Technological progress in long, medium andb short run

Productivity, Output, and Unemployment in the Short Run

A production function with technological progress can be written as:

$$Y = F(K, AN)$$

Leaving aside matters concerning capital, then:

$$Y = AN$$

Output is produced using only labor, *N*, and each worker produces *A* units of output. Increases in *A* represent technological progress.

Productivity, Output, and Unemployment in the Short Run

$$Y = F(K, AN)$$

Then, employment is equal to output divided by productivity.

$$N = Y/A$$

The concern is that, given output, an increase in productivity decreases the level of employment. This chapter explores this issue, in particular, the short- and medium-run responses of output, employment, and unemployment.

Productivity, Output, and Unemployment in the Short Run

Technological Progress, Aggregate Supply, and Aggregate Demand

Recall the basic structure of the aggregate supply and aggregate demand model:

- Output is determined by the intersection of the aggregate supply curve and the aggregate demand curve.

- The *aggregate supply* relation gives the price level for a given level of output.

- The *aggregate demand* relation gives output for a given price level.

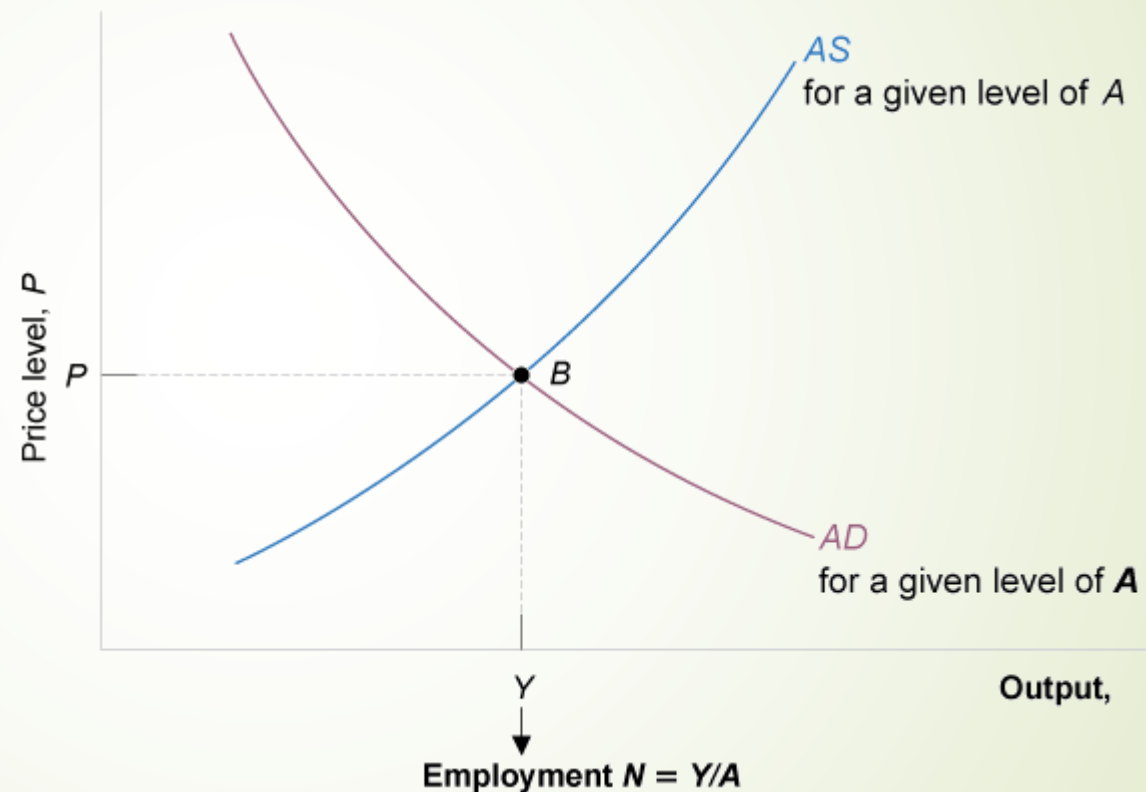# Productivity, Output, and Unemployment in the Short Run

Technological Progress, Aggregate Supply, and Aggregate Demand

■ Figure 1

Aggregate Supply and Aggregate Demand for a Given Level of Productivity

The aggregate supply curve is upward sloping: An increase in output leads to an increase in the price level. The aggregate demand curve is downward sloping: An increase in the price level leads to a decrease   in output.

