

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.

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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.

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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.

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Determinants of **high Investment**

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



KEY:
opportunity cost
of Investment

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STUDY

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

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MODEL

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

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Consumer Budget

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

- **LIFETIME**

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

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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)

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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

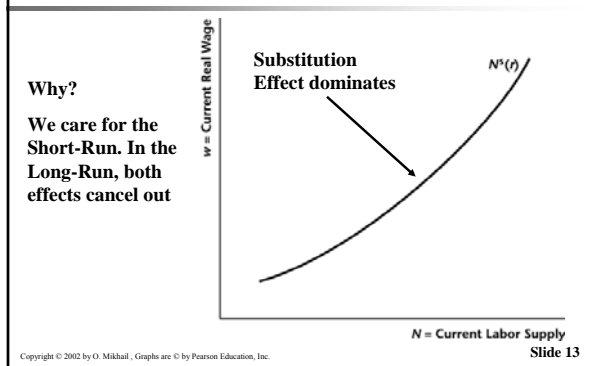


Figure 9-2 An Increase in the Real Interest Rate Shifts the Current Labor Supply Curve to the Right

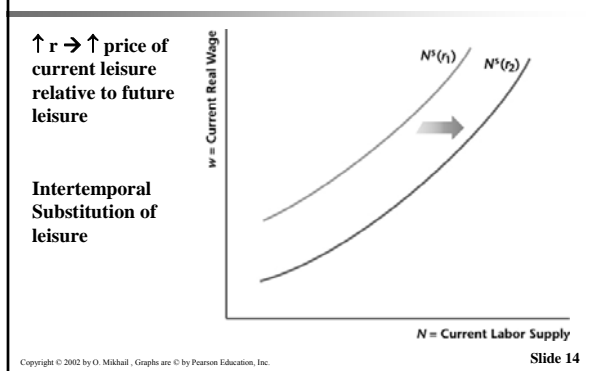
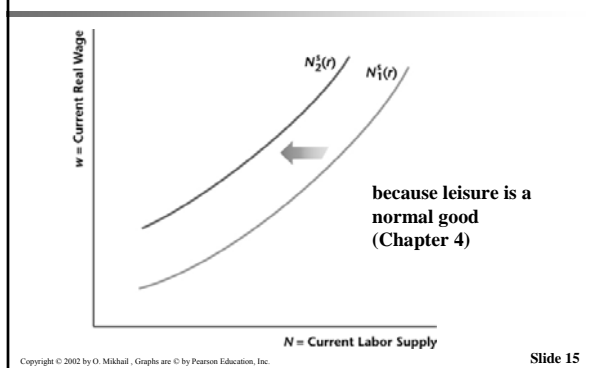


Figure 9-3 Effects of an Increase in Lifetime Wealth



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

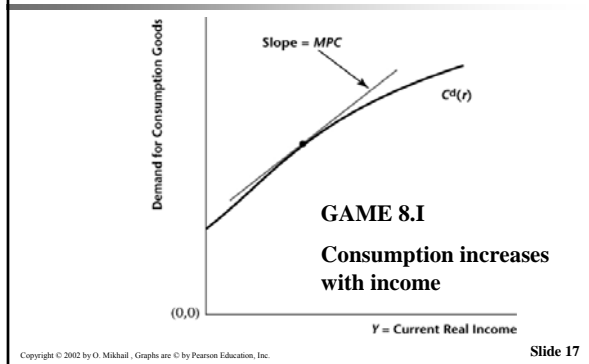
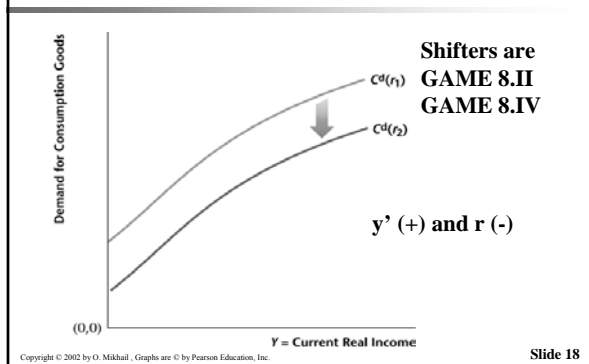


Figure 9-5 An Increase in the Real Interest Rate from r_1 to r_2 Shifts the Demand for Consumption Goods Down



