PART II. THE LONG RUN: ECONOMIC GROWTH, LONG-RUN UNEMPLOYMENT AND STRUCTURAL ECONOMIC POLICY

2.   SOME FACTS ABOUT PROSPERITY AND GROWTH

■ In the title of his book *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776) **Adam Smith** stated what he considered to be the most important issue in economics: **what is it that makes a nation prosperous**.

■ In modern economics textbooks you can read that the **average level of prosperity in a country can be measured by the country's GDP or income per person**. It is not necessarily all of the annual income that is consumed during the year, but **what is not consumed is saved, and becomes either investment or an export surplus**. In both uses it **adds to the national wealth** and thereby becomes a **source of future consumption**.

■ **Consumption is thus always rooted in production and income**, and in so far as consumption is a good proxy for the economic well-being of people, **annual GDP or income**

per person is a relevant measure of prosperity. Clearly, not only the average income per person but also the **distribution of income** across persons might be of interest or the relationship of **income to happiness** etc.

■ Nevertheless, **we will be much concerned with economic growth**, i.e. the **annual increase in GDP per person**. We are interested in **growth, not as an end in itself**, but because the way a country can reach a higher level of income is through a process of growth.

■ Figure 2.1 gives some clear illustrations of the importance of gradual growth for reaching higher, or falling to lower, levels of income per person. Note that the figure shows **GDP per worker** (GDP per person in the labour force), not GDP per capita (GDP per person in the population) for reasons to be explained.
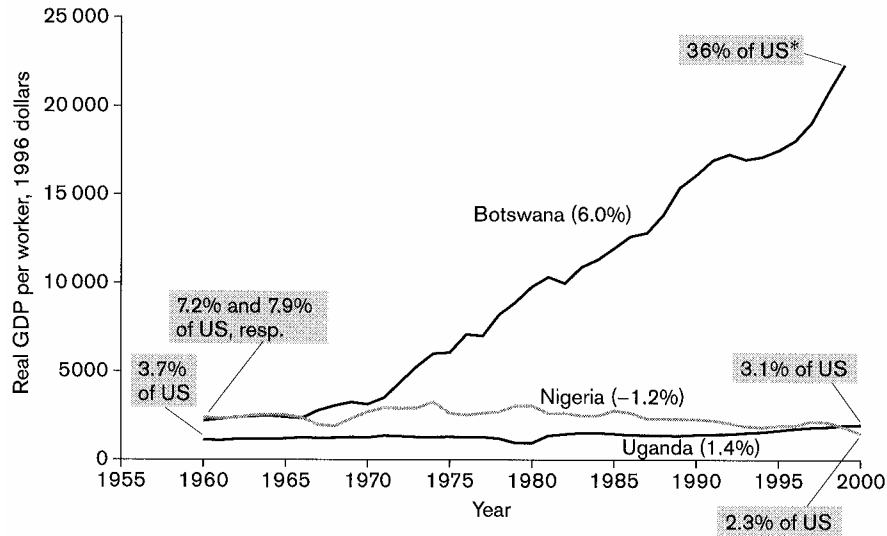
Figure 2.1: The importance of growth in GDP per worker for the level of GDP per worker

■ Around 1960, three African nations, **Botswana, Nigeria and Uganda**, were all at about the same level of GDP per worker, and this level was very low by international standards. Over the subsequent 40 years, **GDP per worker in Botswana grew at an impressive average rate** of about 6 per cent per year, while the growth rates of Nigeria and Uganda were –1.2 per cent and 1.4 per cent, respectively. This implied that around the year 2000 the level of GDP per worker in Botswana was more than **10 times greater** than in Nigeria and Uganda. By 2000 Botswana had not become extremely rich, but rather than having, as Nigeria and Uganda, a GDP per worker at or below 3 per cent of the US level, Botswana had reached a level of 36 per cent of US income per capita. The **differences in the conditions of life** caused by these different growth experiences are not difficult to imagine.

■ In 1960 **Venezuela was one of the world's richest countries** with a GDP per worker of 83 per cent of the US level, while **Italy was considerably behind** at 55 per cent of the US level. However, until 2000, average annual growth in Italy was 2.9 per cent, but in Venezuela it was negative. Today it is **Italy, not Venezuela, that is one of the world's richest countries**, with

a GDP per worker at 84 per cent of the US level. Venezuela has fallen to 28 per cent of the US level.

■ **What allows a country to escape from poverty**, or to achieve prosperity, is a **process of growth** over a succession of years. Therefore one of the **most important questions in economics**, probably the most important one, is: **what creates growth?**

■ **Growth theory** and **growth empirics** are fascinating subjects in economics. We start by stating and discussing some **empirical regularities** concerning prosperity and growth. These "**stylized facts**" **constitute important knowledge** in themselves. They will also be used later on as **yardsticks**: the **growth theory** to be presented will be **held up against the empirical facts**.

Measuring the wealth of a nation

■ Agreeing with Adam Smith that the ratio of the annual "produce" to "the number of those who are to consume it" is a relevant measure of the average standard of living in a nation, we

will use **GDP per person as a proxy for living standards**. You are assumed to know about statistics such as GDP, total consumption, total investment, etc., from an earlier course in macroeconomics. We will therefore only discuss a few aspects of measuring economic welfare by GDP per person.

■ Suppose we would like to **compare the standard of living** between a **highly developed country** such as the US, and a somewhat **less developed country** with relatively fewer transactions in the official market economy and relatively more self-sufficiency. The GDP of each country is the value of the **"official" marketed production**.

■ First, a comparison between the two countries requires that their **GDPs be measured in the same currency**, say US dollars. For this purpose we need an **exchange rate that converts** amounts denominated in the currency of the less developed country, the peso say, into amounts in dollars.

■ It may be **misleading to use the official prevailing exchange rate** between the peso and the dollar since prevailing exchange rates are **volatile**. A 10 per cent increase in the peso

relative to dollars from one month to the next will typically not reflect that the less developed country has become 10 per cent richer compared to the US in one month. It will rather be a reflection of some change in expectations.

■ **Current exchange rates are not appropriate for converting GDPs** if one is interested in standards of living. Instead one should use a **rate of conversion that reflects purchasing power**. The **total cost of a relevant bundle of goods** should be computed in the two countries, and the **purchasing-power-adjusted exchange rate** could then be defined as the relation between the two total costs. If the bundle has a total cost of 1000 dollars in the US, and a cost of 100,000 pesos in the less developed country, the purchasing-power-adjusted exchange rate is one dollar for 100 pesos. One should use this computed exchange rate to convert the GDP of the less developed country into a purchasing-power-adjusted GDP in US dollars.

■ According to **GDP per capita**, Ireland was 79 per cent as rich as the US in 2000, but measuring by **GDP per worker**, **Ireland was just as rich as the US**. The difference is a reflection of the **much higher participation rate in the US**. Nevertheless, it can still be

argued that **GDP per worker is a more appropriate measure** of economic standards of living than GDP per capita, because **home production and leisure** should **also count**.

