

Chapter 9

A Real Intertemporal Model with **Investment**

Already Done

- Consumer Behavior:
 - Work-Leisure choices (CHAPTER 4)
 - Intertemporal Consumption-Savings choices (CHAPTER 8)
- Production Side:
 - Firms' Production Technology and Labor Demand (CHAPTER 4)
 - Changes in Productivity affect c , E and y . (CHAPTER 5)
- Government Side:
 - Government expenditure and the timing of taxes.

To do: REAL Model

- **REAL INTERTEMPORAL MODEL:**
show how real aggregate output, real consumption, real investment, employment, real wage and the real interest rate are determined.

- CHAPTER 9: Investment behavior.

Investment Behavior

- **Determinants of Investment:**
Study the microeconomic investment behavior of the firm, which makes an intertemporal decision regarding investment in the current period.
- Forgoes current profits to have higher capital stock and higher profits in the future.

Determinants of **high Investment**

- Lower capital stock.
- Higher expected future total factor productivity.
- Lower real interest rate.



KEY:
opportunity cost
of Investment

STUDY

- Effects of:
 - Government Spending Shock.
 - Total Factor Productivity Shock.
 - Capital Stock Shock.

MODEL

- Representative Consumer:
 - Supply labor and demand goods.
- Representative Firm:
 - Demand labor, supply goods and demand investment goods.
- Government:
 - Demand goods for purchases.

Consumer Budget

- CURRENT $c + s = w(h-l) + \pi - T$
- FUTURE $c' = w'(h-l') + \pi' - T' + (1+r)s$

- **LIFETIME**

$$c + c'/1+r = w(h-l) + \pi - T + (w'(h-l') + \pi' - T')/1+r$$

Consumer Problem

- Choose c, c', l and l'
- Given w, w', r, T and T'
- Cannot depict this on a single graph,
- Solution: describe consumer decision in terms of THREE marginal conditions (Chapter 4 and 8)

Three Marginal (Optimal) Decisions

- Work-leisure decision (CHAPTER 4):

$$MRS_{l,c} = w$$

Substitution between l and c is determined by w

Remember: Income/Substitution effects of a change in w

- Same in the future:

$$MRS_{l,c'} = w'$$

- Consumption-Savings decision (CHAPTER 8):

$$MRS_{c,c'} = 1 + r$$

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NOTE

w

price of current leisure (labor) in terms of current c

w'

price of future leisure in terms of future c'

$1+r$

price of current consumption in terms of future consumption

$w(1+r)/w'$

current price of leisure relative to the future price of leisure

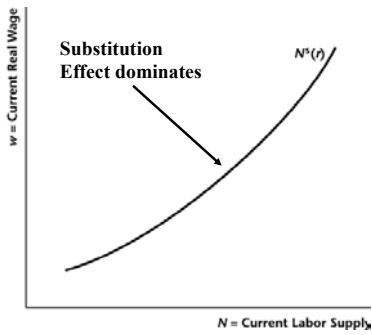
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CONSUMER The Labor Supply

Figure 9-1 The Representative Consumer's Current Labor Supply Curve

Why?
We care for the Short-Run. In the Long-Run, both effects cancel out



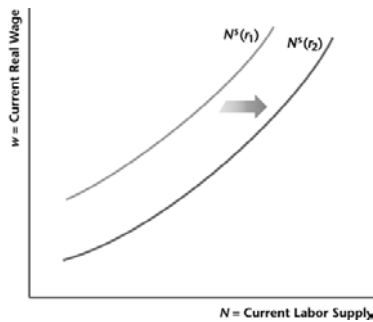
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Figure 9-2 An Increase in the Real Interest Rate Shifts the Current Labor Supply Curve to the Right

$\uparrow r \rightarrow \uparrow$ price of current leisure relative to future leisure

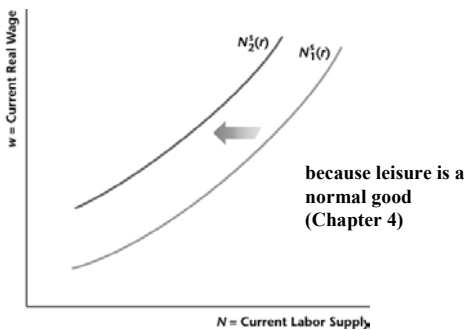
Intertemporal Substitution of leisure



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Figure 9-3 Effects of an Increase in Lifetime Wealth



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CONSUMER The Demand for Goods

Remember the FOUR games in chapter 8.

