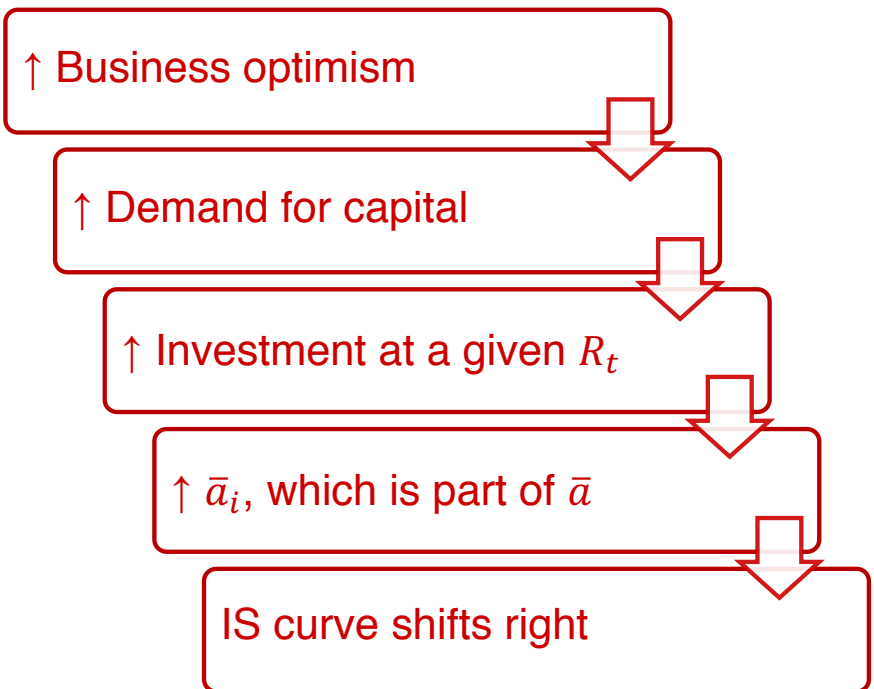
$$K^* = \left(\frac{\bar{s}\bar{A}}{\delta}\right)^{\frac{1}{1-\alpha}} L$$

$$Y^* = \bar{A}K^{\alpha}L^{1-\alpha} = \bar{A}^{\frac{1}{1-\alpha}}\left(\frac{\bar{s}}{\delta}\right)^{\frac{\alpha}{1-\alpha}} L$$

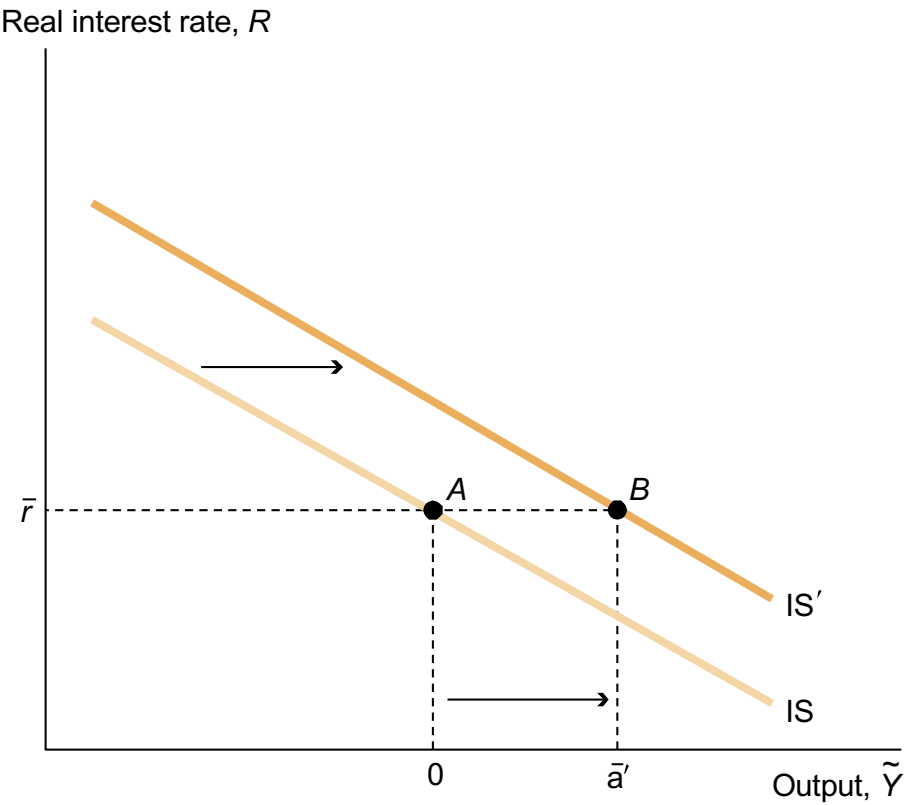
$$\frac{\partial Y}{\partial K} = \bar{A}\alpha K^{\alpha-1}L^{1-\alpha} = \frac{\alpha\delta}{\bar{s}}$$

