National Income & Business Cycles

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3. National Income: Where it Comes From and Where it Goes

Objectives

- what determines the economy’s total output/income
- how the prices of the factors of production are determined
- how total income is distributed
- what determines the demand for goods and services
- how equilibrium in the goods market is achieved

Key Concepts

- Factors of production
- Production technology
- Constant returns to scale
- Factor prices
- MPL and MPK
- Cobb-Douglas production function
- Marginal propensity to consume
- Neoclassical theory of distribution
- Crowding out
- Loanable funds
- Saving

Outline of model

A simple microeconomic view of
Production = Income = Spending

- Supply side
  - factor markets (supply, demand, price)
  - determination of output/income
- Demand side
  - determinants of $C$, $I$, and $G$
- Equilibrium
  - goods market
  - loanable funds market
What determines production of goods and services

- quantity of inputs \(\rightarrow\) factors of production
  - \(K\) = capital, tools, machines, and structures used in production
  - \(L\) = labor, the physical and mental efforts of workers

- technology \(\rightarrow\) production function
  - denoted \(Y = F(K, L)\)
  - shows how much output \((Y)\) the economy can produce from \(K\) units of capital and \(L\) units of labor.
  - reflects the economy's level of technology.

Assumptions of the model

1. The economy's supplies of capital and labor are fixed at
   \[ K = \overline{K} \quad \text{and} \quad L = \overline{L} \]

2. Factors are fully utilized

3. Constant returns to scale in production

The distribution of national income

- determined by \______________, the prices per unit that firms pay for the factors of production.
  - the ________ is the price of \(L\)
  - the ________ is the price of \(K\).

Determining GDP

The above assumptions imply a fixed supply of goods and services. Output is determined by the fixed factor supplies and the fixed state of technology.

\[ \overline{Y} = F(\overline{K}, \overline{L}) \]

Output changes when
- factor supplies change \((K, L)\)
- technology changes \(F(\ast)\)
  (ex. from \(Y=2KL\) to \(Y=3KL\))
**Notation**

\[
\begin{align*}
W &= \text{nominal wage} \\
R &= \text{nominal rental rate} \\
P &= \text{price of output} \\
\frac{W}{P} &= w = \text{real wage} \\
&\quad \text{(measured in units of output)} \\
\frac{R}{P} &= r = \text{real rental rate}
\end{align*}
\]

Factor prices are determined by supply and demand in factor markets.

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**Firm’s problem**

- Maximize profits
- Profit =

Firms
- \(\ldots\) goods and services (\(Y\))
- \(\ldots\) labor and capital (demand for factors of production)

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**Demand for labor**

- Assume markets are competitive: each firm takes \(W, R,\) and \(P\) as given.

- Basic idea:
  A firm hires each unit of labor if the cost does not exceed the benefit.
  
  condition:
  - marginal cost = \(\ldots\)
  - marginal benefit = \(\ldots\)
  - the extra output the firm can produce using an additional unit of labor (holding other inputs fixed)

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**The MPL and the production function**

\[ F(K, L) \]
**MPL and the demand for labor**

Each firm hires labor up to the point where

\[ MPL, \text{ Labor demand} \]

Units of output

Units of labor, \( L \)

**The equilibrium real wage**

The real wage adjusts to equate labor demand with supply.

**Demand for capital**

We have just seen that \( MPL = \)

The same logic shows that \( MPK = \)

- diminishing returns to capital: \( MPK \downarrow \text{ as } K \uparrow \)
- The \( MPK \) curve is the firm's demand curve for renting capital.
- Firms maximize profits by choosing \( K \) such that ____________.
Result

2 conditions:
   i. $MPL = $
   ii. $MPK = $

The Neoclassical Theory of Distribution

Example

Suppose there is a “shock” to a factor such as the Bubonic plague or AIDS.

A large decrease in $L$ (plague/AIDS) implies:
   - increase/decrease in $MPL$?
   - increase/decrease in $W/P$?

How income is distributed:

- ____ units of labor $\rightarrow$ each paid ____
- ____ units of capital $\rightarrow$ each paid ____

total labor income =

then

$$\bar{Y} = MPL \times \bar{L} + MPK \times \bar{K}$$

The ratio of labor income to total income in the U.S., 1960-2007

Labor’s share of income is approximately constant over time. (Thus, capital’s share is, too.)
The Cobb-Douglas Production Function

- The Cobb-Douglas production function has constant factor shares:
  \[ \alpha = \text{capital's share of total income:} \]
  \[ \text{capital income} = MPK \times K = \alpha Y \]
  \[ \text{labor income} = MPL \times L = (1 - \alpha) Y \]
- The Cobb-Douglas production function is:
  \[ Y = AK^\alpha L^{1-\alpha} \]
  where \( A \) represents the level of technology.
- In the US, \( \alpha = \)

