



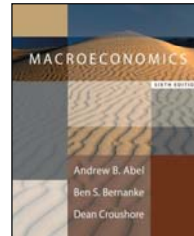
## Business Cycles

### Econ 402

Professor Yamin Ahmad

#### Lecture 7: Introduction to Real Business Cycle Theory

- Overview
- Robinson-Crusoe
- Debate over RBC theory
- How Theories fit the Facts



## Key Points

- An overview of Real Business Cycle theory
- Understanding RBC:
  - Robinson Crusoe's world
- The Debate over RBC Theory:
  - Proponents Views
  - Critics Views
- How well does RBC models fit the stylized observations?

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## Real Business Cycles

- Traditional Business Cycle Theories assume  $\bar{Y}$  (trend) evolves smoothly over time (e.g.  $\bar{Y} = a + bt$ ) and seek to explain  $Y_t - \bar{Y}_t$  (cycles or deviations from trend).
- RBC theory notes that assuming  $\bar{Y}_t = b + \bar{Y}_{t-1} + u_t$  also fits the facts and that much of the movements in  $Y_t$  is then attributable to movements in  $\bar{Y}_t$  rather than  $Y_t - \bar{Y}_t$ .

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## Real Business Cycles

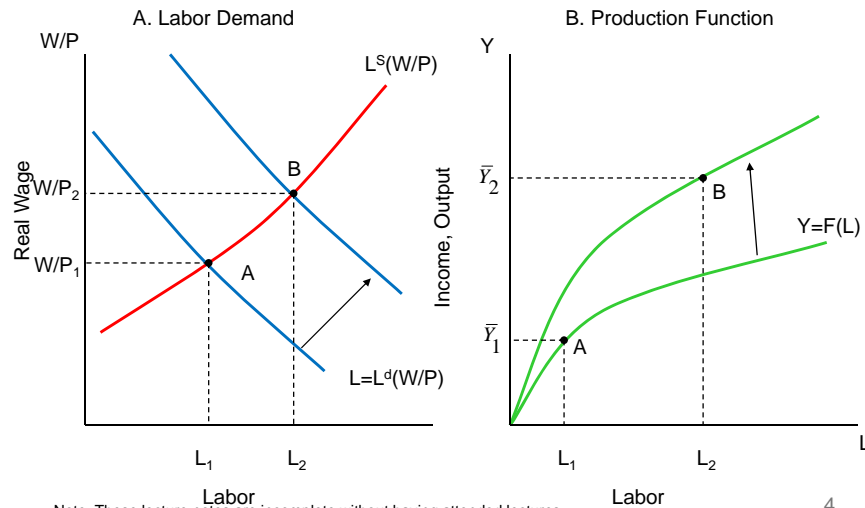
- RBC theory locates the main source of fluctuation in the erratic nature of technological progress
- Suppose  $Y = ZK^\alpha L^{1-\alpha}$ ;  
Profit Maximization  $\Rightarrow$
- So technological progress shifts  $L^d$  and AS schedules.
- Variations in employment and activity are seen as the efficient response of a competitive economy to such shocks.

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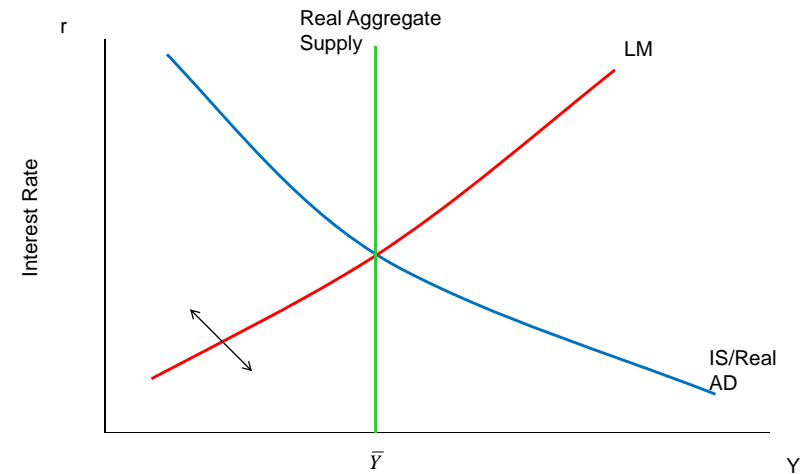
## Positive Technology Shock



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## IS/LM with Flexible Prices



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## The Theory of Real Business Cycles

- All prices are flexible, even in short run:
  - thus, money is neutral, even in short run.
  - classical dichotomy holds at all times.
- Fluctuations in output, employment, and other variables are the optimal responses to exogenous changes in the economic environment.
- Productivity shocks are the primary cause of economic fluctuations.