An Aggregate Demand Shock—1

- Suppose that information technology improvements create an investment boom:

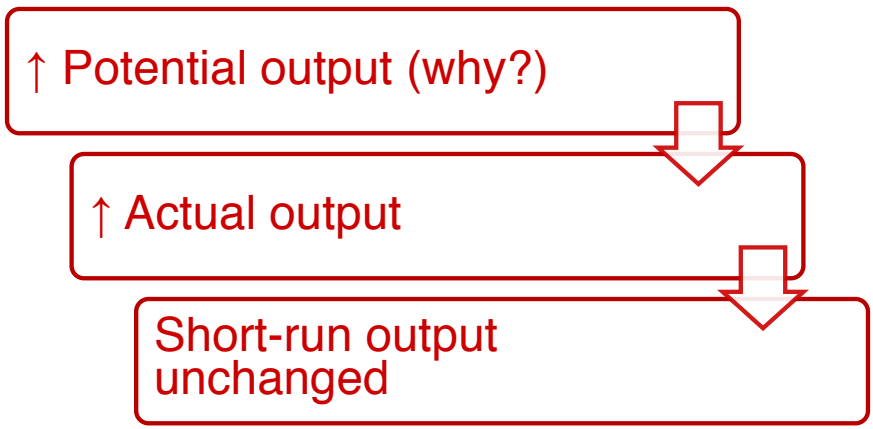


An Aggregate Demand Shock—2



A Shock to Potential Output

- Suppose there is a discovery of a new technology:



- Recall the definition of short-run output: $\tilde{Y}_t = \frac{Y_t}{\bar{Y}_t} - 1$
- If Y_t and $\bar{Y}_t$ increase by the same amount, the ratio $\frac{Y_t}{\bar{Y}_t}$ will be equal to 1 and $\tilde{Y}_t = 0$

