2. Three Key Aggregate Markets

2.1 The Labor Market: Productivity, Output and Employment
2.2 The Goods Market: Consumption, Saving and Investment
2.3 The Asset Market: Money and Inflation
2.1 The Labor Market:
Productivity, Output and Employment

- The Production Function
- The Demand for Labor
- The Supply of Labor
- Labor Market Equilibrium
- Unemployment
- Relating Output and Unemployment: Okun’s Law
The Production Function

What determines an economy’s capacity to produce?
Let’s look at individual firm $i$

$$y_i = AF (K_i, N_i, M_i)$$

- The factors of production
  - capital $K_i$
  - hours of labor $N_i$
  - raw materials and energy $M_i$

- Factor productivity $A$
Now suppose firm $i$’s production function is **Cobb Douglas**

$$y_i = AK_i^\alpha N_i^{1-\alpha}, \ 0 < \alpha < 1$$

**Properties:**

- **Constant returns to scale**
  $$y_i^2 = A(\lambda K_i^1)^\alpha (\lambda N_i^1)^{1-\alpha} = \lambda y_i^1$$

- **Marginal product of capital**
  decreasing in $K_i$, increasing in $N_i$
  $$MP_K = \alpha AK_i^{\alpha-1} N_i^{1-\alpha} = \alpha \frac{y_i}{K_i} > 0$$

- **Marginal product of labor**
  decreasing in $N_i$, increasing in $K_i$
  $$MP_N = (1 - \alpha) AK_i^\alpha N_i^{-\alpha} = (1 - \alpha) \frac{y_i}{N_i} > 0$$
The Aggregate Production Function

Suppose all firms have the same constant returns to scale production function, then the aggregate production function is

$$y = AK^\alpha N^{1-\alpha}$$

where, if $I$ is the total number of firms:

- $K = \sum_{i=1}^{I} K_i$ is the aggregate capital stock
- $N = \sum_{i=1}^{I} N_i$ is the total hours worked
Output as a function of $K$
Output as a function of $N$
Positive supply shock (increase in $A$)
Accounting for Changes in Output

\[ y_t = A_t K_t^\alpha N_t^{1-\alpha} \]

\[ \Rightarrow \frac{\Delta y_t}{y_t} \approx \frac{\Delta A_t}{A_t} + \alpha \frac{\Delta K_t}{K_t} + (1 - \alpha) \frac{\Delta N_t}{N_t} \]

A change in real output must come from either of three sources

- **\( \frac{\Delta A_t}{A_t} \): Solow residual**, changes in technology, supply shocks e.g. weather, inventions and innovations, government regulations, oil prices

- **\( \frac{\Delta K_t}{K_t} \): capital accumulation/decumulation**, i.e. investment or depreciation of existing capital

- **\( \frac{\Delta N_t}{N_t} \): changes in the number of hours worked**, e.g. changes in population, length of the workweek, unemployment
## Table 8-3

**Accounting for Economic Growth in the United States**

<table>
<thead>
<tr>
<th>Years</th>
<th>Output Growth $\Delta Y/Y$</th>
<th>Capital $\alpha \Delta K/K$</th>
<th>Labor $(1 - \alpha) \Delta L/L$</th>
<th>Total Factor Productivity $\Delta A/A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948–2002</td>
<td>3.6</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>1948–1972</td>
<td>4.0</td>
<td>1.2</td>
<td>1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>1972–1995</td>
<td>3.2</td>
<td>1.3</td>
<td>1.4</td>
<td>0.5</td>
</tr>
<tr>
<td>1995–2002</td>
<td>3.7</td>
<td>1.7</td>
<td>0.9</td>
<td>1.1</td>
</tr>
</tbody>
</table>

(average percentage increase per year)

*Source: U.S. Department of Labor. Data are for the non-farm business sector.*
The Demand for Labor and Capital

What determines the quantity of factor inputs that producers use?