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## The economics of Robinson Crusoe

- Economy consists of a single producer-consumer, like Robinson Crusoe on a desert island.
- Crusoe divides his time between
  - leisure
  - working
    - catching fish (production/consumption)
    - making fishing nets (investment)
- Crusoe optimizes given the constraints he faces.

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## Shocks in the Crusoe island economy

- Suppose that a big school of fish swims by the island.
- GDP rises because:
  - Crusoe's fishing productivity is higher – more fish per hour
  - Crusoe's employment rises:  
He decides to shift some time from leisure to fishing to take advantage of the high productivity

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## Shocks in the Crusoe island economy

- Suppose that a big storm hits the island.
- GDP falls:
  - The storm reduces productivity, so Crusoe spends less time fishing for consumption.
  - Investment falls, because it's easy to postpone making nets until storm passes.
  - Employment falls: Since he's not spending as much time fishing or making nets, Crusoe decides to enjoy more leisure time.

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## Economic fluctuations as optimal responses to shocks

- In Real Business Cycle theory, fluctuations in our economy are similar to those in Crusoe's economy.

The shocks are not always desirable.  
 But once they occur, fluctuations in  
 output, employment, and other  
 variables are the optimal  
 responses to them.

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## The debate over RBC theory

...boils down to four issues:

1. Do changes in employment reflect voluntary changes in labor supply?
2. Does the economy experience large, exogenous productivity shocks in the short run?
3. Is money really neutral in the short run?
4. Are wages and prices flexible in the short run? Do they adjust quickly to keep supply and demand in balance in all markets?

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# 1. The Labor market

## Key Concept: Intertemporal substitution of labor

- In RBC theory, workers are willing to reallocate labor over time in response to changes in the reward to working now versus later.
- Note: This means that they change the amount of hours they work, i.e. work more hours or fewer hours, based on the impact of shocks hitting the economy.



# Intertemporal Labor Substitution

- Let  $W_1$ =current (nominal) wage;  $W_2$ =future wage;
- Relative price of leisure today =  $W_1(1+i)/W_2$ .
- Theory suggests  $L^s = L^s[W_1/P_1, W_2/P_2(1+r)]$   
 (+)                      (-)
- Temporary** change in  $W/P$  has strong effect;
- Permanent** change in  $W/P$  has weak effect.

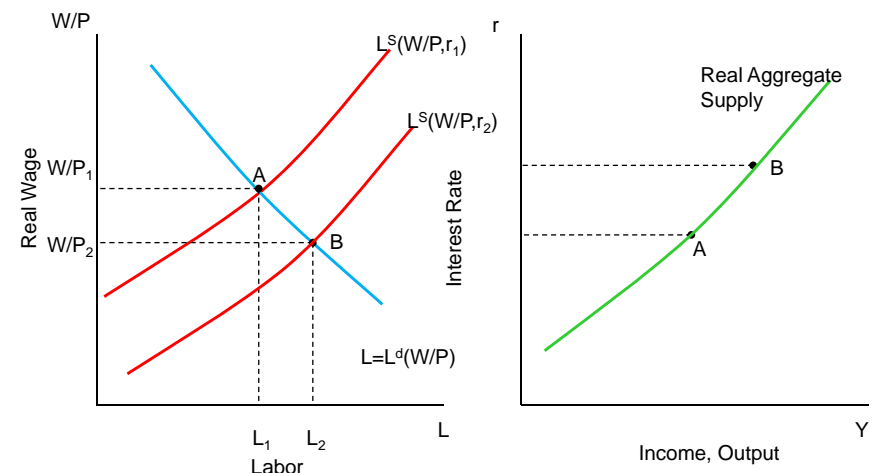


# Intertemporal Labor Substitution

- In RBC theory:
  - shocks cause fluctuations in the intertemporal relative wage
  - workers respond by adjusting labor supply
  - this causes employment and output to fluctuate

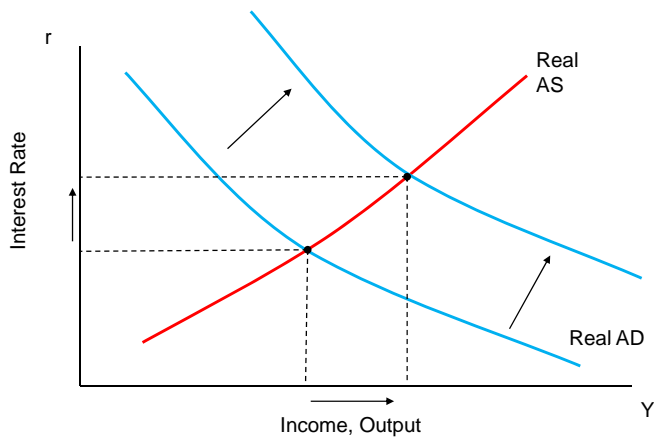


# Intertemporal Labor Substitution





## Demand Shock



Intuition:

- Increase in demand raises  $r$
- Higher  $r$  lowers the PDV of real wages tomorrow
- Hence Labor Supply today increases
- Movement along the Real AS curve!