■ **GDP per worker is closer to a productivity measure** than GDP per capita. **In the growth models** presented in the subsequent lectures, **average labour productivity is a key variable**, and **productivity has a closer correspondence to GDP per worker** than to GDP per capita.

■ Since **we want a close correspondence between our empirical and theoretical variables**, this is **another reason for studying GDP per worker**. By this argument one should perhaps go all the way to **GDP per work hour** to allow not only for differences in participation rates, but also for **differences in annual working time and unemployment rates**. Lack of good internationally comparable statistics for annual work hours prevents this.

■ The **statistics** used for international comparison in these lectures are of the **purchasing-power-adjusted** type, and we will mainly use **GDP per worker as a proxy for the standard of living and for labour productivity**.

■ Data will, to a large extent, come from a database called the **Penn World Table** (PWT) (http://pwt.econ.upenn.edu/Downloads/index.htm), which is an attempt to create **internationally comparable statistics** relevant for growth issues for the countries of the world for a considerable period.

The rich and the poor, the growing and the declining

■ We have already given some **illustrations of the enormous differences** between rich and poor countries, and of the fact that **some countries have managed to develop** from poor to not so poor through a good growth performance. We now go into more detail about the issues of **poverty and prosperity**, and about moving **in and out of these categories**.

The world income distribution

■ Some countries are poor and some are rich, but **is there any sign that the world income distribution has become more equal** over, say, the last 40 years? We can investigate this by

means of so-called **Lorenz curves**. Figure 2.2 shows two Lorenz curves for the world, one for 1960 and one for 1998. A **point (*x*, *y*) on a Lorenz curve** indicates that the **fraction *x* of the people in the world with the smallest incomes earns the fraction *y* of all the income** in the world. For instance, the Lorenz curve for 1960 shows that in that year, the 60 per cent of the world population that lived in the poorest countries earned around 15 per cent of the world's income. In 1998 the corresponding figure was around 20 per cent.
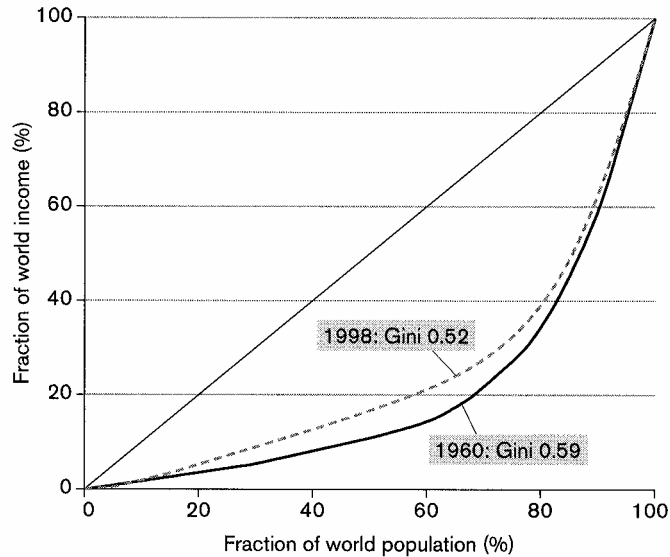
Figure 2.2: Lorenz curves for the world, 1960 and 1998, 104 countries (Source: Penn World Table 6.1)

■ **Absolute equality** corresponds to a **Lorenz curve identical to the 45° line**. **The further the Lorenz curve is below the diagonal, the more unequal is the income distribution**. Therefore the **area between the diagonal and the Lorenz curve**, as a fraction of the entire area below the diagonal, is an aggregate **measure of inequality**. This measure, called the **Gini coefficient**, is a number between zero and one, and the closer it is to one the more inequality there is. The Gini coefficients for 1960 and 1998 are shown in Figure 2.2, and they are 0.59 and 0.52, respectively.

■ Investigating the Lorenz curves and the Gini coefficients reveals that **there were enormous income differences in the world both in 1960 and in 1998**. Between the two years the world income distribution does seem to have become **more equal, but not much**, and **not at the bottom**.

■ Most of the **improvement** indicated by Figure 2.2 comes from the relatively **good growth performances of some heavily populated countries**, in particular **China**, but also **India** and **Pakistan**. This still **neglects the influence of inequality within countries** by attributing the same income to all persons in each country. Although more thorough studies of the evolution

in the world income distribution, which account for inequality within countries, reach conclusions similar to the one appearing from our more crude analysis.

> **Stylized fact 1**. Some countries are rich and some are poor. The **differences are enormous**, and it has pretty much **stayed like that in relative terms over the last 40 years**. However, there is **some tendency towards a more equal world income distribution**, but **not much at the bottom**.

■ Two features should be noted. First, the **Lorenz curve** and the associated Gini coefficient illustrate the **income distribution in relative terms**. If the Lorenz curve had been completely unchanged from 1960 to 1998 it would mean that the percentage change in income per capita in the **world's poorest country would have been the same as in the richest country**.

■ **In absolute terms the poorest country would be much less poor** by 1998 than in 1960. Indeed, the **world average income per worker** (computed with population sizes as weights) increased from 1960 to 1999 by an average annual rate of 1.9 per cent, corresponding more or less to a **doubling over the full period**.

■ Second, it is **not exactly the same countries** that are the poorest (or the richest) in 1960 and 1998. The fact that the 10 per cent of people living in the poorest countries earned only around 1.5 per cent of world income in 1960 as well as in 1998 **does not mean that it is impossible to escape from poverty**. There were some countries that did move out of the group of the poorest countries by having high growth (compared to the world). However, the other countries that took their place among the poorest had sufficiently bad growth experiences to ensure that the group of poorest countries did not increase their share of the world's income.

■ For instance, **in 1960 China was among the poorest** with a level of GDP per worker at 4.3 per cent of that in the US. By 1998 China had advanced to 8.9 per cent of the US level. Hong Kong and Ireland, starting at levels of GDP per worker relative to the US of 19 per cent and 43 per cent, respectively, moved into the top 15, and ended at levels 79 per cent and 91 per cent, respectively. Most **spectacular dropouts** of the top 15 were **Argentina, Venezuela and New Zealand**.

■ Since **a country can move from poor to rich through a process of growth, and vice versa**, it is of interest to **look directly at growth performances**. You have probably heard about so-called **"tiger economies"** of **East Asia**: Taiwan, Hong Kong, South Korea, and also Japan. These countries are often called **"growth miracles"**. Likewise, there are countries that can be called **"growth disasters"**.

■ Altogether, our insights can be summarized as follows:

Stylized fact 2. **Growth rates vary substantially** between countries, and by the process of growing or declining **a country can quickly move** from being relatively poor to being relatively rich, or from being relatively rich to being relatively poor.

Stylized fact 3. **Growth can break** in a country, turning from a high rate to a low one or vice versa.

