Chapter 1: Descriptive statistics Continue
Time series data

- Slightly different techniques are used for time series data – data on one or more variable over time
- We look at investment data in the UK by way of example

Investment data: 1973-2005

Year	Investment	Year	Investment	Year	Investment
1973	15 227	1984	58 589	1995	118 031
1974	18 134	1985	64 400	1996	126 593
1975	21 856	1986	68 546	1997	133 620
1976	25 516	1987	78 996	1998	151 083
1977	28 201	1988	96 243	1999	156 344
1978	32 208	1989	111 324	2000	161 468
1979	38 211	1990	114 300	2001	165 472
1980	43 238	1991	105 179	2002	173 525
1981	43 331	1992	101 111	2003	178 751
1982	47 394	1993	101 153	2004	194 491
1983	51 490	1994	108 534	2005	205 843

Not very informative – we need a graph

Time series chart of investment

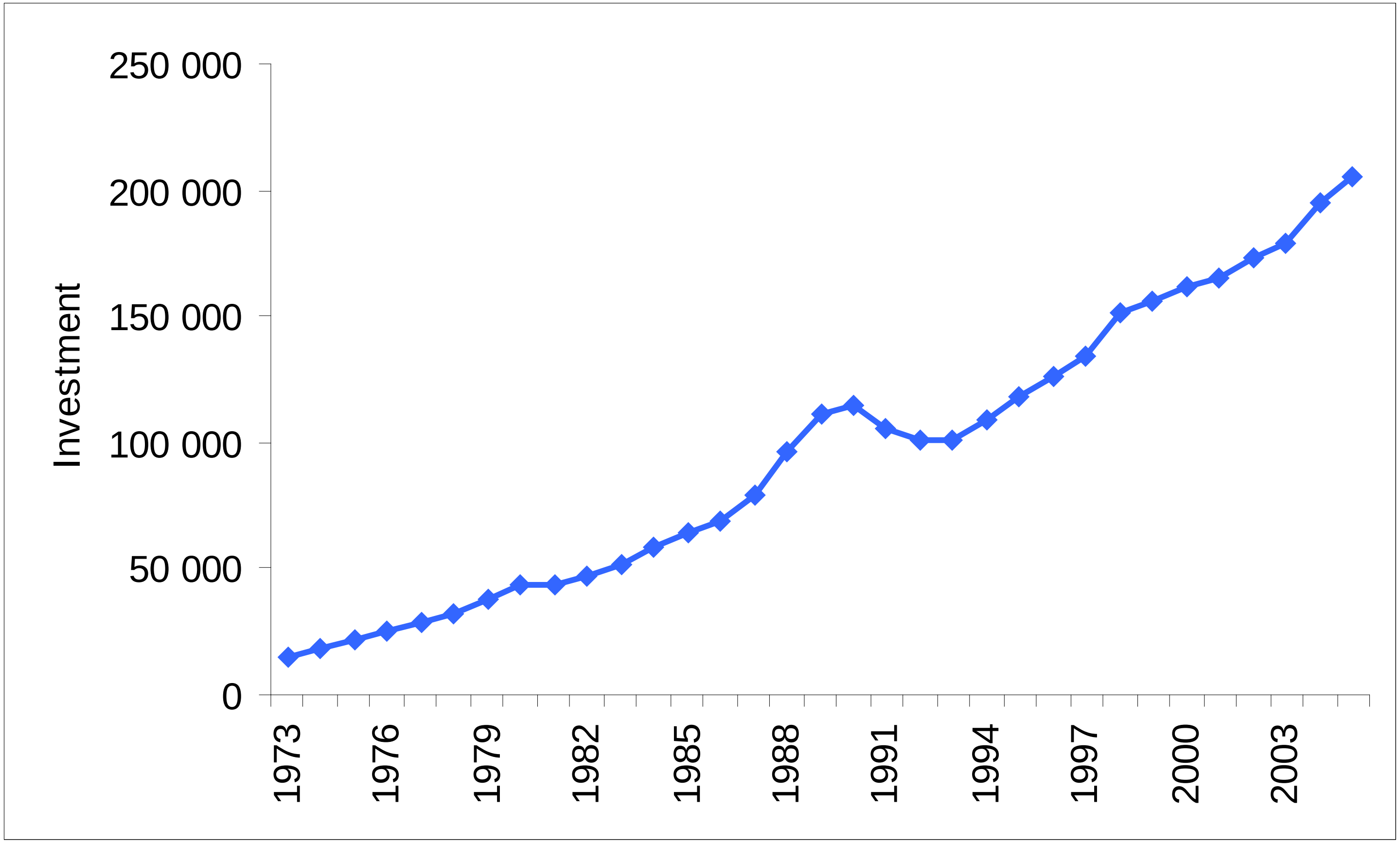

Figure 1.16 Time-series graph of investment in the UK, 1973–2005

Slide 1.37

Chart of the change in investment

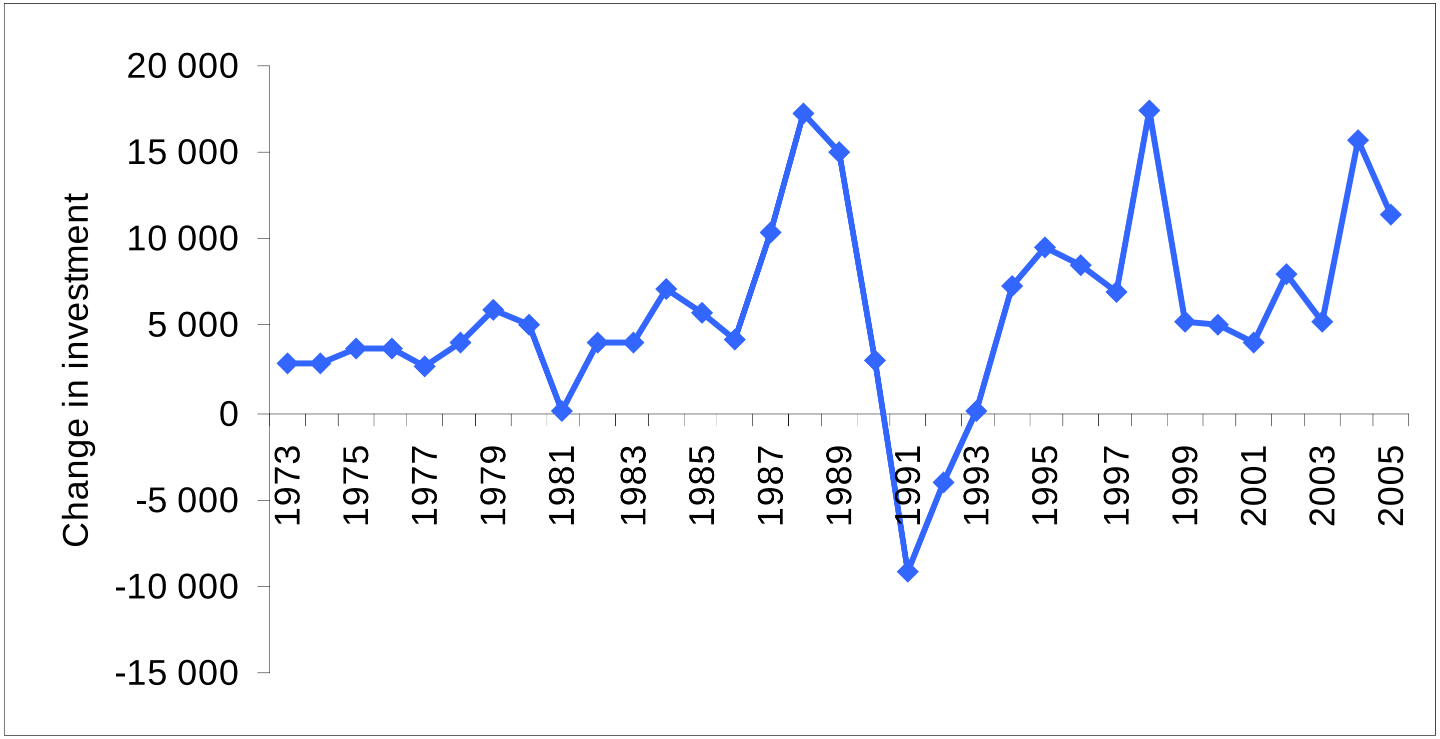