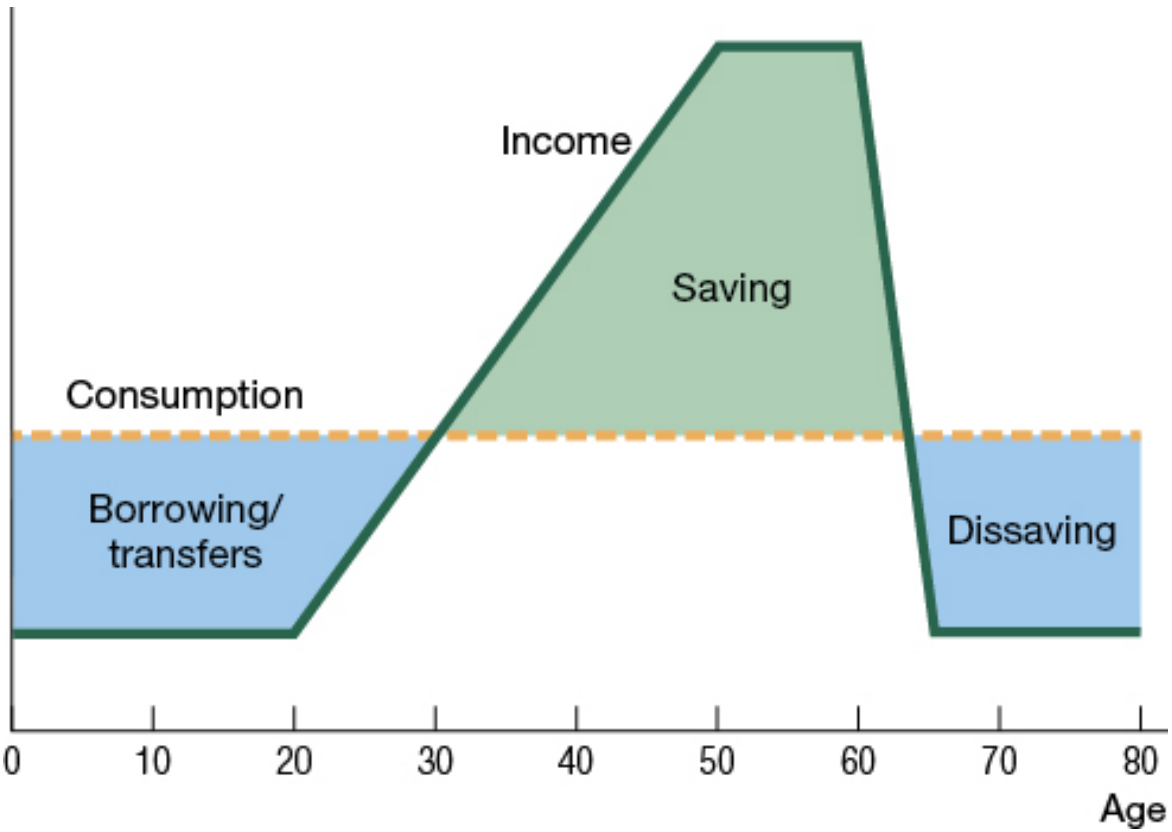
11.5 Micro-Foundations of the IS Curve

- Microfoundations:
  - Explain the **microeconomic** behavior that establishes the demands for C, I, G, EX and IM
- Key theory of **consumption** behavior: Individuals prefer to smooth their consumption spending over time.
  - The **permanent-income hypothesis**: People will base their consumption on an average of their income over time rather than on their current income
  - The **life-cycle model of consumption**: Suggests that consumption is based on average lifetime income rather than on income at any given age

Consumption

- Consider an example: You are given the choice between Option A and Option B below.
- Option A:
  - Consumption: one piece of cake ($3) every day Monday through Friday
  - Income: $15 on Friday, but you may borrow $3 a day (at no interest) to consume during the week.
- Option B:
  - Consumption: five pieces of cake ($15) on Friday
  - Income: $15 on Friday
- The permanent income hypothesis predicts that people will choose Option A.

The Life-Cycle Model of Consumption



Empirical Evidence—1

- Is there any evidence to support the two hypotheses?
- Case study: Alaska – How do consumers respond to two **different** types of income shocks?
  - Annual payment from the State of Alaska's Permanent Fund (from oil revenues)
  - Federal tax refunds
  - What distinguishes the annual payment from tax refunds?

Empirical Evidence—2

- The LC/PI hypothesis predicts that consumption should not change when the Permanent Fund check is received
  - Hsieh finds that this is the case for the Permanent Fund
  - But, the same is not true in response to a tax refund
  - For every $1 of a tax refund, consumers spend 0.30 cents
- Hsieh concludes that the LC/PI hypothesis applies to large and anticipated changes, but not necessarily to unanticipated changes.

