

Productivity, Output and Employment (Ch3)

1. **The Production Function**
2. **The Demand for Labor**
3. **The Supply of Labor**
4. **Labor Market Equilibrium**
5. **Unemployment**
6. **Relating Output and Unemployment: Okun's Law**

1. The Production Function

Big Goal: Analyze long-term growth and factors that affect it &
Develop model of the economy

Question: How much can economy produce?
Depends on 1) amount of inputs (capital, labor, raw materials, land, energy)
2) productivity of inputs (technology, management)

The Production Function: relationship between output and factors of production

$$Y = AF(K, N) \quad (3.1)$$

Parameter A is “total factor productivity” (the effectiveness with which capital and labor are used)

Application: The production function of the U.S. economy and U.S. productivity growth

Cobb-Douglas production function works well for U.S. economy:

$$Y = A K^{0.3} N^{0.7} \quad (3.2)$$

Data for U.S. economy—Table 3.1

“ A ” number hard to interpret, so use productivity growth rate.

Productivity moves sharply from year to year

Productivity grew slowly in the 1980s and the first half of the 1990s, but increased in the second half of the 1990s

Graph production function (Y vs. one input; hold other input and A fixed)

A, N fixed

K changes

Production function for 2004: $N=139.3$

$A=20.68$

$$Y = 20.63 * K^{0.3} * 139.3^{0.7}$$

$$Y = 655 * K^{0.3}$$

$K=0$

$K=5000$

$K=6000$

Production Function

Two main properties of production functions:

1. Slopes upward:- more of any input produces more output
2. Slope becomes flatter as input rises

Marginal product of capital, $MPK = DY/DK$

Equal to slope of production function graph (Y vs. K)

1. MPK always positive
2. Diminishing marginal productivity of capital: MPK declines as K rises

We can repeat the same analysis for N

A fixed

K fixed

- Check relationship between Y and N

Marginal product of labor, $MPN = DY/DN$

Equal to slope of production function graph (Y vs. N)

1. MPN always positive
2. Diminishing marginal productivity of labor

Q: Does economy's production function change?

A: It can change b/c of supply shocks

Supply shock = productivity shock = a change in an economy's production function

Supply shocks affect the amount of output that can be produced for a given amount of inputs (the other factor that affect production in addition to K, N)

Shocks may be positive (increasing output) or negative (decreasing output)

Figure 3.4 An adverse supply shock that lowers the MPN

- Examples: weather, inventions and innovations, government regulations, oil prices
- Supply shocks shift graph of production function
 Negative (adverse) shock: Usually slope of production function decreases at each level of input (for example, if shock causes parameter A to decline)
 Positive shock: Usually slope of production function increases at each level of output (for example, if parameter A increases)

2. The Demand for Labor

Q: How much labor (input) do firms want to use?

Assumptions: Hold capital stock fixed—short-run analysis
 Workers are all alike
 Labor market is competitive
 Firms maximize profits

Example:
 The Clip Joint

Q: How many workers to hire to max profits?

$$MPN = \Delta Y / \Delta N$$

$$MRPN = P * MPN \tag{3.3}$$

Assume: $W = \$240$ (nominal wage)

Profit is max if:

$$\begin{array}{ccc} W & \leq & MRPN \\ \text{Marginal cost} & \leq & \text{marginal benefit} \end{array}$$

And firm will choose number of workers to satisfy this condition, b/c this max profit.

Define: w (real wage) as $w = W/P$

$$w = \$240 / \$30 = 8 \text{ groomings}$$

Restate the above condition in terms of real wage:

$$\begin{array}{ccc} W/P & \leq & MRPN/P \\ w & \leq & MPN \end{array}$$

Q: What if wage changes?

If real wage (w) > marginal product of labor (MPN), profit rises if number of workers declines

If $w < MPN$, profit rises if number of workers increases

Q: relationship between the marginal product of labor and the labor demand curve

Labor demand curve shows relationship between the real wage rate and the quantity of labor demanded

It is the same as the MPN curve, since $w = MPN$ at equilibrium

So the labor demand curve is downward sloping; firms want to hire less labor, the higher the real wage

Factors that shift the labor demand curve

Note: A change in the wage causes a movement along the labor demand curve, not a shift of the curve

- a. Supply shocks: Beneficial supply shock raises MPN , so shifts labor demand curve to the right; opposite for adverse supply shock (new technology)
- b. Size of capital stock: Higher capital stock raises MPN , so shifts labor demand curve to the right; opposite for lower capital stock

Table 3.3 The Clip Joint's Production Function After a Beneficial Productivity Shock

Aggregate labor demand is the sum of all firms' labor demand

Same factors (supply shocks, size of capital stock) that shift firms' labor demand cause shifts in aggregate labor demand

3. The Supply of Labor

- Supply of labor is determined by individuals
- Aggregate supply of labor is the sum of individuals' labor supply
- Labor supply of individuals depends on labor-leisure choice (income-leisure trade-off)
- Utility depends on consumption and leisure

Need to compare costs and benefits of working another day (hour)

Costs: Loss of leisure time

Benefits: More consumption, since income is higher
If benefits of working another day(hour) exceed costs, work another day(hour)
Keep working additional days until benefits equal costs.