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

**THE FIRM
The Labor DEMAND**

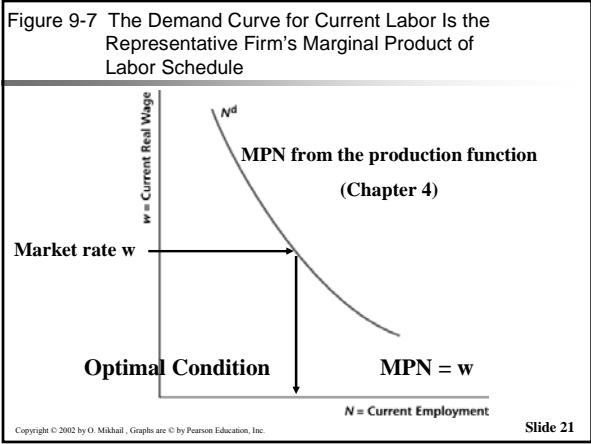
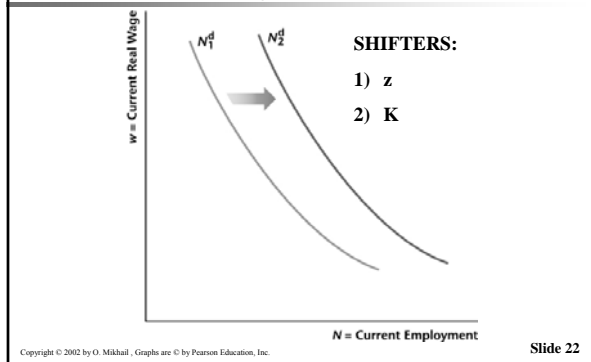


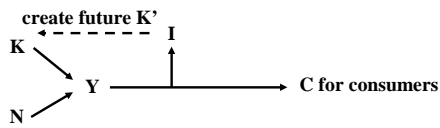
Figure 9-8 The Current Demand Curve for Labor Shifts Due to Changes in Current Total Factor Productivity z and in the Current Capital Stock K



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
 - $\pi = Y - wN - I$
 - $\pi' = Y' - w'N' + (1-d)K'$

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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.

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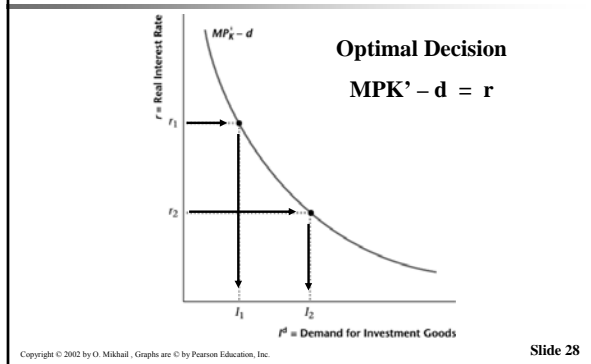
Continue

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

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Figure 9-9 Optimal Investment Schedule for the Representative Firm



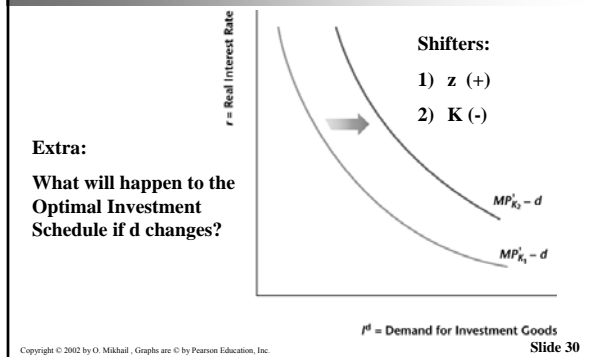
Remember

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



GOVERNMENT

Government

Finances purchases through taxation and issuing bonds.