Figure 1.17 Time-series graph of the change in investment

The logarithm of investment

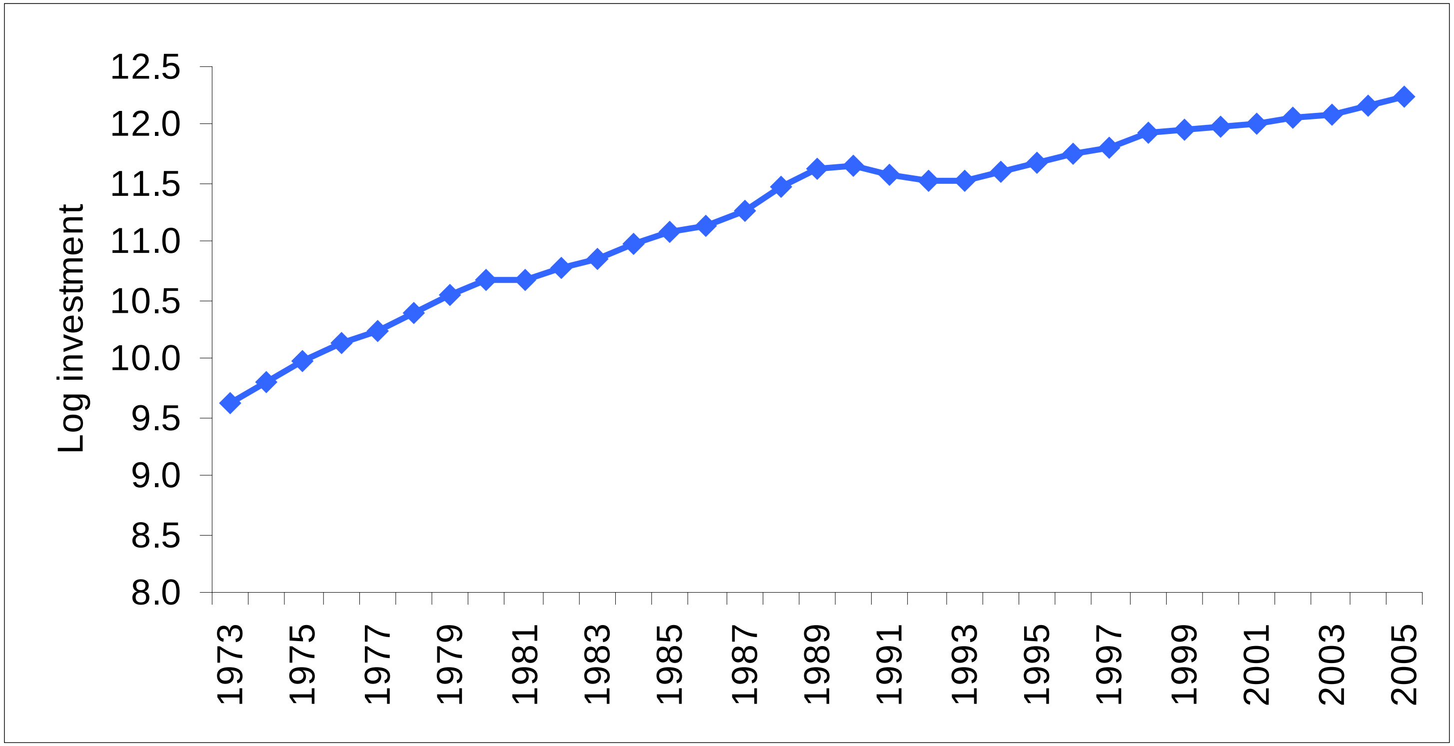

Figure 1.18 Time-series graph of the logarithm of investment expenditures

Graphing several series

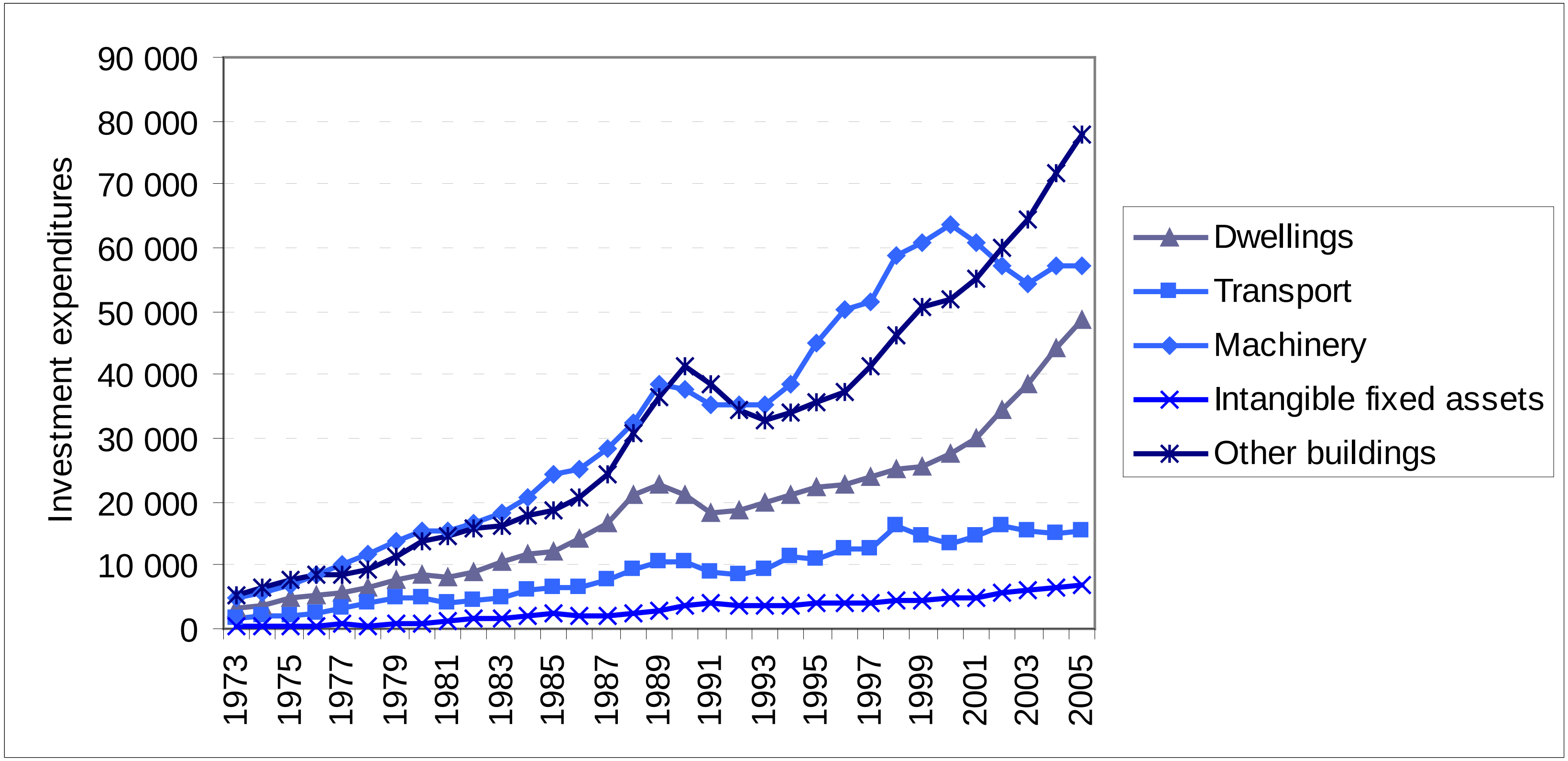

Figure 1.20 A multiple time-series graph of investment

An area graph of the same data

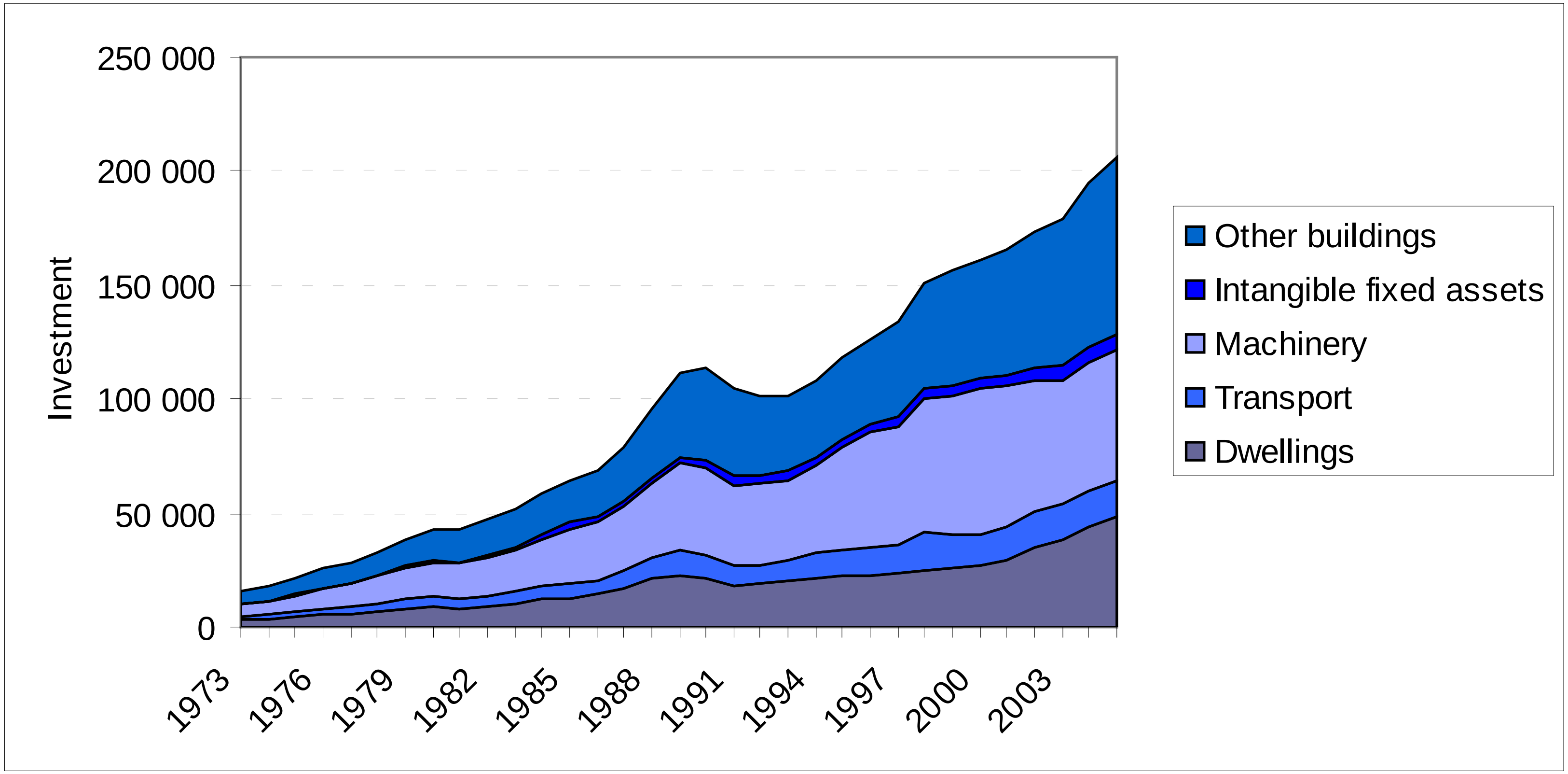

Figure 1.22 Area graph of investment categories, 1973–2005

Slide 1.41

Using separate axes – investment and the interest rate