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## The Labor Market: Problems

- Evidence suggests long-run labor supply is independent of real wage:
  - Problem for market clearing theories (Neoclassical and Real Business Cycle).
- Critics argue that
  - labor supply is not very sensitive to the intertemporal real wage
  - high unemployment observed in recessions is mainly involuntary

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## 2. Technology shocks

- Recall: In RBC theory, economic fluctuations are caused by productivity shocks.

### Impact of a Technology Shock:

- Suppose you have a positive productivity shock (i.e.  $Z$  increases in  $Y = ZK^\alpha L^{1-\alpha}$ )
- A productivity shock changes both the MPL and the MPK
  - $MPK =$
  - $MPL =$

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## Profit Maximization

- Using our Cobb-Douglas Production function, profit maximization implies:

$$\max_{K,L} \Pi = ZK^\alpha L^{1-\alpha} - \frac{W}{P}L - \frac{R}{P}K - \delta K$$

- First order conditions are:
  - $MPL = W/P$ , i.e.
  - $MPK = R/P + \text{Rate of Depreciation}$ , i.e.

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## Effect of Technology Shocks

- A change in the MPL affects the real wage,  $W/P$ 
  - Hence it affects both the  $L^d$  and  $L^s$  schedules
- A change in the MPK affects the real rental rate of capital,  $R/P$ ,
  - Hence it affects Investment
- So a technology shock shifts  $L^d$ ,  $L^s$ , i.e. Real AS as well as the Real AD

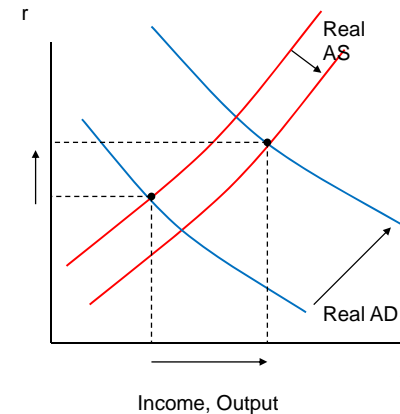
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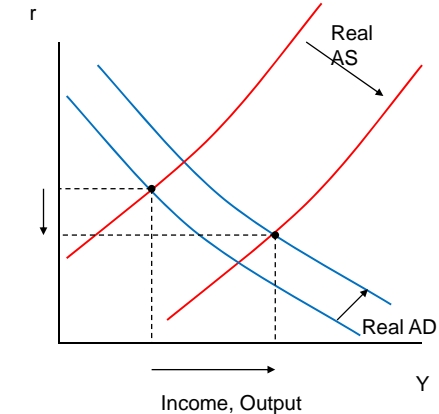
## Technology Shock

A. Real Aggregate Demand Shifts More Than Real Aggregate Supply



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B. Real Aggregate Supply Shifts More Than Real Aggregate Demand



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## Solow Residual/TFP

- Consider the Production Function:  $Y=ZK^\alpha L^{1-\alpha}$ . Then:

$$\frac{\Delta Y}{Y} = \frac{\Delta Z}{Z} + \alpha \frac{\Delta K}{K} + (1-\alpha) \frac{\Delta L}{L}$$

$$\Rightarrow \frac{\Delta Z}{Z} = \frac{\Delta Y}{Y} - \alpha \frac{\Delta K}{K} - (1-\alpha) \frac{\Delta L}{L}$$

where  $\alpha$  is the share of capital income in output.

- **Solow residual  $\Delta Z/Z$ :** a measure of productivity shocks, shows the change in output that cannot be explained by changes in capital and labor.

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## TFP and Output

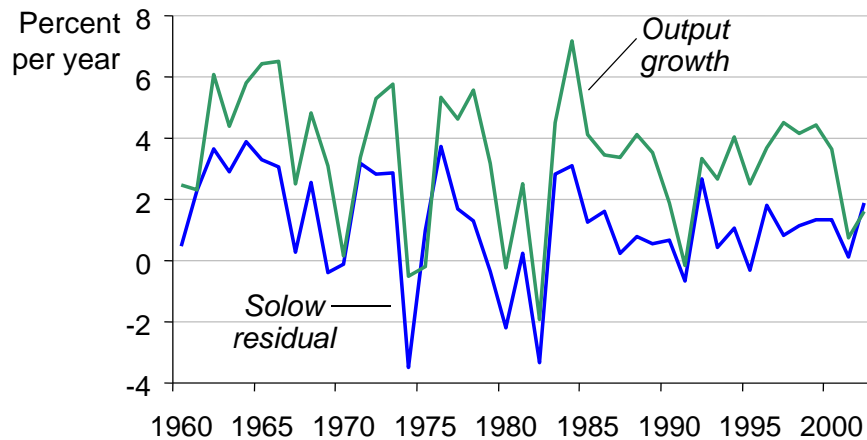
$$\frac{\Delta Z}{Z} = \frac{\Delta Y}{Y} - \alpha \frac{\Delta K}{K} - (1-\alpha) \frac{\Delta L}{L}$$

- Looking at the equation above, RBC theory implies that the Solow residual should be highly correlated with output.
- Is it in the data?