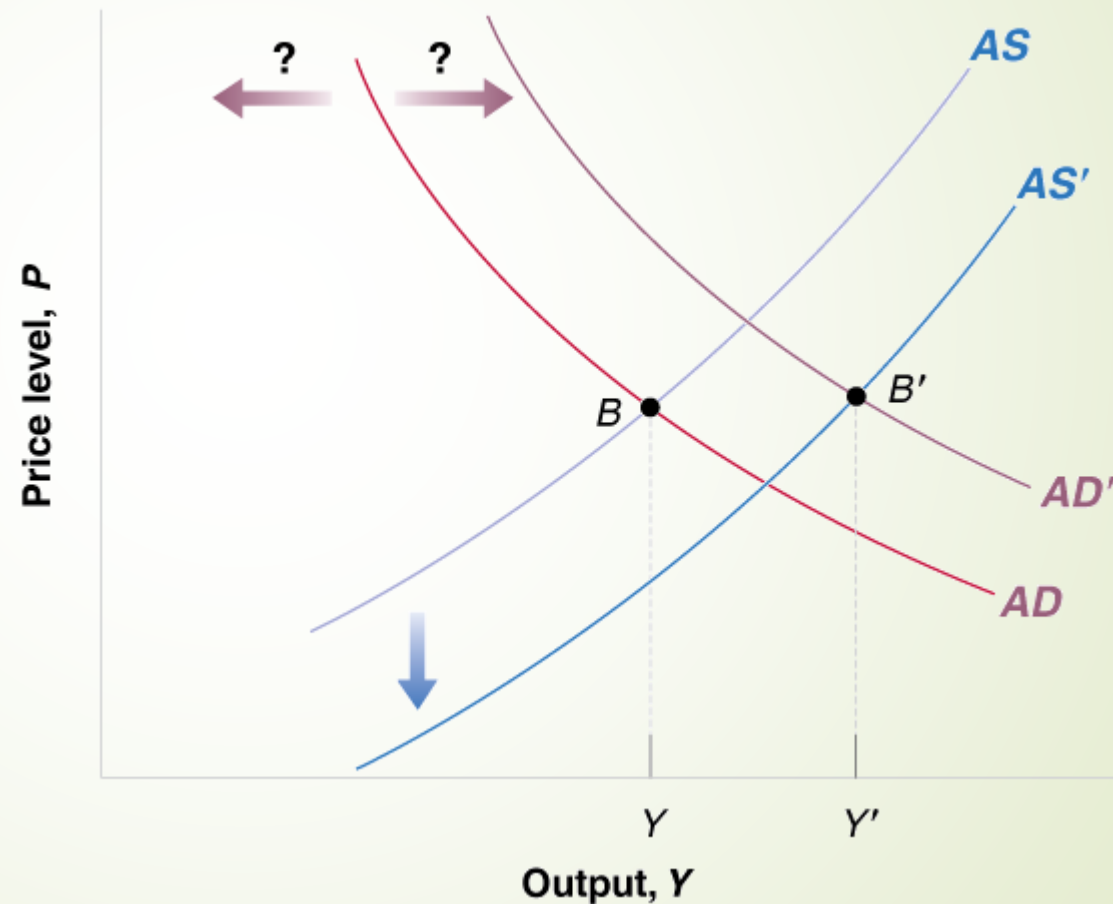# Productivity, Output, and Unemployment in the Short Run

Technological Progress, Aggregate Supply, and Aggregate Demand

■ **Figure 2**

The Effects of an Increase in Productivity on Output in the Short Run

An increase in productivity shifts the aggregate supply curve down. It has an ambiguous effect on the aggregate demand curve, which may shift either to the left or to the right. In this figure, we assume that it shifts to the right.

Productivity, Output, and Unemployment in the Short Run

Technological Progress, Aggregate Supply, and Aggregate Demand

The effects of higher productivity on aggregate demand depend on the source of the productivity increase:

- Technological breakthroughs will bring prospects of higher profits and a boom in investment. The demand for goods rises—aggregate demand shifts to the right.