Figure 9-4 The Representative Consumer's Current Demand for Consumption Goods Increases with Income

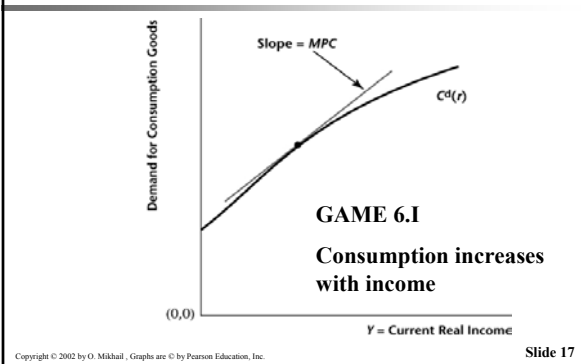
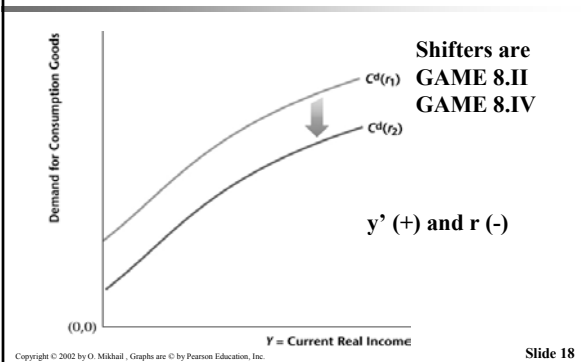


Figure 9-5 An Increase in the Real Interest Rate from r_1 to r_2 Shifts the Demand for Consumption Goods Down



**THE FIRM
THE DEMAND FOR LABOR
THE INVESTMENT DECISION**

**THE FIRM
The Labor DEMAND**

Figure 9-7 The Demand Curve for Current Labor Is the Representative Firm's Marginal Product of Labor Schedule

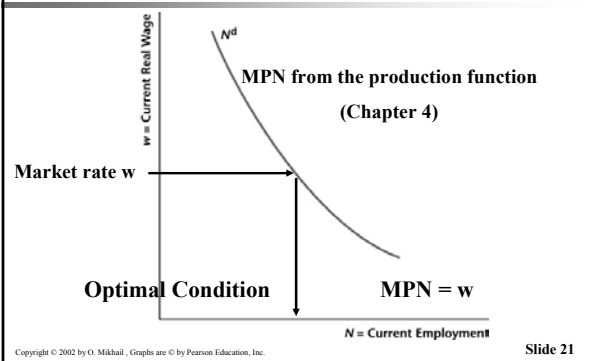
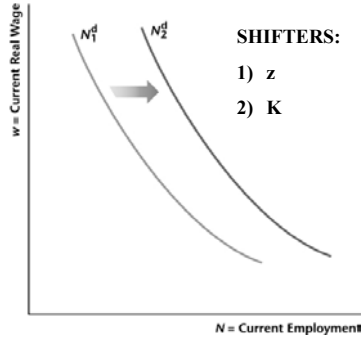


Figure 9-8 The Current Demand Curve for Labor Shifts Due to Changes in Current Total Factor Productivity z and in the Current Capital Stock K



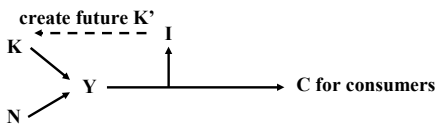
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THE FIRM The Investment Decision

