Chapter 3 A Classical Economic Model

- 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
Economic models

...are simplified versions of a more complex reality

- irrelevant details are stripped away
- assumptions are made

...are used to

- show relationships between variables
- explain the economy’s behavior
- devise policies to improve economic performance
Endogenous vs. Exogenous Variables

- The values of **endogenous** variables are determined in the model.

- The values of **exogenous** variables are determined outside the model: the model takes their values & behavior as given.

- In the model of supply & demand for pizza,
  - endogenous: \( P, Q^d, Q^s \)
  - exogenous: \( P_m \)
Exogenous Variables → Model → Endogenous Variables
Model Equilibrium

- There are usually two elements of model equilibrium:
  - Optimization
  - Market clearing

- Examples:
  - Supply and demand
  - Inflow and outflow
The Use of Multiple Models

- No one model can address all the issues we care about.

- For each new model, you should keep track of
  - its assumptions
  - which variables are endogenous, which are exogenous
  - the questions it can help us understand, those it cannot
A Simplified Structure of the Economy

- Households
  - Work and get paid
  - Consume and save
  - Pay taxes to the government

- Firm
  - Decide on inputs and produce
  - Pay out factor income

- Government
  - Collect tax revenues and pay for government purchases
Chapter 3  National Income

Figure 3.1 The Circular Flow of Dollars Through the Economy

Households → Taxes → Government
Government purchases → Markets for Goods and Services → Firm revenue
Firms → Investment → Markets for Goods and Services
Households → Consumption
Government → Public saving
Financial Markets

Markets for Factors of Production → Factor payments

Private saving
Outline of the model - I

Key Assumptions:
- A closed economy
- Flexible prices (long-run)
- Factors in fixed supply and fully utilized
- Perfect competition
- Market-clearing
Outline of the Model - II

- Supply side
  - determination of Inputs
- Demand side
  - determinants of C, I, and G
- Equilibrium
  - goods market
  - factor markets
  - loanable funds market
Factors of Production

\[ K = \text{capital:} \]
\[ \text{tools, machines, and structures used in production} \]

\[ L = \text{labor:} \]
\[ \text{the physical and mental efforts of workers} \]
The production function: \( Y = F(K,L) \)

- shows how much output \( (Y) \) the economy can produce from \( K \) units of capital and \( L \) units of labor
  - capital:
    - tools, machines, and structures used in production
  - labor:
    - the physical and mental efforts of workers
- reflects the economy’s level of technology
The Determination of Inputs

- Taking factor prices as given (the assumption of perfect competition)
  Factor prices: the prices per unit firms pay for the factors of production
  - wage = price of $L$
  - rental rate = price of $K$
- The firm maximizes

$$PF(K, L) - WL - RK$$
Notation

\[ W \] = nominal wage
\[ R \] = nominal rental rate
\[ P \] = price of output
\[ \frac{W}{P} \] = real wage  
  (measured in units of output)
\[ \frac{R}{P} \] = real rental rate
Demand for labor

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

- Basic idea: A firm hires an extra unit of labor if the cost does not exceed the benefit.
  - $\text{cost} = \text{real wage}$
  - $\text{benefit} = \text{marginal product of labor}$
Marginal product of labor \((MPL)\)

- **definition:**
  The extra output the firm can produce using an additional unit of labor (holding other inputs fixed):

\[
MPL = \frac{\partial F(K,L)}{\partial L},
\]

or approximately,

\[
MPL = F(K, L+1) - F(K, L)
\]
MPL and the production function

As more labor is added, $MPL \downarrow$

Slope of the production function equals $MPL$
Example:

![Production function and Marginal Product of Labor graphs]

- Production function: Output (Y) vs. Labor (L)
- Marginal Product of Labor (MPL): MPL (units of output) vs. Labor (L)
Diminishing marginal returns

- As a factor input is increased, its marginal product falls (other things equal).

- Intuition:
  Suppose $\uparrow L$ while holding $K$ fixed
  $\implies$ fewer machines per worker
  $\implies$ lower worker productivity
Each firm hires labor up to the point where $MPL = \frac{W}{P}$.
How factor prices are determined

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

- Recall: Supply of each factor is fixed.
The equilibrium real wage

The real wage adjusts to equate labor demand with supply.

Units of output

Labor supply

MPL, Labor demand

Units of labor, $L$

equilibrium real wage
Determining the rental rate

- We have just seen that $MPL = W/P$.
- The same logic shows that $MPK = R/P$:
  - diminishing returns to capital: $MPK \downarrow$ as $K \uparrow$
  - The $MPK$ curve is the firm’s demand curve for renting capital.
- Firms maximize profits by choosing $K$ such that $MPK = R/P$. 
The equilibrium real rental rate

The real rental rate adjusts to equate demand for capital with supply.