■ There is **nothing inevitable about growth**. However, it illustrates once again that the **fight against poverty is not a hopeless one**. In particular, **one cannot point to a continent or part of the world in which the break in growth from low to high should be impossible**.

■ We stress this because sometimes in the public debate it is taken for granted that countries in some parts of the world, sub-Saharan Africa or the Middle East for instance, will never be able to grow out of poverty. The **data simply do not support such an idea**. There are **no growth-preventing areas** in the world, but there may be **growth-preventing policies or circumstances** (such as civil war, for instance).

■ Most of all, Stylized fact 3 raises again the perhaps most important question in economics: **how can a country create a positive growth break? What kinds of policies** can do that?

■ **Growth theory and empirics can contribute** some possible answers.

Convergence

■ An **interesting idea** in economics would, if it were true, imply that **poverty should disappear by itself**.

Absolute convergence

■ Figure 2.3 plots the **log of annual GDP** per worker for the period 1950 to 2000 for a selection of OECD member countries in 1998. A glance at the figure suggests that **all the countries tend to approach one and the same "growth path"**.

■ Since $\ln y_t - \ln y_{t-1}$ is (approximately) the rate of growth in y_t, in a figure showing $\ln y_t$ against time t, **constant growth corresponds to a straight line**, and the **slope of the line is the growth rate**. Figure 2.3 suggests **a tendency for countries to approach one and the same upward sloping straight line**, perhaps more or less a line corresponding to the USA.
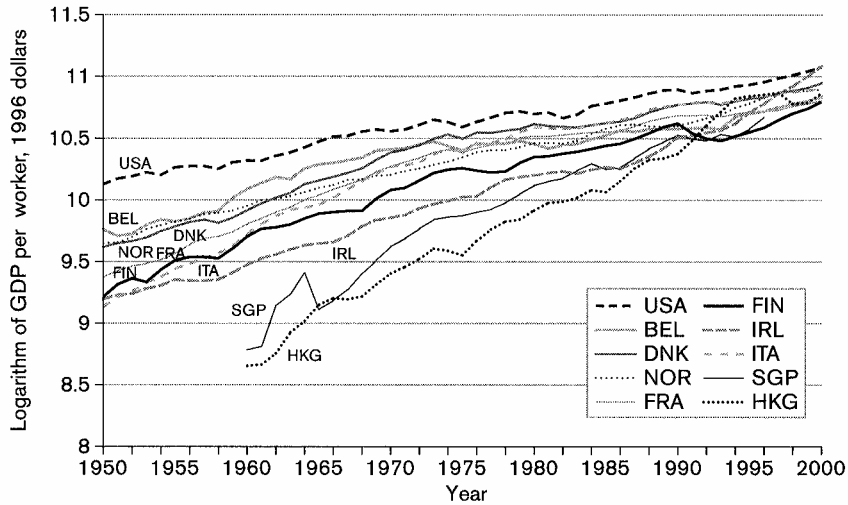
Figure 2.3: Convergence of GDP per worker among selected countries, 1950-2000

Source: Penn World Table 6.1

■ Figures like Figure 2.3 (drawn for even longer periods, up to 100 years and more) were presented by William J. Baumol in a famous article "Productivity Growth, Convergence and Welfare: What the Long-Run Data Show", *American Economic Review*, 76, 1986, suggesting some of the "laws" discussed below. Such figures open up the **fascinating possibility that the differences with respect to output and income per person between the countries of the world automatically vanish in the long run**. This possibility is sufficiently intriguing to have a name of its own:

The Hypothesis of Absolute Convergence. In the long run GDP per worker (or per capita) converges to one and the same growth path in all countries, so that **all countries converge on the same level of income per worker**.

■ A main reason why this hypothesis is so fascinating is the **implication that poverty should disappear by itself in the long run**. The hypothesis of absolute convergence implies

that **countries with relatively low levels of GDP per worker in an initial year will grow relatively fast** after that initial year.

■ In other words, **average growth in GDP per worker from year 0 to year T**, say, **should be negatively correlated with GDP per worker in year 0**. Indexing countries by i, and denoting country i's GDP per worker in year t by y_t^i, the following equation (where the left-hand side is the approximate average annual growth rate in GDP per worker, β_0 is a constant, and β_1 is a positive parameter) should then be expected to fit well:

$$(\ln y_T^i - \ln y_0^i)/T = \beta_0 - \beta_1 \ln y_0^i \qquad\qquad 2.1$$

■ Figure 2.4 plots the **average annual growth rate of GDP per worker from 1951 to 2000 against the log of GDP per worker in 1951** for all OECD member countries in 2000 for which data were available from the PWT.
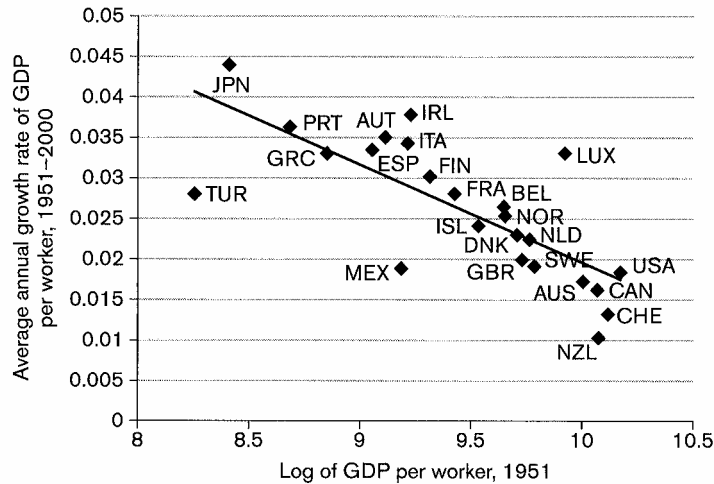
Figure 2.4: Average annual growth rate of GDP per worker against initial level of GDP per worker, 24 OECD countries

Source: Penn World Table 6.1

■ The country points in Figure 2.4 are **nicely located along a decreasing straight line**. The line that has been drawn in the figure is a best fit to the points according to a standard statistical method, ordinary least squares (OLS) estimation. The line has the particular formula:

$$(\ln y^i_{00} - \ln y^i_{51})/49 = 0.14 - 0.012 \ln y_0^i \qquad\qquad 2.2$$

■ Figure 2.3 and Figure 2.4 **seem to support the hypothesis of absolute convergence**, but they **only present data for some countries**. This would **not be so much of a problem if those countries were randomly selected** and representative. However, **they are not**.

■ Both figures have, in different ways, **selected countries which had relatively high and relatively similar GDPs per worker in 2000**. Figure 2.4, for instance, focuses on the **club of relatively rich OECD members** in 2000. The **countries** in Figure 2.4 that had relatively low GDPs per worker around 1950 **must have grown relatively fast to be able to join the rich club** in 2000. The **selection of countries thus has a bias in favour of the hypothesis** we are

testing. This problem is known as the "**sample selection bias**" problem, and was noted in the present context by J. Bradford DeLong ("Productivity Growth, Convergence, and Welfare: Comment", *American Economic Review*, 78, 1988).