We need some economic theory

Assumptions:

1. Workers are identical
2. Factor prices are determined in a competitive market
3. Firms are profit maximizers
Profit maximizing behavior

A firm’s profit is

\[ \text{Profit} = \text{Sales Revenue} - \text{Labor Costs} - \text{Capital Costs} = Py - WN - RK \]

where

- \( y \) is the quantity produced
- \( P \) is the price of a good produced
- \( W \) is the nominal hourly wage rate
- \( N \) is the number of hours worked
- \( R \) is the nominal rental price of capital
- \( K \) is the amount of capital rented
Profit maximizing behavior

A firm’s profit objective is

\[
\text{Profit} = Py - WN - RK = PAK^\alpha N^{1-\alpha} - WN - RK
\]

Profit maximizing behavior implies

\[
\alpha AK^{\alpha-1}N^{1-\alpha} = MP_K = \frac{R}{P}
\]

\[
(1 - \alpha)AK^\alpha N^{-\alpha} = MP_N = \frac{W}{P}
\]
Factor Demands

Manipulating these optimality conditions we get the factor demands:

\[ N^d = (A(1 - \alpha))^{\frac{1}{\alpha}} \left( \frac{W}{P} \right)^{-\frac{1}{\alpha}} K \]

\[ K^d = (A\alpha)^{\frac{1}{1-\alpha}} \left( \frac{R}{P} \right)^{-\frac{1}{1-\alpha}} N \]

- Labor demand \( N^d \) depends negatively on the real wage \( W/P \) and positively on \( K \)
- Capital demand \( K^d \) depends negatively on the real rental price \( R/P \) and positively on \( N \)
Note: The Division of National Income

Recall the income approach to real GDP:

\[ y = \frac{W}{P}N + \frac{R}{P}K + \text{Real Profits} \]

\[ = MP_N N + MP_K K + \text{Real Profits} \]

\[ = (1 - \alpha) \frac{y}{N} N + \alpha \frac{y}{K} K + \text{Real Profits} \]

\[ = y + \text{Real Profits} \]

- Real Profits = 0. Firms make no excess profit (don’t confuse profits with \( MP_K K \))
- The labor share in total income is constant and equals \( 1 - \alpha \)
- The capital share in total income is constant and equals \( \alpha \)
Why $\alpha$ is constant and roughly equals 0.3
The Labor Demand Curve

$MPN$ curve and labor demand curve, $ND$

Real wage, $w^*$

Marginal product of labor, $MPN$

Real wage (goods per unit of labor)

$w^*$

$A$

$N^*$

Real wage

Labor, $N$
The labor demand curve is downward sloping in the real wage.

Factors that shift the labor demand curve:

1. **Supply shocks** $A$: Beneficial supply shock raises $MP_N$, so shifts labor demand curve to the right; opposite for adverse supply shock

2. **Size of capital stock** $K$: Higher capital stock raises $MP_N$, so shifts labor demand curve to the right; opposite for lower capital stock
Labor Supply

- Aggregate supply of labor is the sum of individuals’ labor supply
- Labor supply of individuals depends on labor-leisure choice
- Working more means more income to buy goods for consumption but less time for leisure
- For higher real wage $W/P$ will labor supply increase or decrease?
  - Yes, substitution effect: Higher real wage encourages work, since reward for working is higher
  - No, income effect: Higher real wage increases income for same amount of work time, so person can afford more leisure, so will supply less labor
Labor Supply

- If I offer $10,000 per day to do some research assistance work for one week, how many days will you work?
- If you win the lottery and get $70,000 per week for the rest of your life, how many days will you work per week?
- If I offer $10,000 per day to do research assistance work for me for the next 40 years how many days will you work per week?
Labor Supply