Real wages and labor supply

Q: What happens with labor supply when real wage changes?

An **increase in the real wage** has offsetting income and substitution effects:

Substitution effect: Higher real wage encourages work, since reward for working is higher

Income effect: Higher real wage increases income for same amount of work time, so person can afford more leisure, so will supply less labor

Example:

A pure substitution effect: a one-day rise in the real wage

A temporary real wage increase has just a pure substitution effect, since the effect on wealth is negligible

A pure income effect: winning the lottery, inheritance

Inheritance doesn't have a substitution effect, because it doesn't affect the reward for working

But inheritance makes a person wealthier, so a person will both consume more goods and take more leisure; this is a pure income effect

Example for the substitution effect and the income effect together: a long-term increase in the real wage

The reward to working is greater: a substitution effect toward more work

But with higher wage, a person doesn't need to work as much: an income effect toward less work

The longer the high wage is expected to last, the stronger the income effect; thus labor supply will increase by less or decrease by more than for a temporary reduction in the real wage

Empirical evidence on real wages and labor supply

Overall result: Labor supply increases with a temporary rise in the real wage

Labor supply falls with a permanent increase in the real wage

Figure 3.7 The labor supply curve of an individual worker

Increase in **the current** (expected future wage stays constant) real wage should raise quantity of labor supplied

Labor supply curve relates quantity of labor supplied to real wage

Labor supply curve slopes upward because higher wage encourages people to work more

Factors that shift the labor supply curve

a. Wealth: Higher wealth reduces labor supply (shifts labor supply curve to the left)

b. 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)

- c. Change in working-age population (birth rate change, i(m)migration)
- d. Change in labor force participation (female, mandatory retirement)

The effect on labor supply of an increase in wealth

Aggregate labor supply

Aggregate labor supply rises when current real wage rises because:

- a. Some people work more hours
- b. Other people enter labor force

Result: Aggregate labor supply curve slopes upward

4. Labor Market Equilibrium

Equilibrium: Labor supply equals labor demand

Classical model of the labor market—real wage adjusts quickly

Determines full-employment level of employment and market-clearing real wage

Problem with classical model: can't study unemployment

Figure 3.11 Effects of a temporary adverse supply shock on the labor market

Full-employment output = potential output = level of output when labor market is in equilibrium
(3.4)

affected by changes in full employment level or production function (example: supply shock, Fig. 3.11)

Application: technical change and wage inequality

Two important features of U.S. real wages since 1970:

- a. Slowdown in growth of real wages
- b. Increased wage inequality

Slowdown in productivity growth combined with increased labor force participation has kept real wages from rising as much as they did before 1970

Skill-biased technical change (such as computerization) has increased real wages of highly educated workers, but reduced real wages of unskilled workers (Fig. 3.13)

Figure 3.13 The effects of skill-biased technical change on wage inequality

5. Unemployment

Measuring unemployment

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

Changes in employment status

Flows between categories

Discouraged workers: people who have become so discouraged by lack of success at finding a job that they stop searching

How long are people unemployed?

Most unemployment spells are of short duration

Unemployment spell = period of time an individual is continuously unemployed

Duration = length of unemployment spell

Most unemployed people on a given date are experiencing unemployment spells of long duration

Why there are always unemployed people?

Frictional unemployment: Search activity of firms and workers due to heterogeneity. Matching process takes time

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

- a. Lack of skills prevents some workers from finding long-term employment

- b. Reallocation of workers out of shrinking industries or depressed regions; matching takes a long time

The natural rate of unemployment : when output and employment are at full-employment levels
 = frictional + structural unemployment ($u \text{ bar}$)

Cyclical unemployment: difference between actual unemployment rate and natural rate of unemployment

$$u - u \text{ bar}$$

In touch with the macroeconomy: labor market data

BLS employment report

Household survey: unemployment, employment

Establishment survey: jobs

Relating Output and Unemployment: Okun's Law

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

$$(Y \text{ bar} - Y) / Y = 2(u - u \text{ bar})$$

Why is the Okun's Law coefficient 2, and not 1?

Other things happen when cyclical unemployment rises: Labor force falls, hours of work per worker decline, average productivity of labor declines

Result is 2% reduction in output associated with 1 percentage point increase in unemployment rate

Alternative formulation if average growth rate of full-employment output is 3%:

$$DY/Y = 3 - 2 Du \quad (3.6)$$

Fig. 3.15 shows U.S. data