The Firm Production and Investment

- Production Function $Y = z F(K,N)$
- Gross Investment $I = K' - K + d K$
- Net Investment $I^N = K' - K$
- Note that $K' = (1 - d) K + I$



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The Firm's Decision

- Maximize the Present Value of π by choosing N , N' and I .
- i.e., $\max V = \max [\pi + \pi'/1+r]$
- Note that
 - $\pi = Y - wN - I$
 - $\pi' = Y' - w'N' + (1 - d) K'$

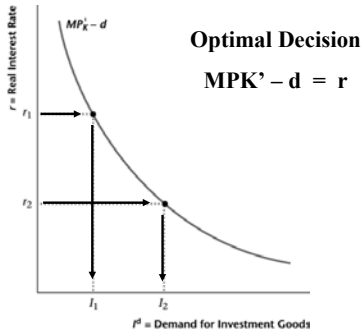
The Investment Decision

- Marginal Cost = Marginal Benefit
- Marginal Cost = 1, an extra unit of Investment, reduces current profits by 1 unit, which reduces PV(profits) by 1.
- Marginal Benefit = $(MPK' + 1 - d) / 1 + r$ where MPK is the extra output from the extra unit of K and $(1 - d)$ is the left over K , all are discounted to the present.

Continue

Solve it
 $MC = MB \rightarrow$
OPTIMAL INVESTMENT RULE
 $MPK' - d = r$
Net Marginal Product K = real interest rate

Figure 9-9 Optimal Investment Schedule for the Representative Firm



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Remember

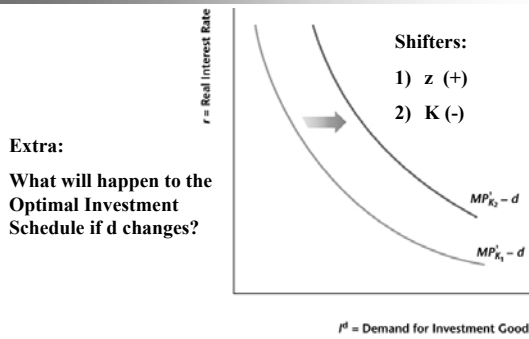
For Labor Demand → relevant price is w
Condition: $MPN = w$

For Investment Demand → relevant price is r
Condition: $MPK^d - d = r$

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Figure 9-10 The Optimal Investment Schedule Shifts to the Right if Current Capital Decreases or Future Total Factor Productivity Is Expected to Increase



Extra:
What will happen to the Optimal Investment Schedule if d changes?

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GOVERNMENT

Government

Finances purchases through taxation and issuing bonds.

The Present Value Budget

$$G + G'/1+r = T + T'/1+r$$

Competitive Equilibrium

BUILD THE MODEL

- The goods Market
- The labor Market

THE GOODS MARKET
CONSTRUCT
THE OUTPUT SUPPLY CURVE

Figure 9-11 Determination of Equilibrium in the Labor Market Given the Real Interest Rate r

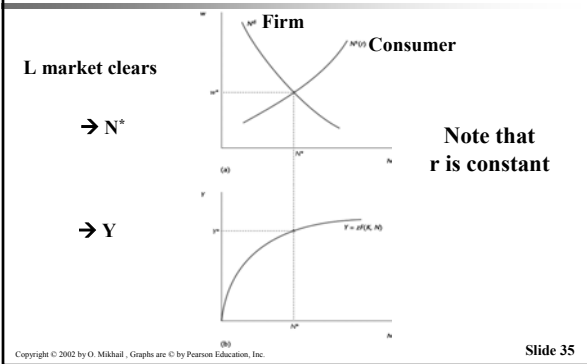
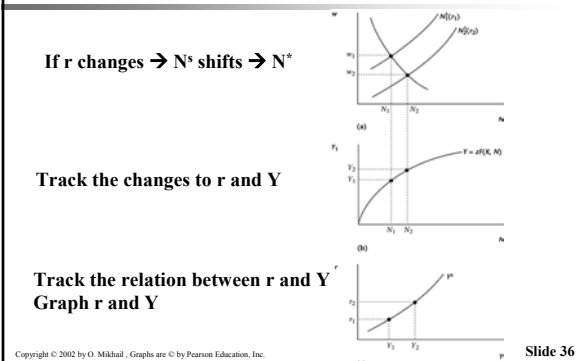


