was probably also high the year before (and will be the year after). We can measure this persistence by the coefficient of correlation between the current unemployment rate and its own past values. The coefficient of correlation between two time series, \( x_t \) and \( x_{t-1} \), running through \( t = 1, \ldots, T \) and with averages \( \bar{x} = \frac{1}{T} \sum_{t=1}^{T} x_t \) and \( \bar{x}_{t-1} = \frac{1}{T} \sum_{t=1}^{T} x_{t-1} \) is:

\[
\rho = \frac{\sum_{t=1}^{T} (x_t - \bar{x})(x_{t-1} - \bar{x}_{t-1})}{\sqrt{\sum_{t=1}^{T} (x_t - \bar{x})^2 \cdot \sum_{t=1}^{T} (x_{t-1} - \bar{x}_{t-1})^2}}.
\]

It should be visible from the formula that the coefficient \( \rho \) measures the degree of (linear) covariance between the two series, that is, roughly the degree to which one series is above average when the other is above average. One can show that \(-1 \leq \rho \leq 1\), and \( \rho = 1 \) and \( \rho = -1 \) correspond to complete linear covariation along a straight line, \( x_t = a + bx_{t-1} \), with positive and negative \( b \), respectively. If \( u_t \) is the annual rate of unemployment and one lets \( x_t = u_{t-1} \), and computes \( \rho \) for the two series \( u_t \) and \( x_t \) (for \( t = 2, \ldots, T \)), one gets the coefficient of correlation between the rate of unemployment in one year and the year before. One can then let \( x_t = u_{t-2} \) to get the correlation with unemployment two years before, etc. Figure 11.5 shows such coefficients of correlation in unemployment for the USA and Denmark.

There is a clear positive correlation between the current rate of unemployment and the rates of unemployment in several previous years, and the degree of correlation decreases as one goes back in time. The tendency for high unemployment in one year to imply high unemployment in several previous and succeeding years is what we mean by the persistence in unemployment.

\[\begin{align*}
\text{USA, 1900-2002} & \\
\text{Coefficient of correlation} & \\
\rho_{u_{10}, u_{12}} & = 0.27 \\
\rho_{u_{10}, u_{09}} & = 0.33 \\
\rho_{u_{10}, u_{08}} & = 0.39 \\
\rho_{u_{10}, u_{07}} & = 0.46 \\
\rho_{u_{10}, u_{06}} & = 0.62 \\
\rho_{u_{10}, u_{05}} & = 0.66 \\
\rho_{u_{10}, u_{04}} & = 0.69 \\
\rho_{u_{10}, u_{03}} & = 0.72 \\
\rho_{u_{10}, u_{02}} & = 0.86 \\
\rho_{u_{10}, u_{01}} & = 1.00
\end{align*}\]

\[\begin{align*}
\text{Denmark, 1903-2002} & \\
\text{Coefficient of correlation} & \\
\rho_{u_{10}, u_{12}} & = 0.27 \\
\rho_{u_{10}, u_{09}} & = 0.33 \\
\rho_{u_{10}, u_{08}} & = 0.39 \\
\rho_{u_{10}, u_{07}} & = 0.46 \\
\rho_{u_{10}, u_{06}} & = 0.62 \\
\rho_{u_{10}, u_{05}} & = 0.66 \\
\rho_{u_{10}, u_{04}} & = 0.69 \\
\rho_{u_{10}, u_{03}} & = 0.72 \\
\rho_{u_{10}, u_{02}} & = 0.86 \\
\rho_{u_{10}, u_{01}} & = 1.00
\end{align*}\]
relative more. From the figure it seems that for both countries a 100 per cent increase in the rate of unemployment implies an approximately 200 per cent increase in long-term unemployment (perhaps somewhat less for the US), pointing to an elasticity of long term unemployment (as defined here) with respect to overall unemployment of around 2.

Stylized fact 5
Long-term unemployment varies positively and more than proportionally with overall unemployment.

As noted above, the most severe consequences of unemployment are felt by the long-term unemployed. Since higher unemployment means even higher long-term unemployment, this may be one of the main reasons for fighting high unemployment.

Does unemployment tend to be of equal size in different regions of the world? Perhaps it does in the very long run, as suggested by Fig. 11.1, but over substantial periods there can be considerable differences between major regions, as shown in Fig. 11.7. For a long time until the early 1980s, unemployment in Europe was lower than in America, but since then joblessness has been substantially higher in the EU than in the US.

Stylized fact 6
There can be large differences in unemployment across geographical areas for long periods of time.

Other systematic variations are also important. Fig. 11.8 shows rates of unemployment across educational groups for the US and Denmark. Although different educational categorisations have been used for the two countries, the general picture is clear:

Stylized fact 7
There are considerable and long-lived differences in rates of unemployment across educational groups with a broad tendency for higher education to mean lower unemployment.

Variations across other categories are of importance in different connections, e.g. across race or sex. However, a relatively high rate of unemployment for a particular
section of the population may, at least partly, reflect that this group contains relatively many unskilled people compared to the general population.

The final "law" we will focus on here is an important one, and the remainder of this chapter is more or less centred around it. Figure 11.9 shows annual rates of unemployment for four countries for the period from 1965 to 2000. For the USA and Denmark, Fig. 11.9 is thus just a close-up of the most recent part of Fig. 11.1.

We see that (except for a special period in the 1960s and early 1970s), even when the rate of unemployment is lowest, there is still a considerable amount of unemployment with annual rates above 4 per cent. Furthermore, if the rate of unemployment fluctuates around a certain "gravity level", as Fig. 11.9 and in particular Fig. 11.1 could indicate, this level seems to be somewhere between 5 per cent and 7 per cent in the countries considered. The period in the 1960s and early 1970s, where unemployment rates in some of the countries went all the way down to below 2 per cent, showed many signs that this was not a sustainable or equilibrium situation: inflation rose sharply in the countries in question. Accounting for this, the figures indicate that even in the best of times the lowest possible rates of unemployment are considerable, perhaps around 4 per cent, and gravity rates of unemployment are around 5–7 per cent.

Figure 11.1 indicates a strong similarity in the (very) long-run behaviour of the rate of unemployment between the USA and Denmark. In both countries the rate of unemployment seems to fluctuate around a common "natural" level of, say, 5 to 7 per cent. However, there may also be some indication, particularly from Fig. 11.9, that the natural rate of unemployment can shift over time, and Fig. 11.7 indicates that the natural rate can differ between countries or regions.

**Stylised fact 8**

When rates of unemployment are at their lowest, there is still a substantial amount of unemployment, seemingly around 4 per cent, and the natural unemployment rate that the annual rates fluctuate around is higher, around 5–7 per cent. The natural rate of unemployment seems to shift over time and can be different in different regions.

### 11.4 Short-run cyclical and long-run structural unemployment

This section links the various types of unemployment, short-run cyclical and long-run structural, to the different types of wage and price rigidity that economists think are associated with them. The section will therefore contain some repetition of material from Chapter 1.

#### Unemployment and excess supply of labour

Figure 11.10 illustrates a situation of unemployment in a labour market (disregarding mismatching). The figure assumes that the individual suppliers of labour take the nominal