The Present Value Budget

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

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Competitive Equilibrium

BUILD THE MODEL

- The goods Market
- The labor Market

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THE GOODS MARKET

CONSTRUCT

THE OUTPUT SUPPLY CURVE

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

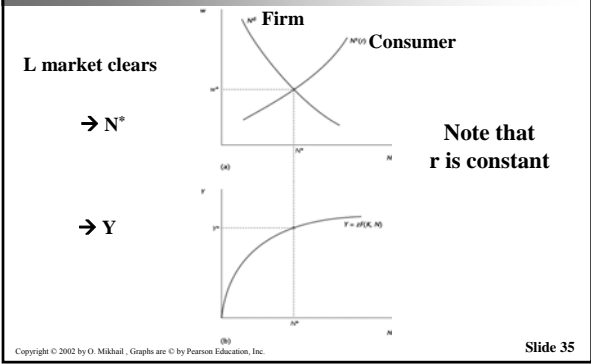
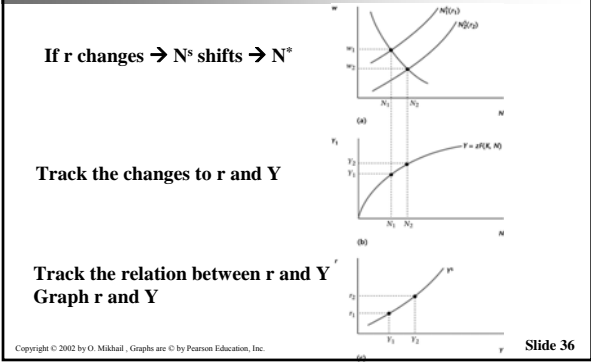


Figure 9-12 Construction of the Output Supply Curve



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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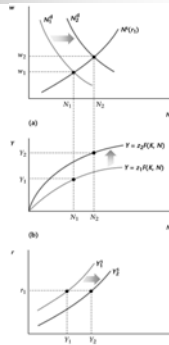
Slide 37

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

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

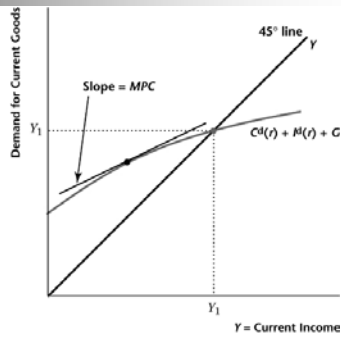
- C^d depends on r , Y (moving on) and Y' (Chapter 9, Slide 17, 18)
- I^d depends on r (moving on), z and K (Chapter 9, Slide 28 and 30)

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Figure 9-15 The Demand for Current Goods

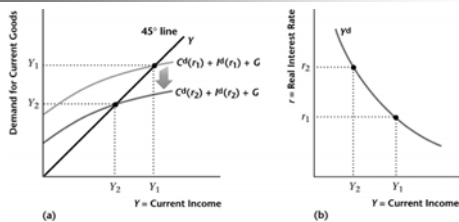
Just added
 C to I and G



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Figure 9-16 Construction of the Output Demand Curve



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

Track r and Y

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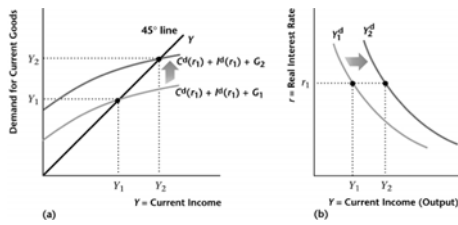
Shifts of the Demand for Output

- 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 $Y = C + I + G$)

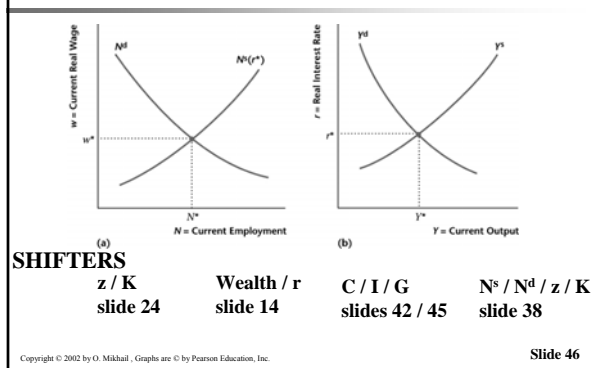
Will $\uparrow Y$ for the same r

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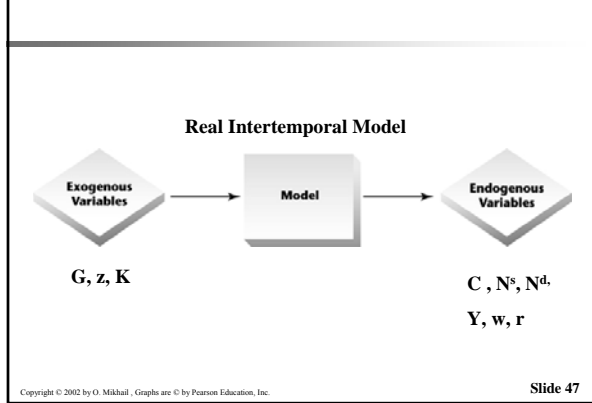
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THE COMPLETE MODEL