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## Correlation of Output and the Solow Residual



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## Technology shocks: Proponents

### Proponent's View:

- Proponents of RBC theory argue that the strong correlation between output growth and Solow residuals is evidence that productivity shocks are an important source of economic fluctuations.
- Thus economic fluctuations are caused by productivity shocks:
  - Expansions arise because of increases in productivity!
  - ... What does that mean about recessions?

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## Technology shocks: Critics

### Critic's View:

- Implies recessions are periods of technical regress!
- Less implausible if supply shock considered more broadly (OPEC, strikes etc.)
- In essence, critics note that the measured Solow residual is biased to appear more cyclical than the true, underlying technology.
  - Why? – Due to Labor Hoarding

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## Labor Hoarding

- In a recession, firms cut back on their output.
- Due to costs of firing workers (such as lower morale among the remaining workers) and the costs of hiring workers back when the recession ends, firms “hoard labor” rather than let go of it.
- They give unneeded workers tasks such as organizing the file cabinets, or let workers take more coffee breaks.
  - Hence in recessions average productivity of workers declines

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## Labor Hoarding

- In booms, firms don't hire as many new workers as theory might suggest, instead making their existing workers work harder.
  - Hence average productivity increases in expansions.
- As a result,
  - observed employment appears less cyclical than firms' true use of labor in production, and ...
  - the Solow residual then appears to move more closely with output.



## 3. The neutrality of money

- RBC critics note that reductions in money growth and inflation are almost always associated with periods of high unemployment and low output.
- RBC proponents respond by claiming that the money supply is endogenous:
  - Suppose output is expected to fall.
  - Central bank reduces money supply in response to an expected fall in money demand.



## 4. Wage and price flexibility

- RBC theory assumes that wages and prices are completely flexible, so markets always clear.

### Proponents:

- RBC proponents argue that the degree of price stickiness occurring in the real world is not important for understanding economic fluctuations.
- RBC proponents also assume flexible prices to be consistent with microeconomic theory.



## 4. Wage and price flexibility

### Critics:

- Critics believe that wage and price stickiness explains involuntary unemployment and the non-neutrality of money.

## Summary of the Criticisms of RBC Theory

- Empirical significance of intertemporal labor substitution mechanism is doubtful.
- Implies recessions are periods of technical regress!
- Money is neutral so does not explain positive correlation between prices and output;
  - this can be rectified by endogenizing the money supply.
- Wage and price rigidity can help to explain involuntary unemployment and non-neutrality of money

## Theories and Facts

### 1. Serial persistence of fluctuations

- Keynesian models: sluggish adjustment of wages and prices.
- Market Clearing models: need intrinsic persistence mechanisms.

### 2. Co-movement across industries

- Not a problem for any theory although RBC models must assume technological shocks are correlated across industries

## Theories and Facts

### 3. Behavior of Consumption and Investment

- Not a problem for any theory; “permanent income” hypothesis explains low cyclical of consumption.

### 4. Procyclical Behavior of Productivity

- Keynesian and Neoclassical models predict countercyclical productivity; need to add labor hoarding.
- RBC theory predicts procyclical productivity.

## Theories and Facts

### 5. Co-movement of Prices and Output

- Keynesian models: Sluggish adjustment.
- Neoclassical models: imperfect information.
- RBC theory: endogenous monetary growth.

### 6. Mild procyclical of real wages

- Keynesian and Neoclassical models: countercyclical real wages.
- RBC theory: procyclical real wages.



## Theories and Facts

### 7. Procyclicality of Interest Rates

- Problem for Neoclassical and LM-driven Keynesian models.
- Consistent with IS-driven Keynesian models and RBC theory.

### 8. Procyclicality of Velocity and Money

- Behavior of velocity consistent with “permanent income” approach to money demand.
- Behavior of money consistent with monetary-driven models of cycle, and with endogenous money RBC theories.



## Further Reading

- Plosser, Charles (1989), “Understanding Real Business Cycles”, *Journal of Economic Perspectives*, 3(3), pp. 51 – 77.
- Mankiw, N. Gregory (1989), “Real Business Cycles: A New Keynesian Perspective”, *Journal of Economic Perspectives*, 3(3), pp. 79 – 90
- [Chatterjee, S. \(1999\) "Real Business Cycles: A Legacy of Countercyclical Policies"](#)