Labor productivity and wages

- Theory: wages depend on labor productivity
- U.S. data:

<table>
<thead>
<tr>
<th>period</th>
<th>productivity growth</th>
<th>real wage growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1959-2007</td>
<td>2.1%</td>
<td>2.0%</td>
</tr>
<tr>
<td>1959-1973</td>
<td>2.8%</td>
<td>2.8%</td>
</tr>
<tr>
<td>1973-1995</td>
<td>1.4%</td>
<td>1.2%</td>
</tr>
<tr>
<td>1995-2007</td>
<td>2.5%</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

EXERCISE: Cobb-Douglas Production Function

- Assume that the production function is given by \( Y = AK^{0.5}L^{0.5} \), where \( Y \) is GDP, \( K \) is capital stock, and \( L \) is labor. Assume that the productivity parameter \( A \) is equal to 2, capital is 25, and labor is 36.
- A. What is the value of \( Y \)?
- B. What is the share of total income going to labor?
- C. What is the real rental price of capital?
Outline of model

A closed economy, market-clearing model

Supply side

DONE ✓ factor markets (supply, demand, price)
DONE ✓ determination of output/income

Demand side

Next ⇒ □ determinants of C, I, and G

Equilibrium

□ goods market
□ loanable funds market

Demand for goods & services (spending)

Components of aggregate demand:

\[ C = \text{consumer demand for g & s} \]
\[ I = \text{demand for investment goods} \]
\[ G = \text{government demand for g & s} \]

(closed economy: no \( NX \))

Consumption, \( C \)

- def: _______ income is total income minus total taxes: \( Y^d = Y - T \)
- Consumption function:
  \[ C = C(Y^d) = C(Y - T) \]
- Shows that \( (Y - T) \Rightarrow C \)
- def: The marginal _______ to consume is the increase in \( C \) caused by a $1 increase in disposable income.
The consumption function

\[ C = a + b Y^d \]

- \( a \) = intercept
- \( b \) =

Investment, \( I \)

- The investment function is \( I = I(r) \), where \( r \) denotes the _____ interest rate, the nominal interest rate corrected for inflation.
- The real interest rate is
  - the ____________ of using one's own funds to finance investment spending.
  - So, \( \uparrow r \Rightarrow I \)

The investment function

Spending on investment goods is ____________ sloping function of the real interest rate

Government spending, \( G \)

- \( G \) includes government spending on goods and services.
- \( G \) excludes ________ payments
- Assume government spending and total taxes are determined outside the model:

\[ G = \bar{G} \quad \text{and} \quad T = \bar{T} \]
The market for goods & services

- Agg. demand: \( C(\bar{Y} - \bar{T}) + I(r) + \bar{G} \)
- Agg. supply: \( \bar{Y} = F(K, L) \)
- Equilibrium: \( \bar{Y} = C(\bar{Y} - \bar{T}) + I(r) + \bar{G} \)

*A key equilibrating variable in the macro economy is the interest rate.*

Since \( K \) and \( L \) are fixed, and \( T \) and \( G \) are determined by government (fiscal) policy, \( r \) and \( I \) are the variables that will adjust to guarantee that \( S = D \rightarrow \)

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The loanable funds market

- A simple supply-demand model of the financial system.
- One asset: “loanable funds”
  - demand for funds:
  - supply of funds:
  - “price” of funds:

Demand for funds: Investment

The demand for loanable funds...

- comes from investment:
  Firms borrow to finance spending on plant & equipment, new office buildings, etc. Consumers borrow to buy new houses.
- depends negatively on \( r \),
  the “price” of loanable funds (cost of borrowing).

Loanable funds demand curve

The investment curve is also the demand curve for loanable funds.
Supply of funds: Saving

The supply of loanable funds comes from saving:

- **Households** use their saving to make bank deposits, purchase bonds and other assets. These funds become available to firms to borrow to finance investment spending.
- The **government** may also contribute to saving if it does not spend all of the tax revenue it receives.

**Notation:** $\Delta = \text{change in a variable}$

- For any variable $X$, $\Delta X = \text{“the change in } X \text{”}$
  - $\Delta$ is the Greek (uppercase) letter *Delta*
  - Example:
  
  Recall: $C = C_0 + MPC \times (Y - T)$ then,
  
  $\Delta C = \ldots$
  
  $\Delta C = \ldots$
  
  $\Delta C = \ldots$
  
  $\Delta C = \ldots$

Types of saving

private saving $= \ldots$

public saving $= \ldots$

national saving, $= \text{private saving + public saving}$

$= \ldots$

EXERCISE: Calculate the change in saving

Suppose $MPC = 0.8$ and $MPL = 20$.