■ To avoid the sample selection bias problem one should try to **get a more representative sample**. One way to proceed is as follows: in order to have good standardized data for a large number of countries, consider the somewhat shorter period from 1960 to 2000, and **include all countries** for which the relevant data for this period are available from the PWT.

■ Figure 2.5 plots the average growth rate of GDP per worker from 1960 to 2000 against the log of GDP per worker in 1960 for **randomly selected countries**.
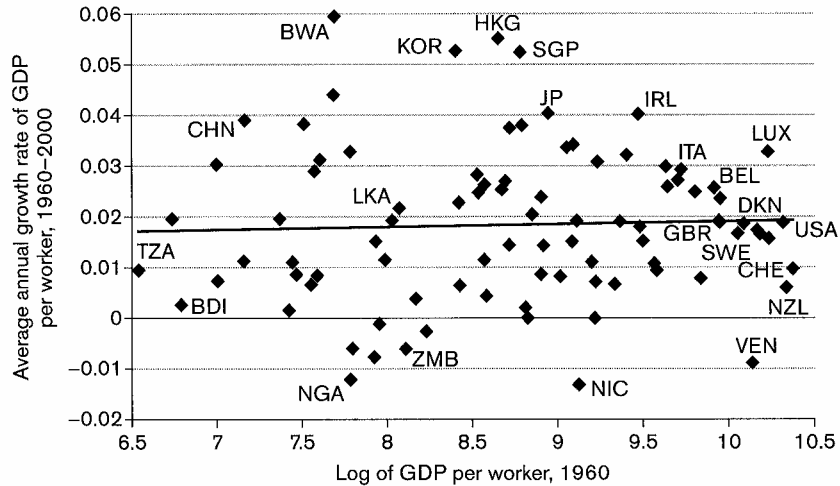
Figure 2.5: Average annual growth rate of GDP per worker against initial level of GDP per worker, 90 countries

Source: Penn World Table 6.1

■ The **nice negative relationship has disappeared**. The slope of the **line of best fit has even become positive**, but the **line fits so poorly** that we cannot attach any statistical significance to its slope. Since absolute convergence implies a clear negative relationship, we have to draw the sad conclusion: the **hypothesis of absolute convergence does not hold**.

Conditional convergence

■ **Absolute convergence is too much to hope for**, because **countries** in Figure 2.5 **differ considerably with respect to basic structural characteristics**. For instance, **some countries have higher rates of saving and investment** than others. Savings and investment accumulate as capital. We should therefore expect **countries with higher savings rates to have higher GDP per worker**, but then **GDP per worker cannot converge to one and the same level for all countries**.

■ Similarly, **some countries spend a larger fraction of GDP on education** (investing in **human capital**) than others, and education makes labour more productive. Countries with

higher investment rates in human capital should therefore be expected to approach higher levels of GDP per worker.

■ A third structural characteristic likely to be important is **population growth**. Higher population growth means that a **larger number of people will come to share the physical and human capital** accumulated in the past. Other characteristics being equal, this should pull GDP per capita down, again preventing absolute convergence.

■ Consider two countries with the same level of GDP per worker in an initial year zero, and suppose that the first country has more favourable structural characteristics than the second. Since the first country will then approach a higher level of GDP per worker than the second, it will also have higher average growth in GDP per worker over a period after year zero. Such reasoning has led to a **weaker notion of convergence**:

The Hypothesis of Conditional Convergence. A **country's income per worker** (or per capita) **converges to a country-specific long-run growth path** which is given by the basic structural characteristics of the country. The further below its **own long-run growth path** a

country starts, the faster it will grow. Income per worker therefore converges to the same level across countries **conditional on the countries being structurally alike**.

■ Again the **convergence hypothesis implies a relationship between the initial level of and the subsequent growth in GDP per worker**: other things (basic structural characteristics) being equal, countries with relatively low levels of GDP per worker in an initial year will grow relatively fast after that initial year. The crucial addition compared to the absolute convergence hypothesis is the phrase "**other things being equal**". According to the hypothesis of conditional convergence, it is **only after controlling appropriately for structural differences** that one should find a negative relationship between initial GDP per worker and subsequent growth. The correct equation would not be 2.1 above, but perhaps an equation like

$$(\ln y_T^i - \ln y_0^i)/T = \beta_0 - \beta_1 \ln y_0^i + \gamma(\mathbf{z}^i) \qquad\qquad 2.3$$

where $\mathbf{z}^i$ is a **vector of variables capturing country-specific structural characteristics**, and γ is a function expressing their influence.

■ The hypothesis of **conditional convergence does not imply that poverty would disappear by itself** in the long run. Nevertheless, **conditional convergence is also a fascinating possibility**. It does imply that **if a poor country can manage somehow to achieve the same structural characteristics as rich countries**, it will become as rich in due time.

■ To work seriously with an equation like (2.3), for example testing it against data, one must have an idea of **how to handle the structural variables**. Which economic variables should be included in $\mathbf{z}^i$ and what should the function γ look like? We have argued intuitively above that the rates of **investment** in physical and human capital and the **population growth** rate should probably be included, but this does not tell us how they should enter.

■ A good **answer will require some growth theory**. At this stage it will be illustrative to consider a specific version of (2.3), which is for now postulated, but will be rooted in theory

later on. So, **assume** that (among) the relevant structural characteristics of country i are the rate of investment in physical capital (the GDP share of gross investment in physical capital), s^i, and the population growth rate, n^i. Assume further that the appropriate way they enter is

$$(\ln y^i_T - \ln y^i_0)/T = \beta_0 - \beta_1 \ln y_0^{i} + \beta_2(\ln s^i - \ln(n^i + 0.075) \qquad 2.4$$

■ Consider the same countries and years as in Figure 2.5. Measure s^i and n^i as the country's **average gross investment rate** and its **average population growth** rate, respectively, over the period 1960 to 2000. Assume that the appropriate value of the parameter β_2 is 0.020 (later we will explain this value). Finally, create a diagram like Figure 2.5, still with $\ln y^i_{60}$ along the horizontal axis, but now **measure the growth rate adjusted for country-specific structural characteristics up along the vertical axis**. Figure 2.6 then results.
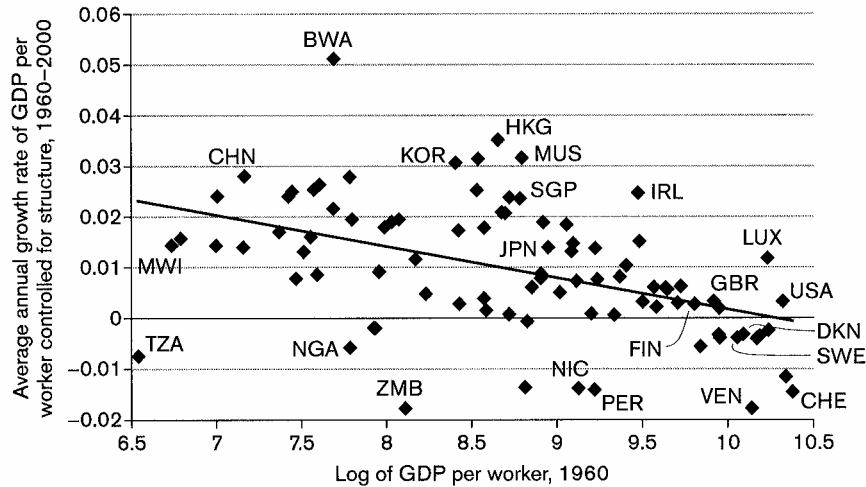
Figure 2.6: Average annual growth rate of GDP per worker adjusted for structural characteristics against the initial level of GDP per worker