- Empirical evidence:
  - Labor supply increases with a temporary rise in the real wage
  - Labor supply falls with a permanent increase in the real wage
- Whether subsitution effect or income effect dominates depends on how long the high wage is expected to last.
- Increase in the *current* real wage should raise quantity of labor supplied and the labor supply curve has an upward slope
The Individual Labor Supply Curve
Factors that shift the individual labor supply curve

- **Wealth**: Higher wealth reduces labor supply (shifts labor supply curve to the left)
- **Expected future real wage**: Higher expected future real wage is like an increase in wealth, so reduces labor supply (shifts labor supply curve to the left)
Aggregate Labor Supply

- Aggregate labor supply is the sum of individuals’ labor supply

\[ N = \text{hours worked per employee} \times \text{total employed} \]

- Aggregate labor supply curve slopes upward and is flatter:
  - Some people work more hours (intensive margin)
  - Other people enter employment (extensive margin)

- Factors that increase aggregate labor supply:
  - Decrease in wealth
  - Decrease in expected future real wage
  - Increase in working-age population (higher birth rate, immigration)
  - Increase in labor force participation (increased female labor participation, elimination of mandatory retirement)
Equilibrium in the labor market occurs at a real wage such that labor demand equals labor supply.
1. A temporary adverse supply shock

2. Real wage falls
Do you think this **classical model of the labor market** is plausible?

- a lot of variation in total hours worked per *person* comes from changes in the number of people employed, instead of hours worked per *employee*
- Is all unemployment strictly voluntary !?
- Do real wages adjust quickly !?
Unemployment

We need to explain unemployment. Some definitions:

- **Categories**: employed, unemployed, not in the labor force
- **Labor Force** = Employed + Unemployed
- **Unemployment Rate** = Unemployed/Labor Force
- **Participation Rate** = Labor Force/Adult Population
- **Employment Ratio** = Employed/Adult Population
<table>
<thead>
<tr>
<th>Category</th>
<th>Number (millions)</th>
<th>Share of labor force (percent)</th>
<th>Share of adult population (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employed workers</td>
<td>142.2</td>
<td>91.7</td>
<td>58.4 (employment ratio)</td>
</tr>
<tr>
<td>Unemployed workers</td>
<td>12.8</td>
<td>8.3</td>
<td>5.3 (unemployment rate)</td>
</tr>
<tr>
<td>Labor force (employed + unemployed workers)</td>
<td>155.0</td>
<td>100.0</td>
<td>63.7 (participation rate)</td>
</tr>
<tr>
<td>Not in labor force</td>
<td>88.3</td>
<td></td>
<td>36.3</td>
</tr>
<tr>
<td>Adult population (labor force + not in labor force)</td>
<td>243.4</td>
<td></td>
<td>100.0</td>
</tr>
</tbody>
</table>

*Note: Figures may not add up because of rounding.*

*Sources: The Employment Situation, July 2012, Table A-1.*
Typical Monthly Labor Market Flows (July 2012)

- **Not in Labor Force**: 88.3 million
  - 3% to Unemployed
  - 21% to Employed

- **Unemployed**: 12.8 million
  - 3% to Not in Labor Force
  - 21% to Employed

- **Employed**: 142.2 million
  - 4% to Unemployed
  - 18% to Not in Labor Force
Why there is always unemployment.

The natural rate of unemployment $\bar{u}$ is the average rate of unemployment around which the economy fluctuates and consists of:

- **Frictional unemployment**: Search activity of firms and workers due to heterogeneity. Matching process takes time. Increases during sectoral shifts.

- **Structural unemployment**: the long-term and chronic unemployment that exists even when the economy is not in a recession.