- The more efficient use of existing technologies may require little or no new investment. Worries about job security will trigger more saving—the aggregate demand curve shifts to the left.
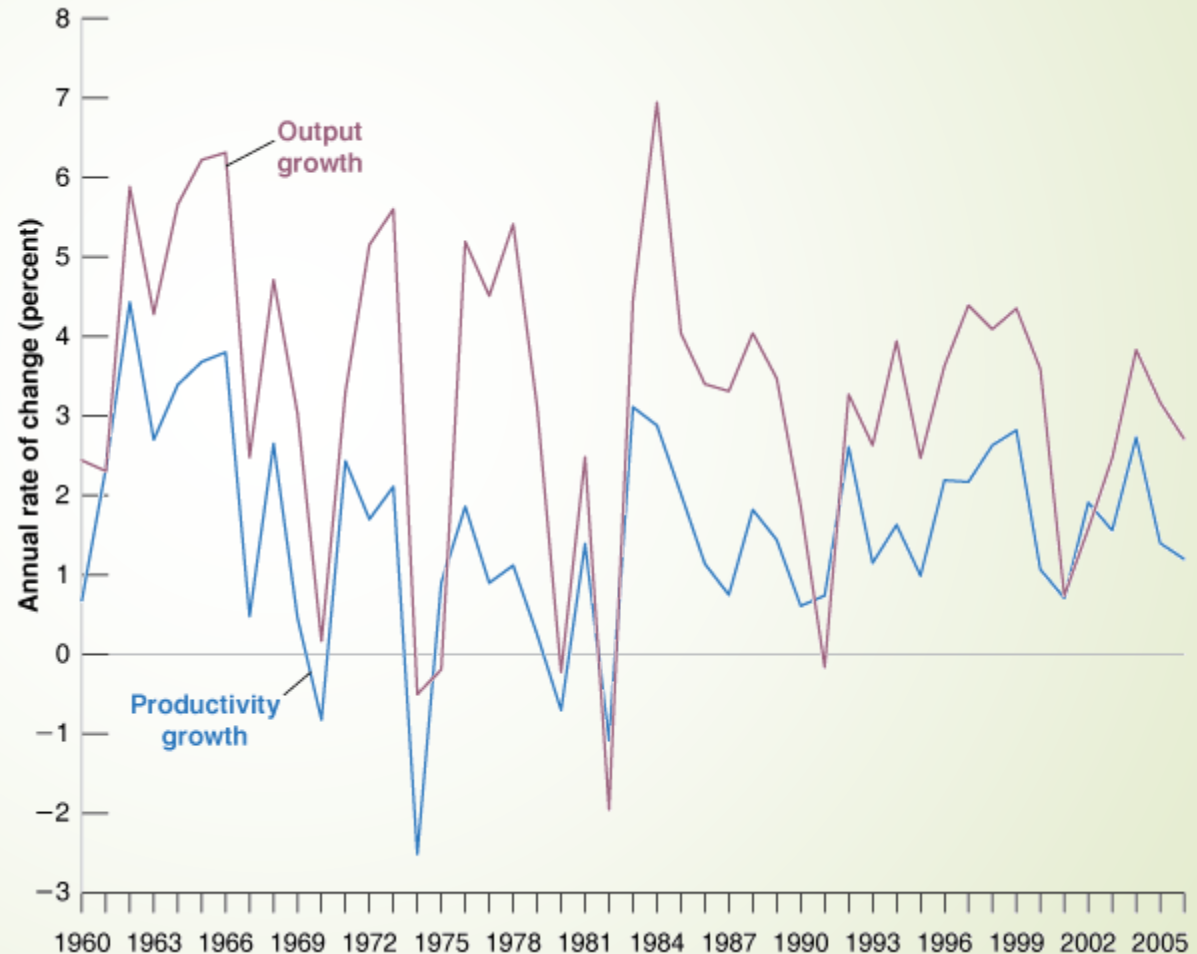
Productivity, Output, and Unemployment in the Short Run

The Empirical Evidence

■ **Figure 3**

Labor Productivity and Output Growth in the United States since 1960

There is a strong positive relation between output growth and productivity growth. But the causality runs from output growth to productivity growth, not the other way around.

Productivity, Output, and Unemployment in the Short Run

The Empirical Evidence

Research on the effects of exogenous movements in productivity growth on output shows that:

- Sometimes increases in productivity lead to increases in output sufficient to maintain or even increase employment in the short run.

- Sometimes they do not, and unemployment increases in the short run.

Productivity and the Natural Rate of Unemployment

Technological unemployment—a concept associated with the *technocracy movement* during the Great Depression—is the argument that unemployment comes from the introduction of machinery.

In its crudest form, the argument that technological progress must lead to unemployment is obviously false.

A more sophisticated version of the argument cannot, however, be dismissed so easily.

Perhaps periods of *fast technological progress* are associated with a *higher natural rate* of unemployment, and periods of *slower progress* are associated with a *lower natural rate* of unemployment.

Productivity and the Natural Rate of Unemployment

Recall from Chapter 6 that the natural rate of unemployment is determined by two relations, the price-setting relation and the wage-setting relation.

Our first step must be to think about how changes in productivity affect each of these two relations.

Price Setting and Wage Setting Revisited

Consider price setting first:

➤ From $Y=AN$, each worker produces A units of output.

➤ If the nominal wage is equal to W, the nominal cost of producing one unit of output is therefore equal to $(1/A) W = W/A$.

➤ If firms set their price equal to $1+\mu$ times cost, the price level is given by:

$$\text{Price setting } P = (1 + \mu)\frac{W}{A}$$

Productivity and the Natural Rate of Unemployment

Price Setting and Wage Setting Revisited

An extension of our earlier wage-setting equation that accounts for increases in productivity equals:

$$\text{Wage setting} \quad W = A^e P^e F(u, z)$$

Wages now depend on the expected level of productivity.

➥ Workers care about real wages, not nominal wages, so wages depend on the (expected) price level, P^e.

➥ Wages now also depend on the expected level of productivity, A^e.

The Natural Rate of Unemployment

$$\frac{W}{P} = \frac{A}{1+\mu}$$

The real wage paid by firms, *W/P*, increases one for one with productivity, *A*. Higher productivity leads to a lower price set by firms given the nominal wage; therefore, the real wage rate rises.