Units of output

Supply of capital

 equilibrium \( \frac{R}{P} \)

MPK, demand for capital

Units of capital, \( K \)
Determining GDP

- Given
  - the production function
  - the assumption of full utilization
- Output is determined by the fixed factor supplies and the fixed state of technology:

\[
\bar{Y} = F(\bar{K}, \bar{L})
\]
The Neoclassical Theory of Distribution

- states that each factor input is paid its marginal product
- a good starting point for thinking about income distribution
How income is distributed to L and K

**total labor income** = \( \frac{W}{P} \bar{L} = MPL \times \bar{L} \)

**total capital income** = \( \frac{R}{P} \bar{K} = MPK \times \bar{K} \)

If production function has constant returns to scale, then

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

- national income
- labor income
- capital income
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.
The Cobb-Douglas Production Function

- Each factor’s marginal product is proportional to its average product:

\[ MPK = \alpha AK^{\alpha-1} L^{1-\alpha} = \frac{\alpha Y}{K} \]

\[ MPL = (1-\alpha) AK^\alpha L^{-\alpha} = \frac{(1-\alpha)Y}{L} \]
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>1995-2009</td>
<td>2.6%</td>
<td>2.3%</td>
</tr>
</tbody>
</table>
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

Components of aggregate demand:

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

(closed economy: no NX)
Consumption, $C$

- **Def**: Disposable income is total income minus total taxes: $Y - T$.

- Consumption function: $C = C(Y - T)$
  Shows that $\uparrow(Y - T) \implies \uparrow C$

- **Def**: Marginal propensity to consume (MPC) is the change in $C$ when disposable income increases by one dollar.
The consumption function

\[ C = C(Y - T) \]

The slope of the consumption function is the \textit{MPC}. 

\[ \text{MPC} \]
The investment function is $I = I(r)$, where $r$ denotes the real interest rate, the nominal interest rate corrected for inflation.

The real interest rate is

- the cost of borrowing
- the opportunity cost of using one’s own funds to finance investment spending

So, $\uparrow r \Rightarrow \downarrow I$
The investment function

Spending on investment goods depends negatively on the real interest rate.

\[ I(r) \]
Government spending, $G$

- $G =$ gov’t spending on goods and services.
- $G$ excludes transfer payments (e.g., social security benefits, unemployment insurance benefits).
- Assume government spending and total taxes are exogenous:

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

- **Aggregate demand:** \[ C(Y - T) + I(r) + G \]

- **Aggregate supply:** \[ Y = F(K, L) \]

- **Equilibrium:** \[ Y = C(Y - T) + I(r) + G \]

The real interest rate adjusts to equate demand with supply.
The loanable funds market

- A simple supply-demand model of the financial system.

- One asset: “loanable funds”
  - demand for funds: investment
  - supply of funds: saving
  - “price” of funds: real interest rate
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).
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 the tax revenue it receives.
Types of saving

private saving  = \((Y - T) - C\)

public saving  = \(T - G\)

national saving, \(S\)

= private saving + public saving

= \((Y - T) - C + T - G\)

= \(Y - C - G\)
Budget surpluses and deficits

- If $T > G$, budget surplus $= (T - G)$
  $= public saving.$

- If $T < G$, budget deficit $= (G - T)$
  and public saving is negative.

- If $T = G$, “balanced budget,” public saving $= 0$.

- The U.S. government finances its deficit by issuing Treasury bonds $-$ i.e., borrowing.
Loanable funds supply curve

National saving does not depend on $r$, so the supply curve is vertical.

\[
\overline{S} = \overline{Y} - C(\overline{Y} - \overline{T}) - \overline{G}
\]
Loanable funds market equilibrium

Equilibrium real interest rate

Equilibrium level of investment

\[ S = Y - C(Y - T) - G \]
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 L.F. market $\iff$ Eq’m in goods market
CASE STUDY:
The Reagan deficits

- Reagan policies during early 1980s:
  - increases in defense spending: $\Delta G > 0$
  - big tax cuts: $\Delta T < 0$

- Both policies reduce national saving:

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

$\uparrow \bar{G} \Rightarrow \downarrow S$

$\downarrow \bar{T} \Rightarrow \uparrow C \Rightarrow \downarrow S$
CASE STUDY: The Reagan deficits

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

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

3. …which reduces the level of investment.
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.
Chapter Summary

- Total output is determined by:
  - the economy’s quantities of capital and labor
  - the level of technology

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

- If the production function has constant returns to scale, then labor income plus capital income equals total income (output).
A closed economy’s output is used for:

- consumption
- investment
- government spending

The real interest rate adjusts to equate the demand for and supply of:

- goods and services
- loanable funds
In the benchmark model, real variables are determined in the real economy. Changes in money supply have no impact on the final output or the real interest rate.

In the benchmark model, changes in government spending or taxes have no impact on the final output. However, such changes affect the real interest rate and the composition of output.