Empirical Evidence—3

- Additional evidence from temporary tax changes in the United States:
  - 1992 change in federal tax withholding schedule (but no change in tax liability itself) under H.W. Bush
  - Economic Growth and Tax Relief Reconciliation Act of 2001 rebates of $300 / $500 / $600, depending on filing status (study by Shapiro and Slemrod)

Multiplier Effects—1

- Suppose we conclude that consumption also depends on temporary changes in income ⇒ multiplier effect
- Consumption equals

$$\frac{C_t}{\overline{Y}_t} = \bar{a}_c + \bar{x}\tilde{Y}_t$$

where $\bar{x}$ is a parameter that determines how much consumption rises when the economy expands.

- We assume $\bar{x}$ is between 0 and 1

Multiplier Effects—2

- Solving for the IS curve assuming that consumption also depends on temporary changes in income:
  - We begin with the national income accounting identity and divide both sides by potential GDP
  - Substituting the new consumption equation yields:

$$\frac{Y_t}{\bar{Y}_t} = \frac{\bar{a}_c \bar{Y}_t + \bar{x}\tilde{Y}_t \bar{Y}_t}{\bar{Y}_t} + \frac{\bar{a}_i \bar{Y}_t - \bar{b}\bar{Y}_t R_t + \bar{b}\bar{Y}_t \bar{r}}{\bar{Y}_t} + \frac{\bar{a}_g \bar{Y}_t}{\bar{Y}_t} + \frac{\bar{a}_{ex} \bar{Y}_t}{\bar{Y}_t} - \frac{\bar{a}_{im} \bar{Y}_t}{\bar{Y}_t}$$

Multiplier Effects—3

- After simplifying:

$$\frac{Y_t}{\bar{Y}_t} = \bar{a}_c + \bar{x}\tilde{Y}_t + \bar{a}_i - \bar{b}R_t + \bar{b}\bar{r} + \bar{a}_g + \bar{a}_{ex} - \bar{a}_{im}$$

- Subtract 1 from both sides of the equation:

$$\frac{Y_t}{\bar{Y}_t} - 1 = \bar{x}\tilde{Y}_t + \bar{a}_i - \bar{b}R_t + \bar{b}\bar{r} + \bar{a}_c + \bar{a}_g + \bar{a}_{ex} - \bar{a}_{im} - 1$$

- Simplifying further:

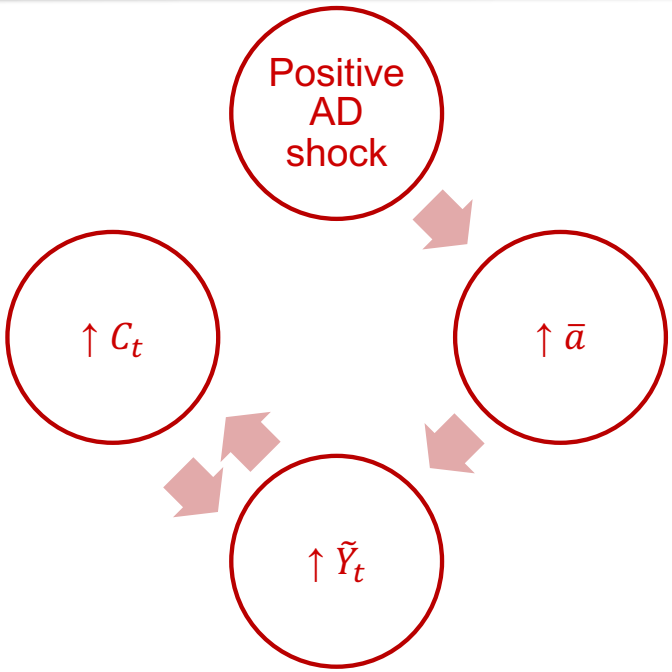
$$\tilde{Y}_t = \frac{1}{1 - \bar{x}}\left(\bar{a} - \bar{b}(R_t - \bar{r})\right)$$

Multiplier Effects—4

- The new IS curve:

$$\tilde{Y} = \underbrace{\frac{1}{1 - \bar{x}}}_{\text{multiplier}} \times \underbrace{[\bar{a} - \bar{b}(R_t - \bar{r})]}_{\text{original IS curve}}$$

Multiplier Effects—4



Note: In this case, $\frac{C_t}{\bar{Y}_t} = \bar{a}_C + \bar{x}\tilde{Y}_t$, and consumption is affected by changes in short-run output .