The Natural Rate of Unemployment

■ **Figure 4**
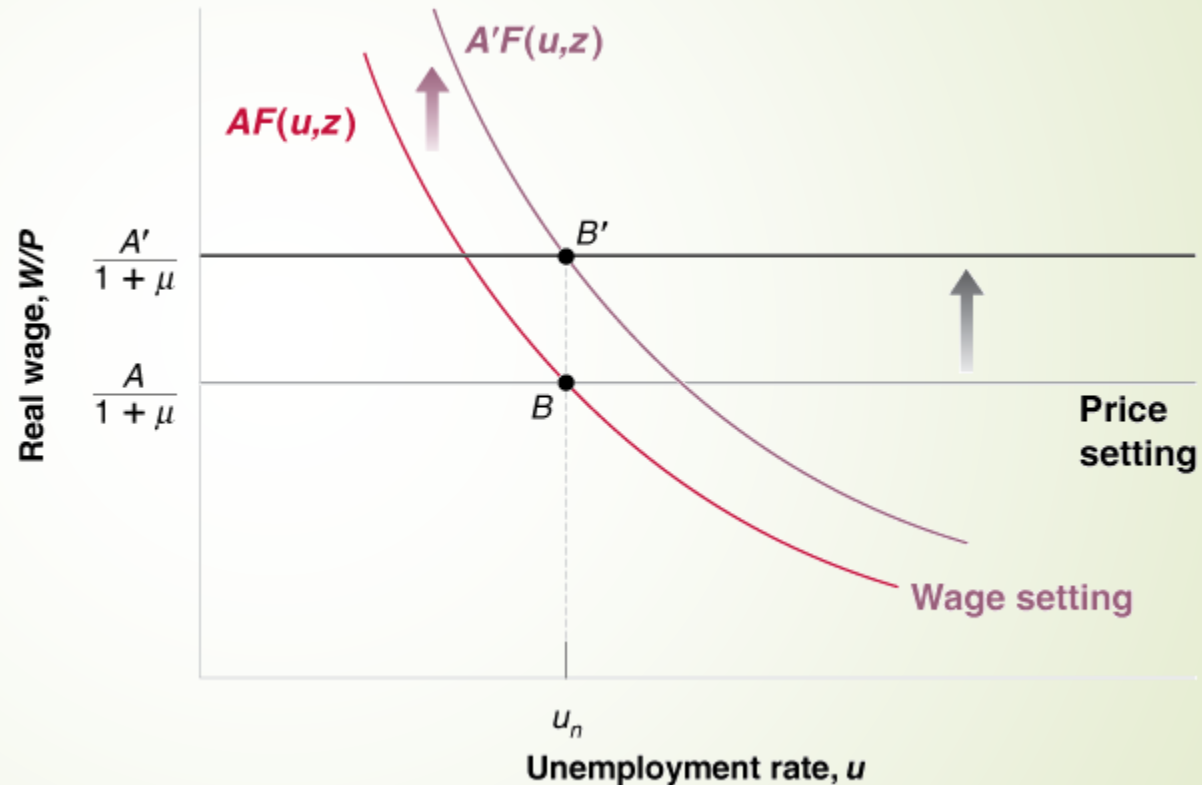
The Effects of an Increase in Productivity on the Natural Rate of Unemployment

An increase in productivity shifts both the wage and the price-setting curves by the same proportion and thus has no effect on the natural rate.

The Natural Rate of Unemployment

Under the condition that expectations are correct, then $P^e=P$ and $A^e=A$, the wage-setting equation becomes:

$$\frac{W}{P} = AF(u,z)$$

The real wage rate depends on both the level of productivity and the unemployment rate.

Productivity and the Natural Rate of Unemployment

The Natural Rate of Unemployment

- From $\dfrac{W}{P} = \dfrac{A}{1+\mu}$, we see that the real wage implied by price setting is now higher by 3%.

- From $\dfrac{W}{P} = AF(u,z)$ we see that at a given unemployment rate, the real wage implied by wage setting is also higher than 3%.