Figure 9-12
Construction of the Output Supply Curve



Shifts in the Output Supply

- Changes in Labor Supply \leftarrow Lifetime Wealth \leftarrow changes in G or G'
- Changes in Labor Demand \leftarrow z or K (Slide 24)
- Changes in the Production Function \leftarrow z or K

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Figure 9-14 An Increase in Total Factor Productivity Shifts the Y^S Curve

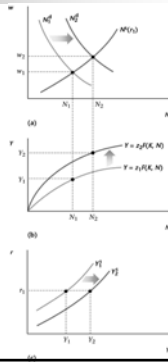
$\uparrow z$ or $\uparrow K \rightarrow \uparrow MPN \rightarrow$

\uparrow Labor Demand

$\uparrow N \rightarrow \uparrow Y$

[On NEW Production Function]

\uparrow Supply of Output for the same r



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THE GOODS MARKET

CONSTRUCT
THE OUTPUT DEMAND CURVE

Total current Aggregate Income Y

$$Y = C^d(r) + I^d(r) + G$$

- C^d depends on r , Y (moving on) and Y' (Chapter 7, Slide 17, 18)
- I^d depends on r (moving on), z and K (Chapter 7, Slide 28 and 30)

Figure 9-15 The Demand for Current Goods

Just added
C to I and G

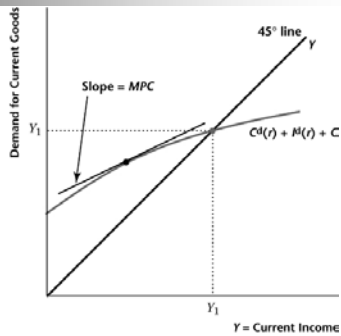
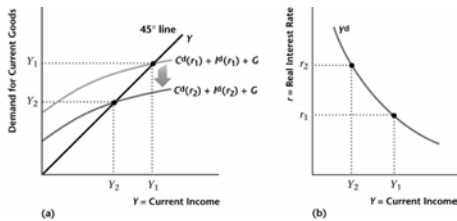


Figure 9-16 Construction of the Output Demand Curve



$\uparrow r \rightarrow \downarrow C$ (also $\downarrow I$) $\rightarrow \downarrow Y$

Track r and Y

Shifts of the Demand for Output

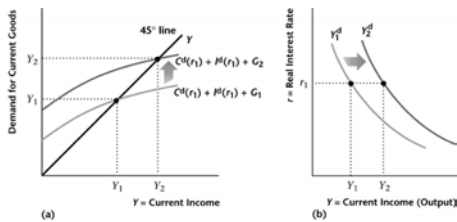
- Changes in Consumption (C)
- Changes in Investment (I)
- Changes in Government (G)

- Note that anything (other than r) that will shift C^d , I^d or G will also shift the Y^d (see Slide 42)

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Figure 9-17 The Output Demand Curve Shifts to the Right if Current Government Spending Increases



$\uparrow G \rightarrow \downarrow \text{Wealth which } \downarrow C$
 by MPC $\rightarrow \uparrow \Delta G \searrow \Delta C$
 $\rightarrow \uparrow Y$ (b/c $Y = C + I + G$)

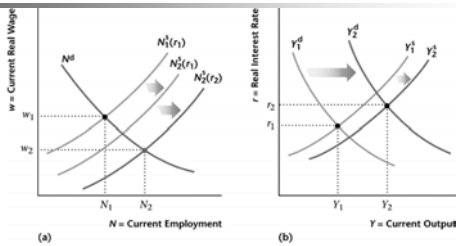
Will $\uparrow Y$ for the same r

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THE COMPLETE MODEL

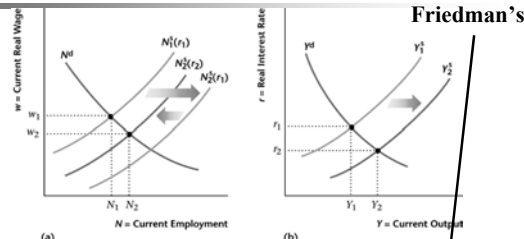
Figure 9-19 A Temporary Increase in Government Purchases