For each of the following, compute $\Delta S$:

a. $\Delta G = 100$

b. $\Delta T = 100$

c. $\Delta Y = 100$

d. $\Delta L = 10$
**Answers**

ΔS

**Budget surpluses and deficits**

- When \( T > G \), budget _____ = ( _____ ) = public saving
- When \( T < G \), budget _____ = ( _____ ) and public saving is ________.
- When \( T = G \), budget is ________ and public saving = 0.
- How is budget deficit financed in the US?

**U.S. Federal Government Surplus/Deficit**

**U.S. Federal Government Debt**

**Fact:** In the early 1990s, about 18 cents of every tax dollar went to pay interest on the debt.

*(In 2007, it was about 10 cents)*
Loanable funds supply curve

National saving depend on \( r \), so the supply curve is _______.

\[ r \]
\[ S, I \]

Loanable funds market equilibrium

\[ \bar{r} = \bar{S} = \bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G} \]

Equilibrium real interest rate

Equilibrium level of investment

\[ r \]
\[ \bar{S}, \bar{I} \]

The special role of \( r \)

\( r \) adjusts to equilibrate the goods market and the loanable funds market simultaneously:

If L.F. market in equilibrium, then

\[ Y - C - G = I \]

Add \((C + G)\) to both sides to get

\[ Y = C + I + G \quad (goods \ market \ eq'm) \]

Thus, Eq’m in ___ market \[ \leftrightarrow \] Eq’m in ____ market

Policy Analysis I

Things that shift the saving curve

- public saving
  -
- private saving
  - tax laws that affect saving
    - 401(k)
    - IRA
    - replace income tax with consumption tax
CASE STUDY
The Reagan Deficits

- Reagan policies during early 1980s:
  - increases in defense spending:
  - big tax cuts:

- According to our model, both policies ________ national saving:

\[
\bar{S} = \bar{Y} - C(\bar{Y} - \bar{T}) - \bar{G}
\]

1. The Reagan deficits, cont.

1. The increase in the deficit ________ saving...

2. …which causes the real interest rate to ________...

3. …which ________ the level of investment.

Policy Analysis II

Things that shift the investment curve

- certain technological innovations
  - to take advantage of the innovation, firms must buy new investment goods
- tax laws that affect investment
  - investment tax credit

Are the data consistent with these results?

<table>
<thead>
<tr>
<th>variable</th>
<th>1970s</th>
<th>1980s</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T - G )</td>
<td>-2.2</td>
<td>-3.9</td>
</tr>
<tr>
<td>( S )</td>
<td>19.6</td>
<td>17.4</td>
</tr>
<tr>
<td>( r )</td>
<td>1.1</td>
<td>6.3</td>
</tr>
<tr>
<td>( I )</td>
<td>19.9</td>
<td>19.4</td>
</tr>
</tbody>
</table>

\( T-G, S, \) and \( I \) are expressed as a percent of GDP

All figures are averages over the decade shown.
An increase in investment demand

...the interest rate

But the equilibrium level of investment because the supply of loanable funds is _____.

An increase in investment demand _______ r, which induces an _______ in the quantity of saving, which allows I to _________.

Saving and the interest rate

- Why might saving depend on r?
- How would the results of an increase in investment demand be different?
  - Would r rise as much?
  - Would the equilibrium value of I change?

Conclusion

This is a simple general equilibrium model that explains:

- Production: \( Y = F(K,L) \)
- Income (distribution): \( Y = MP_KK + MP_LL \)
- Spending (allocation): \( Y = C + I + G + NX \)

These are the pieces of the national income identity that we started with:

Production = Income = Spending
Intermediaries and the 2008 Crisis

Intermediaries: match savers and investors (indirectly)
• often savers don’t know where funds go

A few details on the financial crisis:
• July ’06 to Dec ’08: house prices fell 27%
• Jan ’08 to Dec ’08: 2.3 million foreclosures
• Many banks, financial institutions holding mortgages or mortgage-backed securities driven to near bankruptcy
• Congress authorized $700 billion to help shore up financial institutions

Summary

1. Total output is determined by
   • how much capital and labor the economy has
   • the level of technology

2. Competitive firms hire each factor until its marginal product equals its price.

3. If the production function has constant returns to scale, then labor income plus capital income equals total income (output).

Summary

4. The economy’s output is used for
   • consumption
     (which depends on disposable income)
   • investment
     (depends on the real interest rate)
   • government spending
     (exogenous)

5. The real interest rate adjusts to equate the demand for and supply of
   • goods and services
   • loanable funds

6. A decrease in national saving causes the interest rate to rise and investment to fall.

7. An increase in investment demand causes the interest rate to rise, but does not affect the equilibrium level of investment if the supply of loanable funds is fixed.