- Note that at the initial unemployment rate u_n, both curves shift up by the same amount, namely, 3% of the initial real wage.
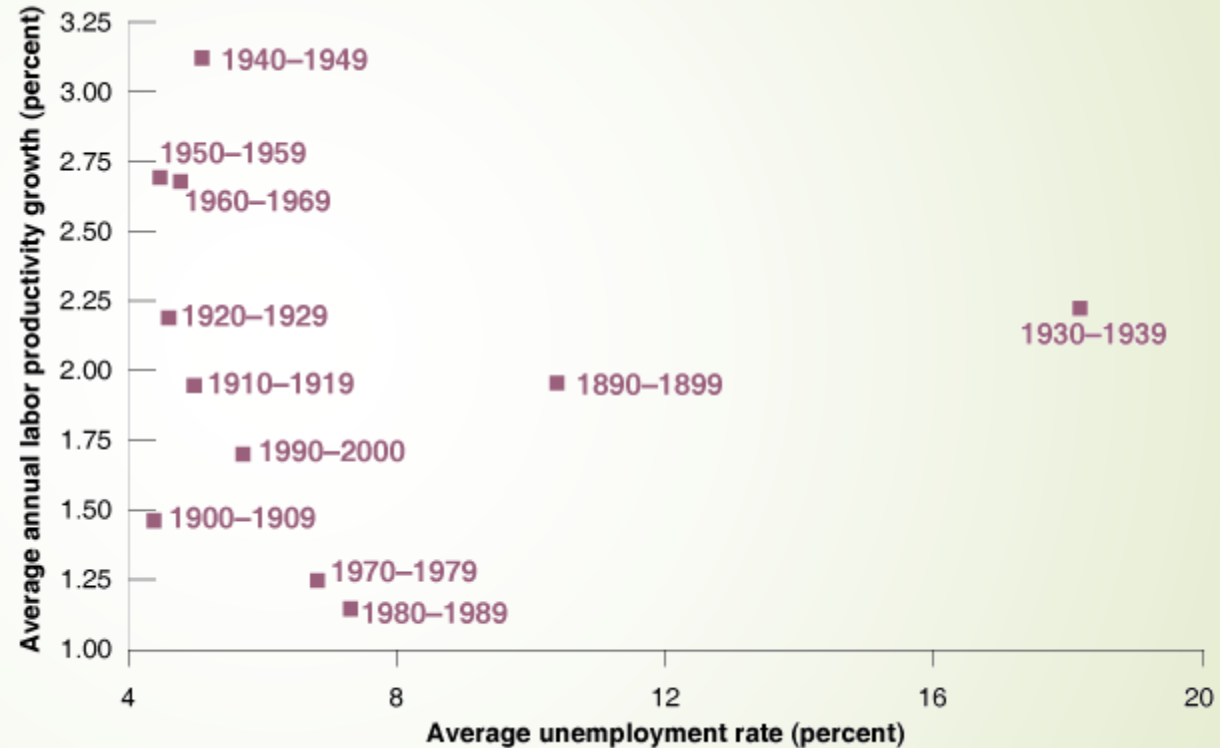
Productivity and the Natural Rate of Unemployment

The Empirical Evidence

■ **Figure 5**

Productivity Growth and Unemployment—Averages by Decade, 1890 to 2000

There is little relation between the 10-year averages of productivity growth and the 10-year averages of the unemployment rate. If anything, higher productivity growth is associated with lower unemployment.
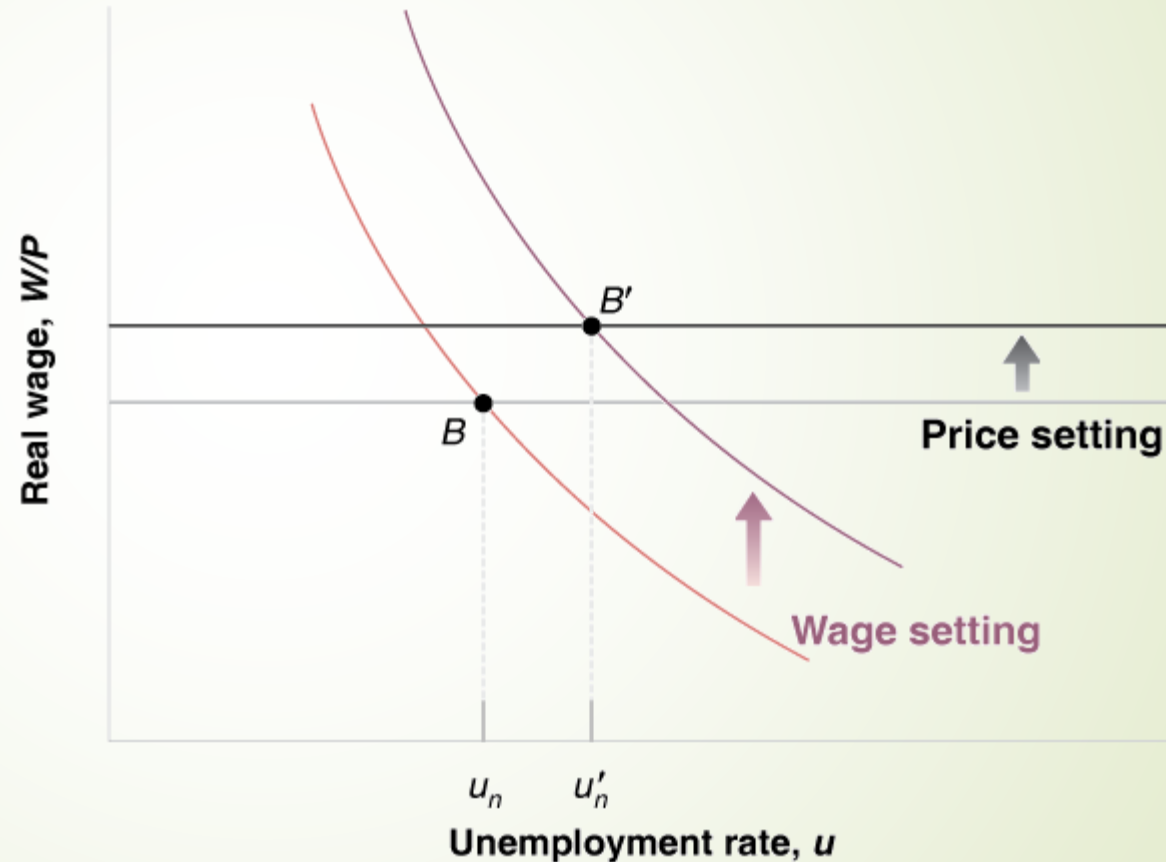
Productivity and the Natural Rate of Unemployment

The Empirical Evidence

Figure 6

The Effects of a Decrease in Productivity Growth on the Unemployment Rate When Expectations of Productivity Growth Adjust Slowly

If it takes time for workers to adjust their expectations of productivity growth, a slowdown in productivity growth will lead to an increase in the natural rate for some time.