Investment—1

- Recall the equation for investment:

$$I_t = \bar{a}_i \bar{Y}_t - \bar{b}(R_t - \bar{r})\bar{Y}_t$$

- There are two main determinants of investment at the firm level:
  - The gap between the real interest rate and the MPK
  - Cash flow

moral hazard adverse selection

Investment—2

- How do we calculate the return to capital?
  - In a simple model, the return on capital = MPK-depreciation
  - A more sophisticated framework would have to account for:
    - Corporate income taxes
    - Investment tax credits
    - Depreciation allowances

Agency Problems

- Investment spending can be financed through:
  - Internal cash flow
  - Borrowing (which tends to be more costly)
- Borrowing introduces agency problems
  - Asymmetric information between individuals involved in a transaction
  - Two main types of agency problems:
    - **Adverse selection** (ex ante) who shows up → loan
    - **Moral hazard** (ex post)

Government Purchases—1

assume to be a fix percent.

- Government purchases of goods and services are an important source of demand
  - In recent years, government purchases are about 20% of GDP
- Government purchases can be:
  - A source of short-run fluctuations
  - An instrument to reduce fluctuations

Government Purchases—2

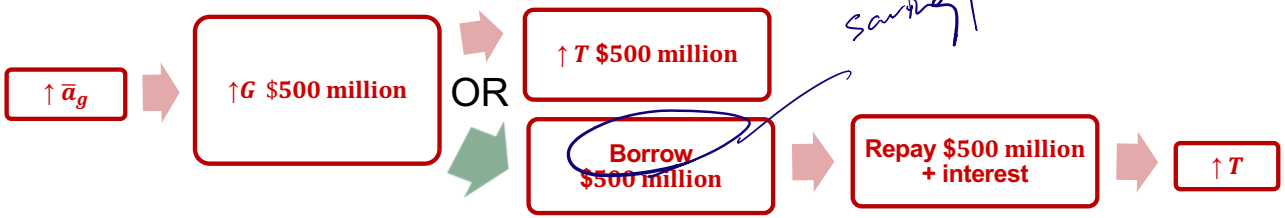
- Discretionary fiscal policy
  - Purchases of new goods or services
    - American Recovery and Reinvestment Act of 2009
  - Tax rate changes
    - Investment tax credit of 1961
    - Economic Growth and Tax Relief Reconciliation Act of 2001

Fiscal Policy

- Automatic stabilizers
  - Transfer spending programs (e.g., unemployment insurance, Medicare)
- The impact of fiscal policy depends on:
  - Timing
  - The "no free lunch" principle (based on PDV of government's budget balance)

Ricardian Equivalence

- Analogous to the permanent-income hypothesis
- According to Ricardian equivalence:
  - The timing of tax changes does not matter for consumer behavior
  - The present value of government tax collection determines behavior
- Consider an example:
  - Suppose Congress decides to hire more teachers, increasing government purchases by $500 million



Net Exports—1

- Trade balance = Net exports
  $= EX - IM$
  $= \bar{a}_{ex}\bar{Y}_t - \bar{a}_{im}\bar{Y}_t$
  $= \bar{Y}_t(\bar{a}_{ex} - \bar{a}_{im})$
- If $EX > IM$
  - $NX > 0$
  - Trade surplus
- If $EX < IM$
  - $NX < 0$
  - Trade deficit

Net Exports—2

- Suppose there is:
  - An increase in demand for U.S. goods from the rest of the world ($\uparrow \bar{a}_{ex}$) → IS shifts right → ↑ short-run output
  - An increase in demand for imports from the rest of the world ($\uparrow \bar{a}_{im}$) → IS shifts left→ ↓ short-run output