Source: Penn World Table 6.1

■ The points in Figure 2.6 do seem to be **clustered around a negatively sloped straight line**. Hence, **controlling** for some structural differences **makes the negative relationship between initial GDP per worker and subsequent growth visible again**, and we have **not even controlled for all the structural characteristics** that should be important on *a priori* grounds. **Education** has not been taken into account. This will make the picture even more compatible with conditional convergence.

■ Based on **theoretical and empirical work**, most economists believe that **if one puts the right structural characteristics** into z^i, and does it **in the right way**, then indeed one will end up with a significant and positive estimate of the β_1 in (**2.4**). That is, if one controls appropriately for the influence of structural characteristics, growth in GDP per worker is negatively correlated with the initial level of GDP per worker for the countries of the world. **This accords with the hypothesis of conditional convergence**.

Club convergence

■ According to the **hypothesis of conditional convergence**, the **long-run growth path** of each country is **given entirely by the country's structural characteristics**. It is independent of the country's initial level of GDP per worker: the **starting point has no influence on the long-run growth path**.

■ Some **economists doubt that this is really true**. They argue that indeed the **initial position of a country may have an influence on the level of the growth path** that the country is approaching in the long run. In this way **history can have a permanent impact** – its influence is not washed out in the long run.

■ What these economists have in mind is that **there is a certain threshold value of GDP per worker** (or perhaps there are several thresholds, but here we present the idea in its simplest version), **which may be country-specific**, such that **if a country happens to start below that value, it will converge to one growth path**, and **if it happens to start above, it will converge to another path**. The **two growth paths may have the same constant growth rate, but they differ with respect to their levels**: the first path lies below the second. Figure 2.7 gives an illustration of **club convergence**.
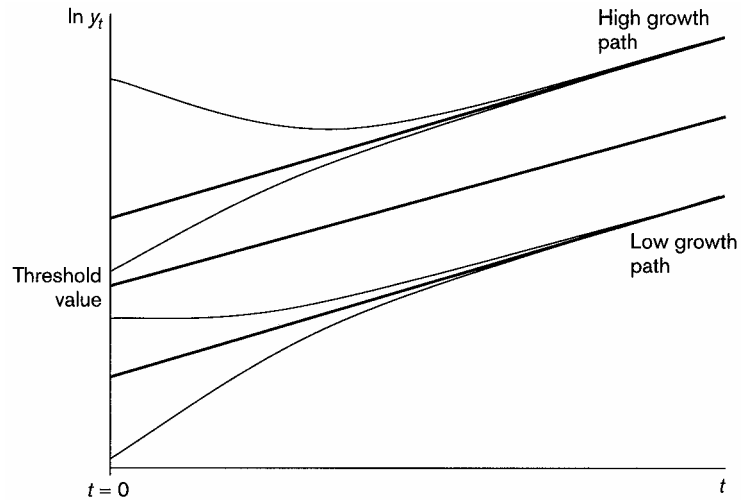
Figure 2.7: Club convergence

■ The meaning of the term **"club"** is that **countries that start off on the same side of the threshold value are in the same category**. Stating the hypothesis comprehensively, what must be changed from the definition of conditional convergence above is that the **long-run growth path depends not only on structural characteristics, but also on the economy's starting point**.

The Hypothesis of Club Convergence. A country's income per worker (or per capita) converges lo a long-run growth path that depends on the country's basic structural characteristics and on whether its initial GDP per capita is above or below a specific threshold value. The **further below the relevant growth path a country starts out, the faster it will grow**. Income per worker therefore converges to the same level across countries **conditional** on the **countries being structurally alike** and on the **countries starting on the same side of their respective threshold values**.

■ One can write down sound economic growth models that support the idea of conditional convergence, as well as models supporting the idea of club convergence. Likewise, **some empirical analyses are in favour of conditional convergence**, and **some are in favour of club convergence**. At present the **issue of conditional or club convergence is unsettled**.

■ We may sum up our discussion of convergence below in Stylized fact 4. You should be warned, however, that the issue of convergence is perhaps a bit more controversial than our use of the word "fact" suggests:

> **Stylized fact 4. Convergence**: If one **controls appropriately for structural differences** between the countries of the world, a **lower initial value** of GDP per worker **tends to be associated with a higher subsequent growth** rate in GDP per worker. This accords with the idea that in the long run income and GDP per worker **converge to a country-specific growth path** which is given by the country's **basic structural characteristics**, and **possibly also by its initial position**.
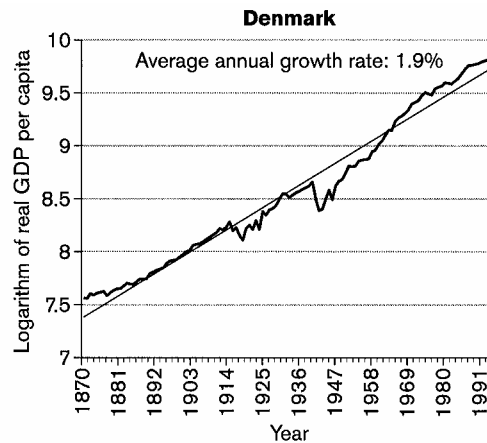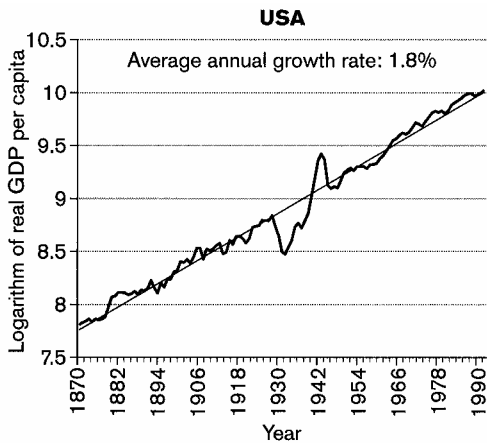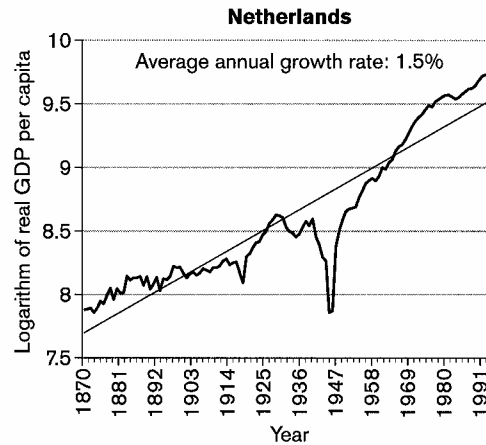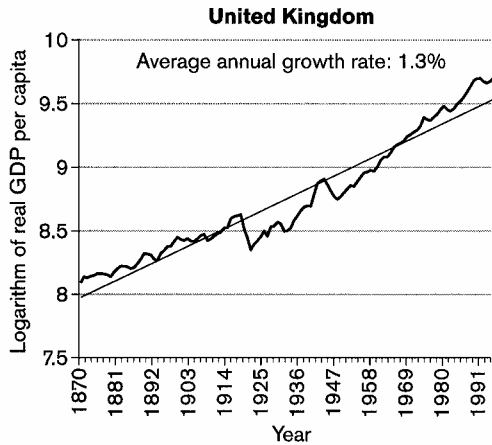
The long-run growth process