Figure 9-18 The Complete Real Intertemporal Model



THE ONLY GAME



Key Messages of the Chapter

- Permanent vs. Temporary shock
 - Temporary: change in G
 - Permanent: change in G and G'

- Expected in the future shock

Figure 9-19 A Temporary Increase in Government Purchases

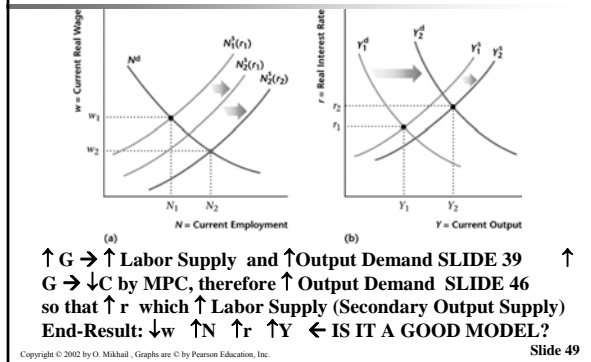
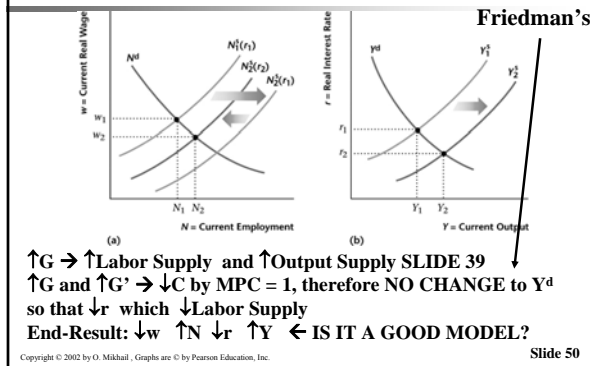


Figure 9-20 A Permanent Increase in Government Purchases

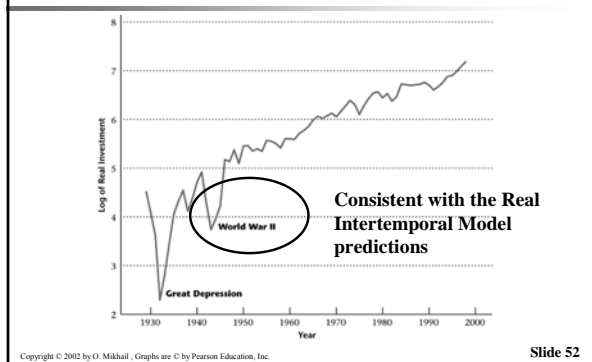


Permanent vs. Temporary Government shock

- 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)

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



Real Interest Rate

Model

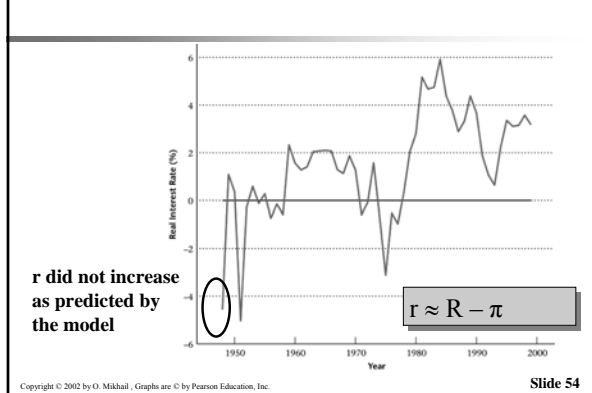
→ r increases when G increases which crowds-out Investment.

Data

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

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Real Interest Rate



Explanation

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

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The effects of a Decrease in K

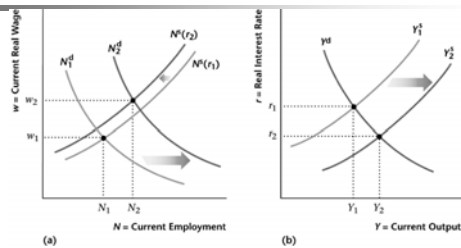
A natural disaster

Cross-country comparison

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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: $\uparrow w \uparrow N \downarrow r \uparrow Y \uparrow C \uparrow I$

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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)

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