Productivity and the Natural Rate of Unemployment

The Empirical Evidence

Let's summarize what we have seen in this and the preceding section:

- In the short run, there is no reason to expect a systematic relation between movements in productivity growth and movements in unemployment.

- In the medium run, if there is a relation between productivity growth and unemployment, it appears to be in inverse relation.

Given this evidence, **structural change** – the change in the structure of the economy induced by technological progress, may where fears of technological unemployment come from.

Technological Progress, Churning, and Distribution Effects

Joseph Schumpeter, a Harvard economist, emphasized that the process of growth was fundamentally a process of **creative destruction** – new goods are developed, making old ones obsolete, new techniques of production are introduced.

Churning is the term used to describe how new techniques of production require new skills and make old skills less useful.

The New Economy, the U.S. Expansion of the 1990s, and the Jobless Recovery of the Early 2000s

By the end of 2001, the recession in the U.S. was over, and output growth was positive in 2002 and 2003. But unemployment continued to increase. The recovery was dubbed the **jobless recovery**.

Table 1	Selected U.S. Macroeconomic Variables, United States, 1996-2003							
	1996	1997	1998	1999	2000	2001	2002	2003
GDP growth (%)	3.6	4.4	4.2	4.4	3.7	0.5	2.2	3.1
Unemployment rate (%)	5.4	4.9	4.5	4.2	4.0	4.8	5.8	6.0
Inflation rate (GDP deflator, %)	1.9	1.9	1.1	1.4	2.2	2.4	1.5	1.7
Labor productivity (%)	1.8	2.2	2.2	2.4	2.6	0.7	3.9	3.4

Technological Progress, Churning, and Distribution Effects

The Increase in Wage Inequality

Technological change is the reason for the large increase in wage inequality in the United States during the last 25 years.

At the low end of the education ladder, both the relative and the absolute wage of workers has declined.

At the high end, the relative wage of those with an advanced degree has increased by 25% since the early 1980s.
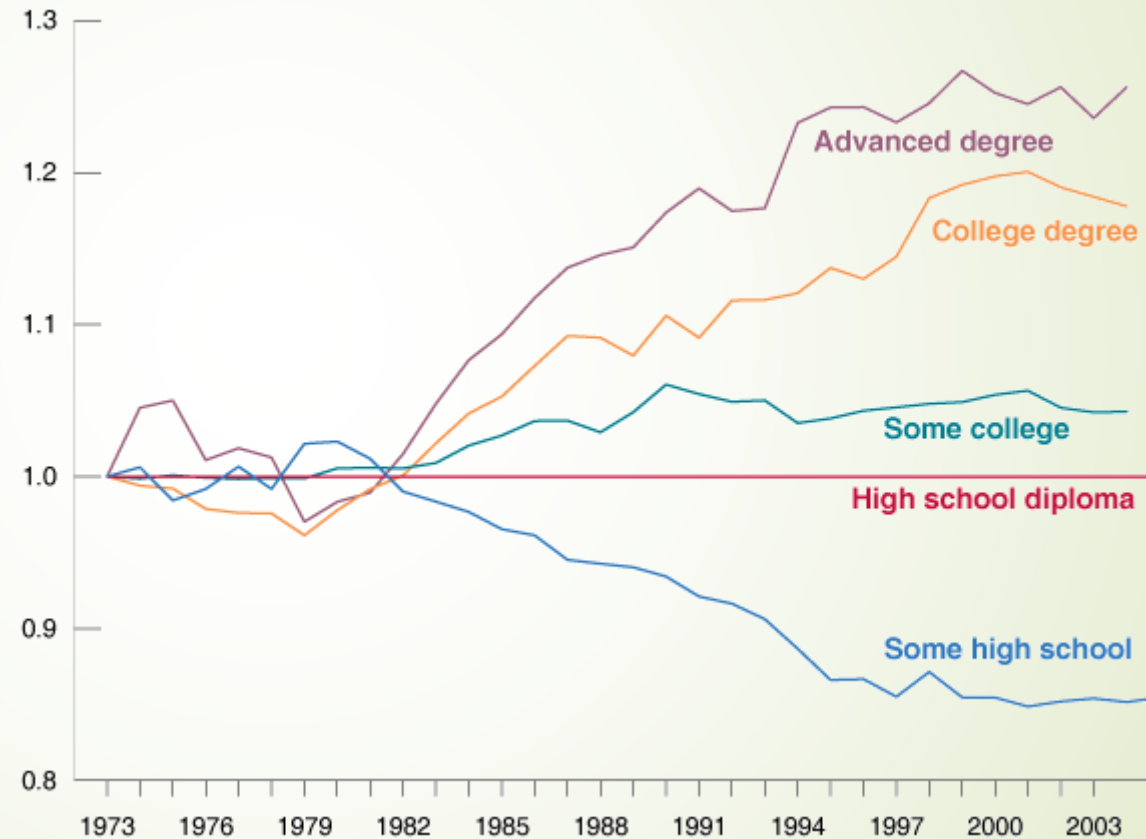
Technological Progress, Churning, and Distribution Effects