■ The previous section was concerned with the relationship between the growth processes in different countries. Now we will **focus on the long-run growth process within a single and steadily growing economy**, that is, on **growth along the country's own long-run growth path**.

■ To separate convergence to the growth path from the long-run growth path itself, we should look at very long series of GDP per person. It turns out that indeed many of the **countries that industrialized early have had relatively constant growth in GDP per person** over quite long periods.
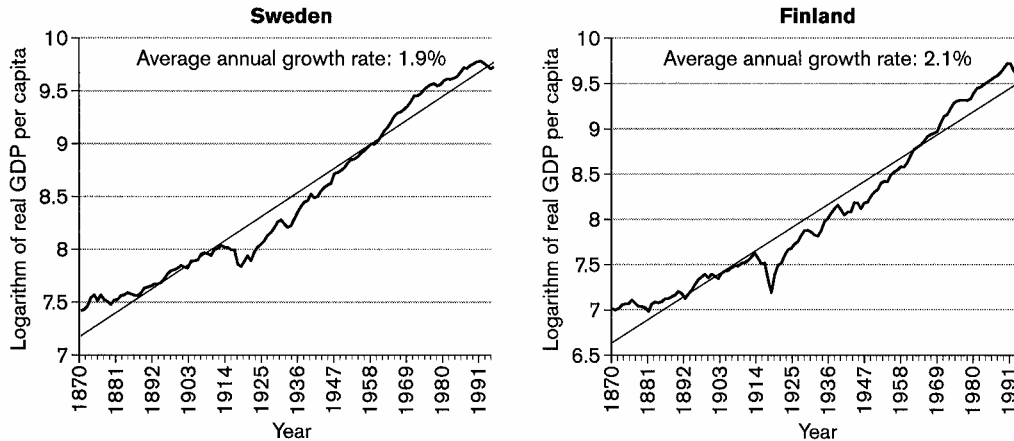
Steady long-run growth

■ Figure 2.8 shows the evolution of the **log of GDP per capita in a number of Western countries** for periods exceeding 100 years, and it also shows the linear trends. **Disregarding shorter run fluctuations and the influences from great wars and depressions**, Figure 2.8

shows for each country a **remarkable tendency towards a constant and positive rate of growth** in output per capita.

United Kingdom

Average annual growth rate: 1.3%

Logarithm of real GDP per capita

Netherlands

Average annual growth rate: 1.5%

Logarithm of real GDP per capita

Year

Year

**Figure 2.8: GDP per capita, Western countries**

Source: Angus Maddison, *Monitoring the World Economy 1820-1992*, OECD, 1995.


Stylized fact 5. Over periods of more than 130 **many countries in Western Europe and North America have had relatively constant annual rates of growth** in GDP per capita in the range of **1.5-2 per cent**.

■ Because of a lack of very long run data for GDP per worker, Figure 2.8 shows GDP per capita. However, there is good reason to believe that **GDP per worker has also grown at constant (slightly lower) rates** in the countries considered, **since participation** rates have typically **increased gradually**.

■ The countries that have experienced relatively constant growth have typically had **remarkably constant factor income shares** over long periods **as well**. The "law" of stable income shares is illustrated in Figure 2.9, which shows the evolution of the **income share of labour** for six OECD countries, five of which also appear in Figure 2.8.
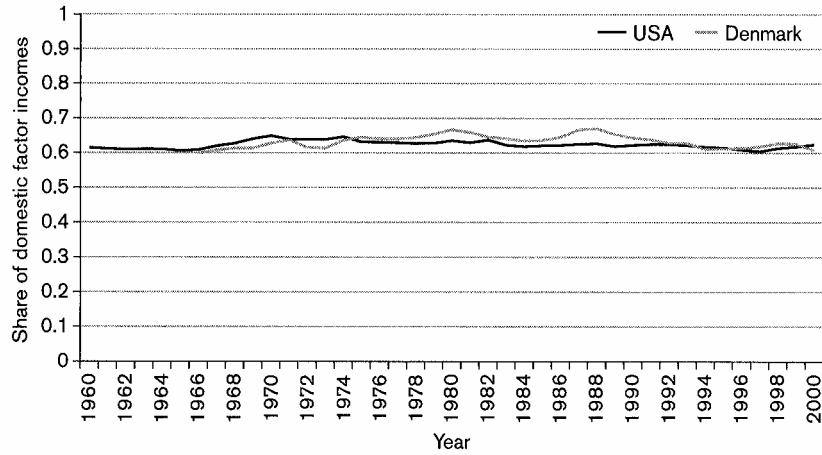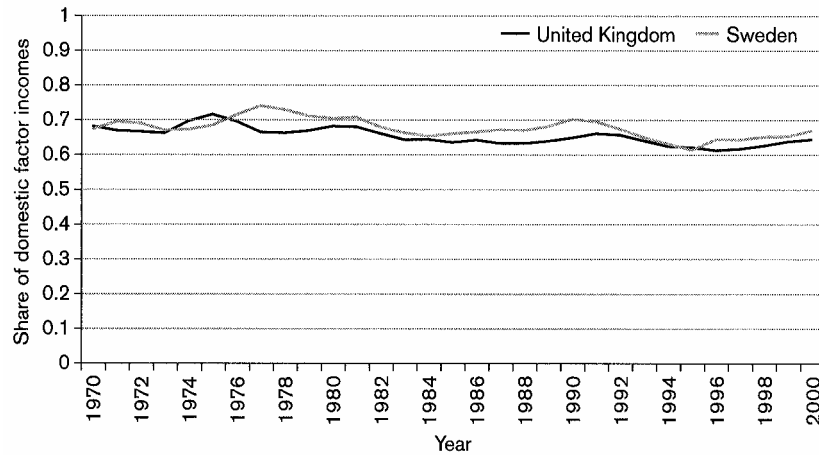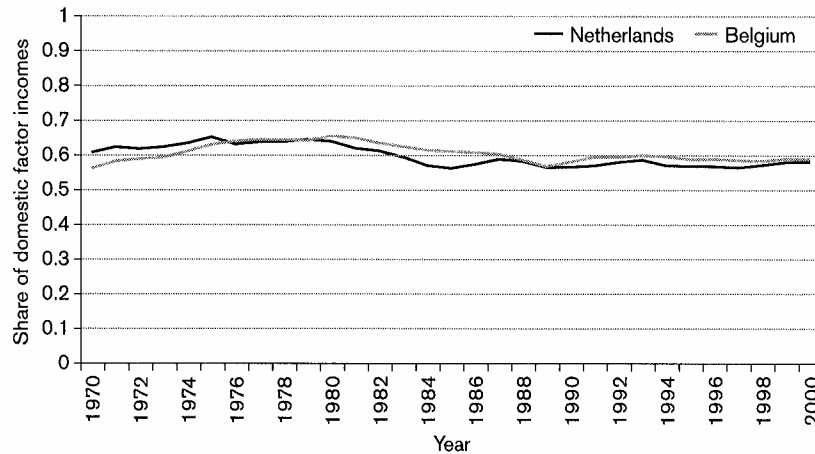
Figure 2.9: Labour's share of domestic factor incomes