$\uparrow G \rightarrow \uparrow$ Labor Supply and \uparrow Output Demand SLIDE 39 \uparrow
 $G \rightarrow \downarrow C$ by MPC, therefore \uparrow Output Demand SLIDE 46
 so that $\uparrow r$ which \uparrow Labor Supply (Secondary Output Supply)
 End-Result: $\downarrow w$ $\uparrow N$ $\uparrow r$ $\uparrow Y$ ← IS IT A GOOD MODEL?

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Figure 9-20 A Permanent Increase in Government Purchases



$\uparrow G \rightarrow \uparrow$ Labor Supply and \uparrow Output Supply SLIDE 39
 $\uparrow G$ and $\uparrow G' \rightarrow \downarrow C$ by MPC = 1, therefore NO CHANGE to Y^d
 so that $\downarrow r$ which \downarrow Labor Supply
 End-Result: $\downarrow w$ $\uparrow N$ $\downarrow r$ $\uparrow Y$ ← IS IT A GOOD MODEL?

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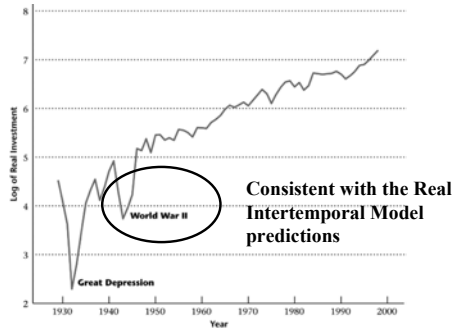
Permanent vs. Temporary Government shock

- Temporary: change in G
 → **CROWDING-OUT** C and I

- Permanent: change in G and G'
 → **NO CROWDING-OUT** I
 → **stronger crowding-out** C
 (because strong wealth effect)

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Figure 9-21 Natural Log of Real Investment, 1929-1998



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Real Interest Rate

Model

→ r increases when G increases which crowds-out Investment.

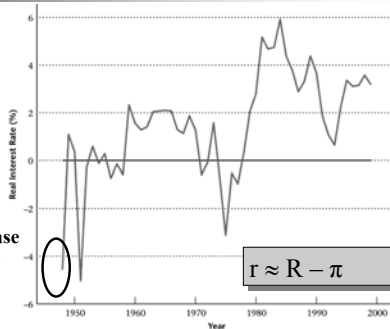
Data

- Investment decreased during WWII
- Did the r increase during WWII ?

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Real Interest Rate



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Explanation

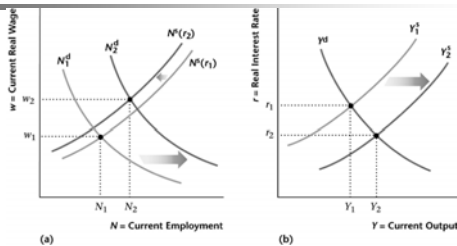
So why did Investment decrease when the real interest rate decreased during WWII ?

The effects of a Decrease in K

A natural disaster

Cross-country comparison

Figure 9-23 The Equilibrium Effects of an Increase in Current Total Factor Productivity



$\uparrow z \rightarrow \uparrow$ Labor Demand (MPN) and \uparrow Output Supply
 so that $\downarrow r$ which \downarrow Labor Supply (small)
 End-Result: $\uparrow w \uparrow N \downarrow r \uparrow Y \uparrow C \uparrow$

Real Business Cycle Theory

Temporary shocks to z are a candidate as a cause of business cycles

Increases in the relative price of energy
(decreases in total factor productivity)