The Increase in Wage Inequality

Figure 7

Evolution of Relative Wages, by Education Level, 1973 to 2005

Since the early 1980s, the relative wages of workers with a low education level have fallen; the relative wages of workers with a high education level have risen.

Technological Progress, Churning, and Distribution Effects

The Causes of Increased Wage Inequality

Among the arguments for the steady increase in the relative wage rate of skilled workers are:

➡ International trade: Firms that hire low-skilled workers usually go abroad to find this source of labor.

➡ **Skill-biased technological progress**: New machines and productive methods require high-skill workers with better education.

Technological Progress, Churning, and Distribution Effects

The Causes of Increased Wage Inequality

There are at least three reasons to think that the future may be different from the recent past where wage inequality is concerned:

➡ The trend in relative demand may simply slow down.

➡ Technological progress is not exogenous.

➡ The relative supply of high-skill versus low-skill workers is also not exogenous.

Institutions, Technological Progress and Growth

For poor countries, technological progress is more a process of imitation than a process of innovation.

Most economists believe that the main source of the problem, for poor countries in general and for Kenya in particular, lies in their poor institutions.

What institutions do economists have in mind? At a broad level, the protection of **property rights** may well be the most important. Few individuals are going to create firms, introduce new technologies, and invest, if they expect that profits will be either appropriated by the state, extracted in bribes by corrupt bureaucrats, or stolen by other people in the economy.
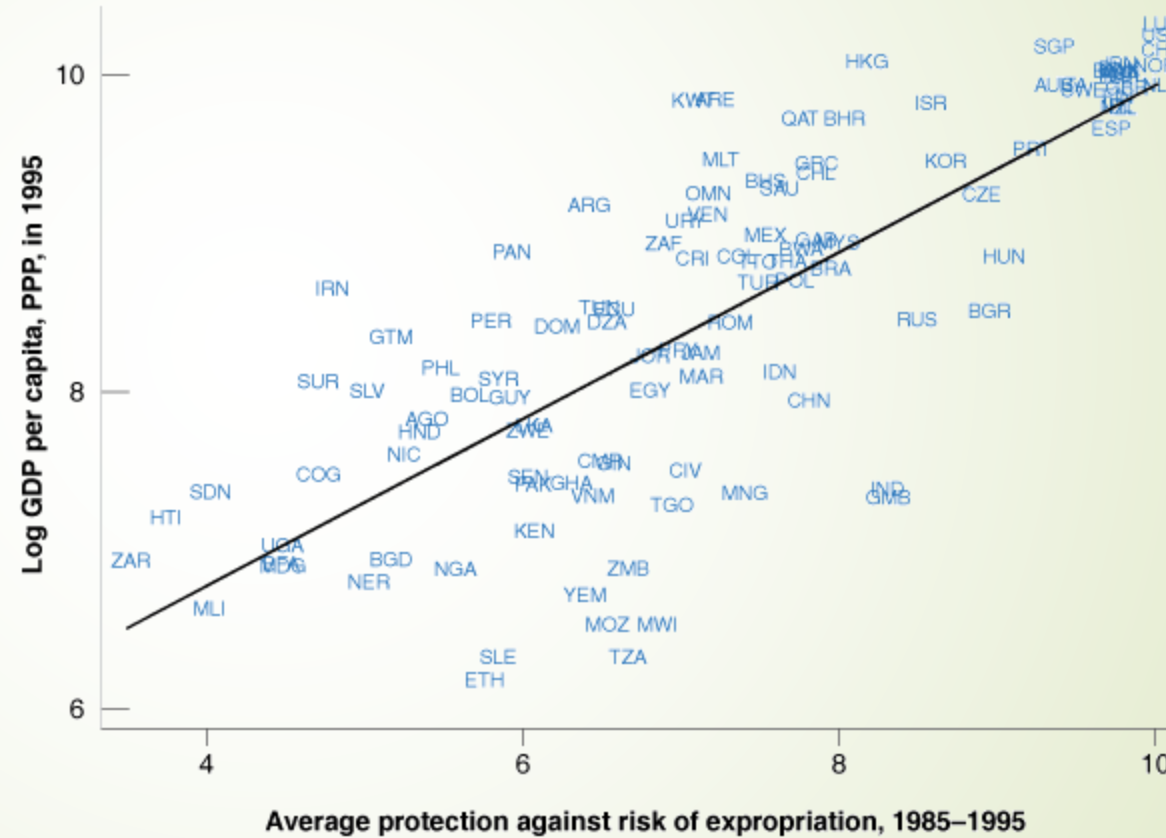
■ **Figure 8**

Protection from Expropriation and GDP per Person

There is a strong positive relation between the degree of protection from expropriation and the level of GDP per person.