Note: Labour income is compensation to employees. Domestic factor income is compensation to employees plus gross operating surplus and gross mixed income. Source: USA: Bureau of Economic Analysis; remaining countries: OECD National Accounts.

■ Not only does labour's share not show any long-run trend, the **relatively constant labour share turns out to be relatively close to 2/3** in all the countries. There are considerable short-run **cyclical movements in labour's share** (not so visible from Figure 2.9), but the long-run evolution in the labour income share is fairly precisely described as being constant.

■ Consider a Western economy that has experienced steady annual growth in GDP per worker, $y_t = Y_t/L_t$, where Y_t and L_t are the **GDP** and the **number of workers** in year t, respectively. Labour's share in year t is $w_t L_t/Y_t$, where w_t is the average real wage per worker. We can rewrite labour's share as $w_t/(Y_t/L_t) = w_t/y_t$. Hence, **if y_t has grown at a relatively constant rate**, and labour's share has stayed relatively constant, the **average real wage rate must have been increasing by more or less the same rate as GDP per worker**. Steady growth in GDP per worker, and a constant labour income share implies steady growth in the real wage.

> **Stylized fact 6.** During the long periods of relatively constant growth rates in GDP per worker in the typical Western economy, **labour's share of GDP has stayed relatively**

constant, and (hence) the average **real wage of a worker has grown by approximately the same rate as GDP per worker**.

■ If labour's share has been relatively constant, so must the **share of all other production factors** since this **latter share is one minus labour's share**. Let us call the other factors "**capital**", including into this category not only reproducible **physical capital**, but also, for example, **land and other natural resources**.

■ Let the total capital input in year t be denoted by K_t. If we denote the **rate of return on capital** by r_t then capital's share is $r_t K_t / Y_t = r_t / (Y_t / K_t)$. Hence, **constancy of capital's share implies that the real rate of return on capital, r_t and the output-capital ratio, Y_t/K_t, must have been changing by the same rates.**

■ Over long periods there **should be no systematic differences between the trends in the real rates of return on different types of assets**. **If the rate of return on capital** (as defined here) over a long period **increased by one half of a per cent per year**, say, **while over the same period the real rate of interest on bonds stayed constant**, **investment in**

real capital would soon **become much more advantageous than buying bonds**. This would direct portfolios away from bonds and towards real capital, which would **tend to equalize the rates of returns between bonds and capital**.

■ In the long run the **trend of the rate of return on capital must**, therefore, **be anchored by the trend of real interest rates on bonds**. Figure 2.10 reports on the long-run behaviour of real interest rates over long periods in some Western countries. The figure shows that **real interest rates (as computed in the figure) fluctuate a lot, but there is no tendency for real interest rates to be systematically increasing or decreasing** over long periods: they have no long-run trend, upwards or downwards.

■ For purposes of **long-run analysis, real interest rates**, and hence the **real rate of return on capital**, may therefore be t**reated as if they were constant**.
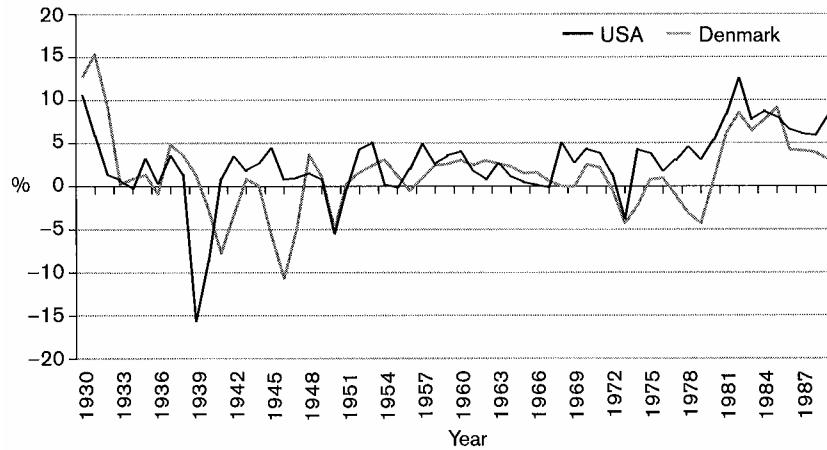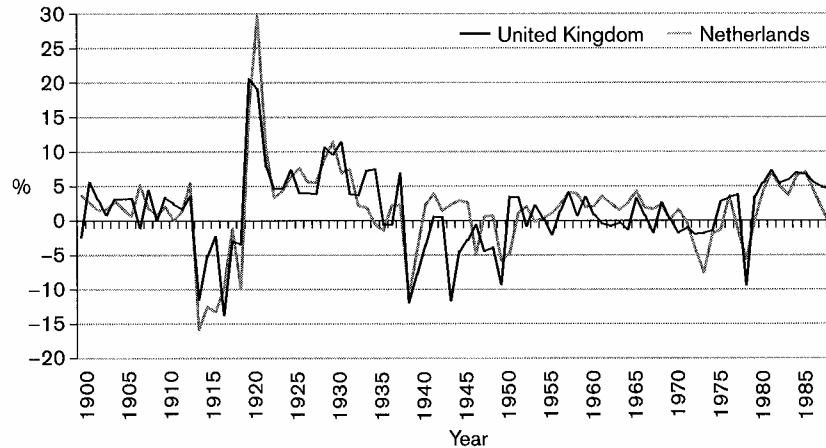
Figure 2.10. Real interest rates, Western countries

Note: The formula used for the real interest rate is $(1 + r)(1 + p) = 1 + i$, where r is the real interest rate, i is the nominal interest rate, and p is the relative change in consumer prices from the current period to the next period. The nominal interest rate used is the average annual yield on long-term government bonds.