$\rightarrow$ **Real wage rigidity**: real wage is higher than the market clearing level

1. Minimum wages, trade unions (more in Europe)
2. Efficiency wage theories
A 10% increase in min. wage reduces teen unemployment by 1-3%

Cannot explain the majority of the natural rate of unemployment, as most workers’ wages are well above the minimum
Trade Unions

- Wages of unionized workers are not outcome of supply and demand equilibrium
- Wages are determined by bargaining between union leaders and firm management
- **Insiders**, those that are already employed, want to keep real wages high
- **Outsiders**, the unemployed, want to low real wages to create jobs
- Unions typically care more about the **insiders** (their members), and less about outsiders.
## Union membership and wage ratios by industry, 2005

<table>
<thead>
<tr>
<th>Industry</th>
<th># Employed (1000s)</th>
<th>U % of Total</th>
<th>Wage Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private sector (total)</td>
<td>105,508</td>
<td>8.5%</td>
<td>122.3</td>
</tr>
<tr>
<td>Government (total)</td>
<td>20,381</td>
<td>40.5%</td>
<td>121.7</td>
</tr>
<tr>
<td>Construction</td>
<td>8,053</td>
<td>13.8%</td>
<td>156.9</td>
</tr>
<tr>
<td>Mining</td>
<td>600</td>
<td>9.5%</td>
<td>113.7</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>15,518</td>
<td>13.7%</td>
<td>107.8</td>
</tr>
<tr>
<td>Retail trade</td>
<td>14,973</td>
<td>5.8%</td>
<td>114.0</td>
</tr>
<tr>
<td>Transportation</td>
<td>4,379</td>
<td>24.4%</td>
<td>129.2</td>
</tr>
<tr>
<td>Finance, insurance</td>
<td>6,304</td>
<td>2.1%</td>
<td>90.7</td>
</tr>
<tr>
<td>Professional services</td>
<td>10,951</td>
<td>3.1%</td>
<td>90.6</td>
</tr>
<tr>
<td>Education</td>
<td>3,312</td>
<td>15.4%</td>
<td>112.7</td>
</tr>
<tr>
<td>Health care</td>
<td>14,045</td>
<td>8%</td>
<td>115.1</td>
</tr>
</tbody>
</table>

\[ \text{wage ratio} = 100 \times \left( \frac{\text{union wage}}{\text{nonunion wage}} \right) \]
Efficiency Wage Theories

Theories in which higher wages increase worker productivity by:

- attracting higher quality job applicants
- increasing worker effort, reducing “shirking”
- reducing turnover, which is costly to firms
- improving health of workers (in developing countries)

Firms willingly pay above-equilibrium wages to raise productivity (Henry Ford).

Result: structural unemployment
Cyclical unemployment $u - \bar{u}$

- In a recession, the actual unemployment rate $u$ rises above the natural rate $\bar{u}$.
- In a boom, the actual unemployment rate $u$ falls below the natural rate $\bar{u}$. 
What we mean with full employment

The natural rate of unemployment for the US is about 5 − 6%

The full-employment level $\bar{N}$ of labor input is the one consistent with the natural rate of unemployment $\bar{u}$ at real wage that has no tendency to change.

For a given $K$ and $A$, it determines the level of full-employment output or potential output, $\bar{y}$:

$$\bar{y} = AK^{\alpha} \bar{N}^{1-\alpha}$$
Okun’s law

Relationship between output (relative to full-employment output) and cyclical unemployment:

\[
\frac{y - \bar{y}}{\bar{y}} = -2(u - \bar{u})
\]

Alternatively,

\[
\frac{\Delta y_t}{y_t} = 3\% - 2\Delta u
\]

A 1% increase in unemployment rate is associated with a 2% reduction in output growth
The natural rate rises during 1960-1984, then falls during 1985-2006! Why?
minimum wage - unionization - babyboomers - sectoral shifts
The rise in European Unemployment
The rise in European Unemployment

- **Shock**: Technological progress has shifted labor demand from unskilled to skilled workers in recent decades.
- **Effect in United States**: An increase in the “skill premium” the wage gap between skilled and unskilled workers.
- **Effect in Europe**: Higher unemployment, possibly due to generous government benefits for unemployed workers and strong union presence.
The rise in European Leisure

taxes - underground economy-unions/holidays - preferences