The Importance of Institutions:
North and South Korea

50 years after Korea was divided into two countries the GDP per person was 10 times higher in South Korea than in North Korea.

This was the result of South Korea's capitalist organization of the economy versus North Korea's nationalized industries and centralized planning by the state. There were no private property rights for individuals. The result was the decline of the industrial sector and the collapse of agriculture. The lesson is sad but transparent: Institutions matter very much for growth.

**The Importance of Institutions:
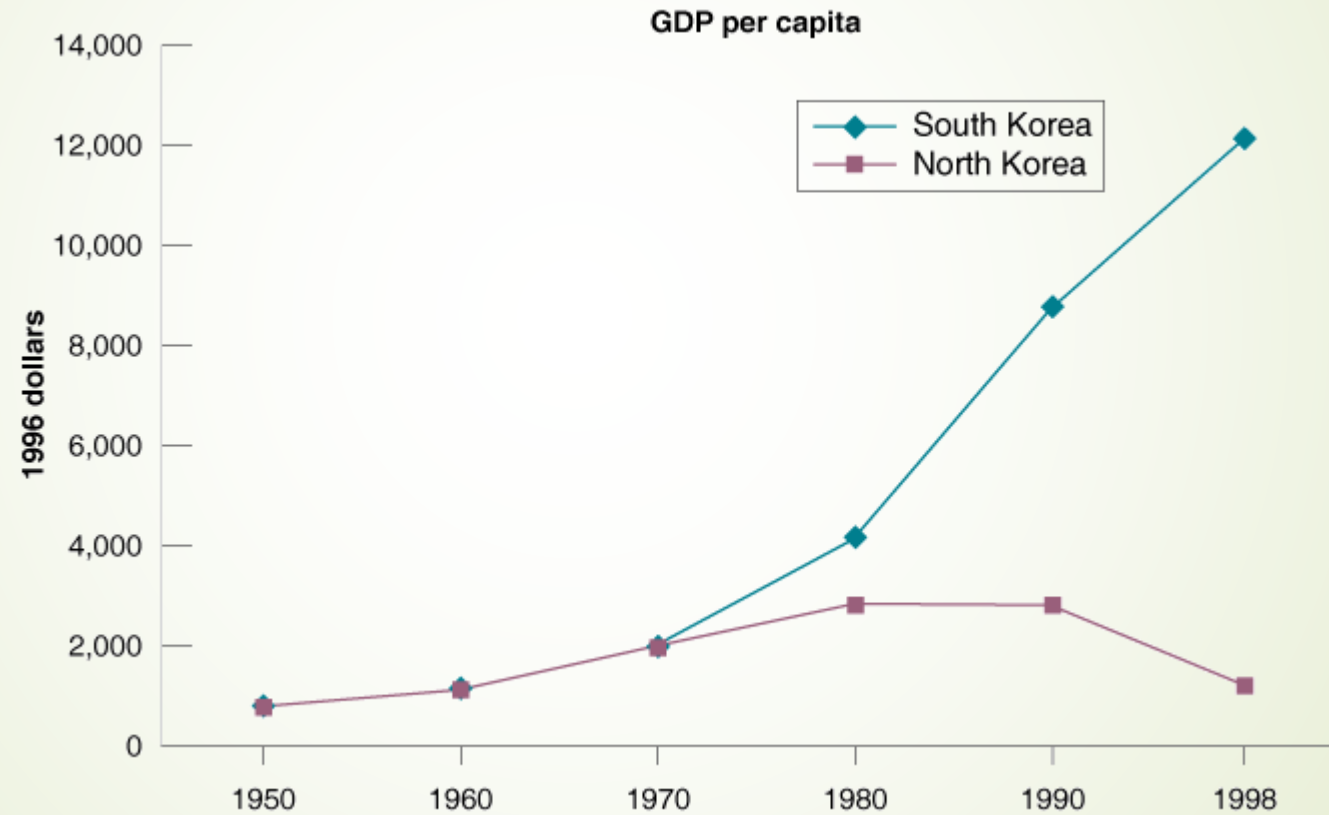North and South Korea**

Figure 1   *PPP GDP per Person,North and South Korea, 1950 to 1998*

What Is Behind Chinese Growth?

In 1978, an agricultural reform was put in place, allowing farmers, after satisfying a quota due to the state, to sell their production on rural markets.

Outside of agriculture, state firms were given increasing autonomy over their production decisions, and market mechanisms and prices were introduced for an increasing number of goods. Private entrepreneurship was encouraged, often taking the form of "Town and Village Enterprises," collective ventures guided by a profit motive. Tax advantages and special agreements were used to attract foreign investors.

Despite poor establishment of property rights and an inefficient banking system China's economy continues to grow.

Thank YOU for attention
End