Source: Interest rates from S. Homer and R. Sylla, *A History of Interest Rates*, Rutgers University Press, 1991. Consumer price indices from B.R. Mitchell, *International Historical Statistics*, 1750-1993, Macmillan, 1998.

■ If capital's share, $r_t/(Y_t/K_t)$, and the rate of return on capital, r_t, have both been relatively constant, then the output-capital ratio, Y_t/K_t and the capital-output ratio, K_t/Y_t, must also have been constant. We can rewrite the capital-output ratio as $K_t/Y_t = (K_t/L_t)/(Y_t/L_t) = k_t/y_t$, where we have denoted the capital-labour ratio, or capital intensity, K_t/L_t, by k_t. Constancy of K_t/Y_t implies that the **capital intensity grows at the same rate as GDP per worker**.

Stylized fact 7. During the long periods of relatively constant growth in GDP per worker in the typical Western economy, **capital's share and the rate of return on capital have shown no trend**, (therefore) the **capital-output ratio has been relatively constant**, and the **capital intensity has grown by approximately the same rate as GDP** per worker.

Balanced growth

■ The **empirical regularities in our Stylized facts 5-7** are much inspired by a famous lecture given by the British economist **Nicholas Kaldor**, who **pioneered the approach of setting up the stylized facts and constructing theories to explain them** ("Capital Accumulation and Economic Growth", in *The Theory of Capital*, F.A. Lutz and D.C. Hague (eds), New York, St Martins, 1961).

■ All three **facts can be expressed** comprehensively **by three fundamental constancies**: the **growth rate of GDP per worker** is relatively constant, the **functional income distribution** between labour and "capital" is relatively constant, and the **rate of return on "capital"** is relatively constant. **All the other features** in our list of facts **follow from these constancies**.

■ The stylized facts have given rise to an **idealized picture of the long-run growth** process called "**balanced growth**". Consider an economy that fulfils the three constancies with an annual growth rate, g, in GDP per worker, a constant annual growth rate, n, in the number of workers, and for which total annual consumption is a constant fraction, $1 - s$, of total annual GDP (a realistic long-run feature for a typical western economy).

■ Since $Y_t = y_t L_t$, one has $\ln Y_t - \ln Y_{t-1} = (\ln y_t - \ln y_{t-1}) + (\ln L_t - \ln L_{t-1}) = g + n$, so **GDP grows at a constant rate equal to the sum of the growth rate of GDP per worker and the population growth rate**. Hence **total consumption**, $(1 - s)Y_t$ and **total investment**, sY_t, must also be growing at the rate, $g + n$. Finally, since $K_t = k_t L_t$, and k_t is growing at the same rate as y_t, **total capital** is growing at the rate, $g + n$.

> **Balanced Growth**. The growth process follows a **balanced growth path if GDP per worker, consumption per worker, the real wage rate, and the capital intensity all grow at one and the same constant rate, g,** the **labour force (population) grows at constant rate**, n, **GDP, consumption, and capital grow at the common rate, $g + n$,** the **capital – output ratio is constant**, and the **rate of return on capital is constant**.

■ **Along a balanced growth path the capital-output ratio is constant**. In fact, the constancy of the capital-output ratio is a main motivating factor behind the definition of balanced growth. We have argued indirectly for this constancy: **it follows from constant income shares and the absence of a trend in the rate of return on capital**, where we argued for the latter by pointing to the long-run behaviour of real interest rates. However, it

should be mentioned that there is some **controversy about whether long-run capital-output ratios are really constant**. Direct estimates of the long-run evolution of capital-output ratios, most notably some by the British economist and economic historian Angus Maddison, suggest that the **capital-output ratio may be close to constant in the US in the long run**, but in several other countries the ratio seems to have been gradually increasing over the last 100 years (Angus Maddison, *Dynamic Forces in Capitalist Development: A Long Run Comparative View*, Oxford University Press, 1991).

■ When we turn to growth models, **balanced growth will be of theoretical importance**. If a growth model predicts that the economy will converge to or move along a specific long-run growth path, then this path should be a balanced growth path, because of the empirical plausibility of balanced growth. Long-run accordance with **balanced growth** will thus be used as an **"empirical consistency check" of growth models**.

Summary

■ A country's GDP per worker may be used as a proxy for the average standard of living and the average productivity of labour in the country. In some countries the population participates much less in the formal market economy than in other countries. Focusing on GDP per member of the official labour force rather than on GDP per capita is a rough way of adjusting for this.

■ The empirical evidence on levels of GDP per worker reveals enormous income differences across countries. Combining data on GDP per worker with data on population size, we found that the relative cross-country income differences have declined a bit over the last 40 years, but there was no reduction in international inequality at the bottom of the world income ladder. The fact that the world income distribution has improved (slightly) in relative terms means that on average poor countries have enjoyed percentage increases in income per worker at or above the percentage increase in income per worker in the world in general. In absolute terms poverty has therefore become less severe, but at the same time the absolute international income differences between the richest and the poorest countries have increased.

■ The evidence shows that growth rates vary substantially across countries. By the process of growing or declining quickly, a country can move from being relatively poor to being relatively rich, or from being relatively rich to being relatively poor. Moreover, growth can break in a country, turning from a high rate to a low one, or vice versa. These facts indicate that the fight against poverty is not hopeless. On the other hand, a relatively prosperous country will not automatically remain so regardless of the policies it follows. These observations point to the importance of structural policies to promote or maintain economic growth.

■ The evidence seems to support the hypothesis that the world's countries converge in a conditional sense: if one controls appropriately for structural differences across countries, a lower initial value of GDP per worker tends to be associated with a higher subsequent growth rate in GDP per worker. In the long run income and GDP per worker thus converge to a country-specific growth path which is given by the country's basic structural characteristics (and possibly also by its initial position).

■ Over periods of more than 130 years, and probably up to 200 years, many countries in Western Europe and North America have had relatively constant annual rates of growth in GDP per capita in the range 1.5-2 per cent. During these long periods, labour's share of GDP has stayed relatively constant. Hence the average real wage of a worker has grown by approximately the same rate as GDP per worker. Furthermore, capital's share and the rate of return on capital have shown no trend, so the capital-output ratio has been relatively constant, that is, the stock of capital per worker has grown at roughly the same rate as GDP per worker.

■ The facts just mentioned have given rise to an idealized picture of the process of constant growth called "balanced growth". In this book balanced growth will describe a situation where GDP per worker, consumption per worker, the (average) real wage rate, and the capital-labour ratio all grow at one and the same constant rate, and the rate of return on capital is constant. We will use long-run accordance with balanced growth as an empirical consistency check for the growth models to be presented in coming lectures.