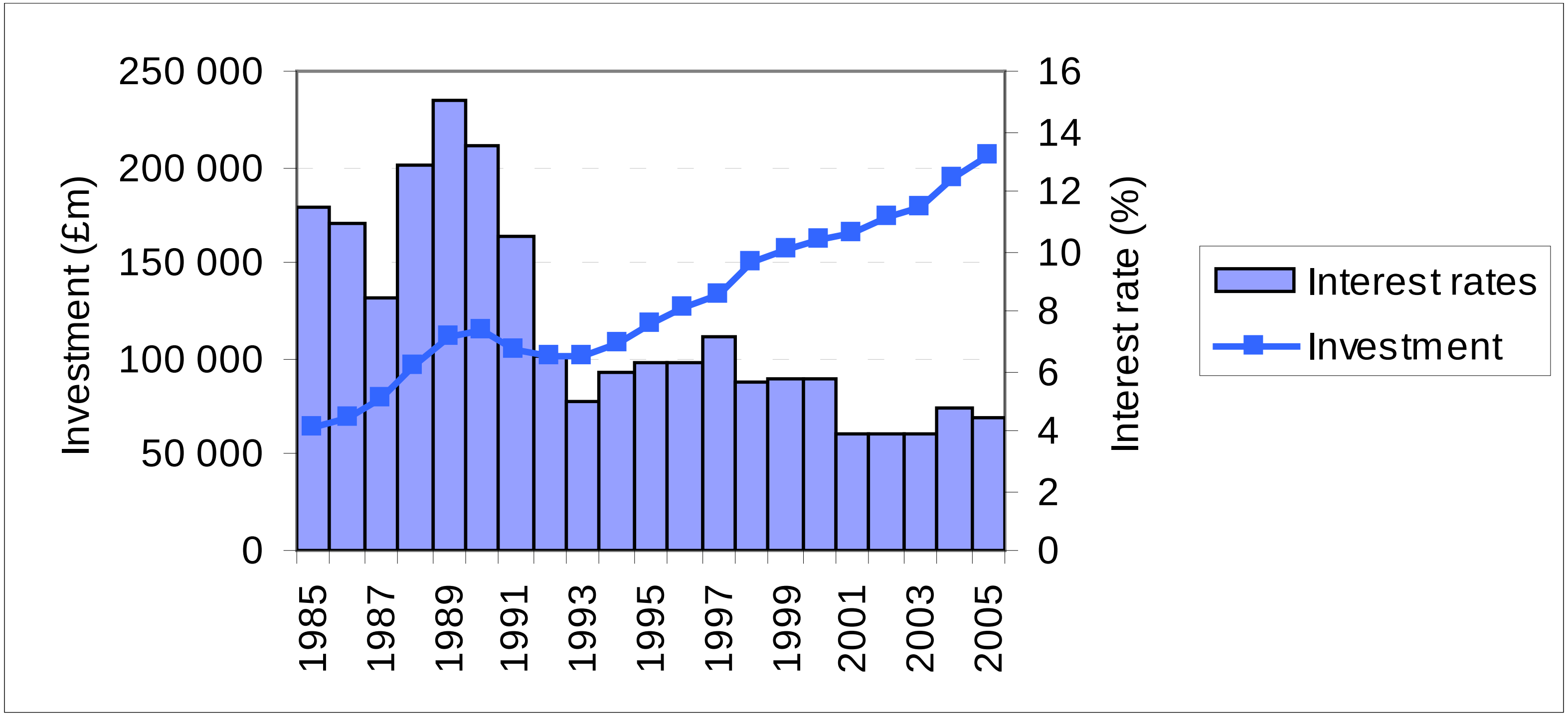

Figure 1.21 Time-series graph using two vertical scales: investment (LH scale) and the interest rate (RH scale), 1985–2005

Numerical summary measures

- It makes more sense to calculate the average growth rate of investment, rather than the level
- The growth rate is similar each year, the level continuously increases

The growth rate of investment

- Calculate the growth factor over the whole time period:

$$\frac{x_T}{x_1} = \frac{205\ 843}{15\ 227} = 13.518$$

- Take the T-1 root: $\sqrt[32]{13.518} = 1.085$

- Subtract 1: 1.085 – 1 = 0.085

- The average growth rate is 8.5% p.a.

An approximate alternative

- The average growth rate can also be calculated as the arithmetic mean of the annual growth rates:

$$\frac{1.191+1.205+\ldots+1.088+1.058}{32}=1.087$$

i.e. 8.7%

- This gives approximately the right answer, as long as the growth rate is not too big

Variance of the growth rate

- The stability of growth can be measured by calculating the variance of the growth rate

Year	Investment	Growth rate, x	x^2
1974	18 134	0.191	0.036
1975	21 856	0.205	0.042
1976	25 516	0.167	0.028
:	:	:	:
2002	173 525	0.049	0.002
2003	178 751	0.030	0.001
2004	194 491	0.088	0.008
2005	205 843	0.058	0.003
Totals		2.7856	0.3990

$$s^2 = \frac{\sum x^2 - n\bar{x}^2}{n-1}$$

$$= \frac{0.399 - 32 \times 0.087^2}{31}$$

$$= 0.0051$$

$$(\Rightarrow s = 0.071)$$

Bivariate data

- We examine the relationship between investment and GDP

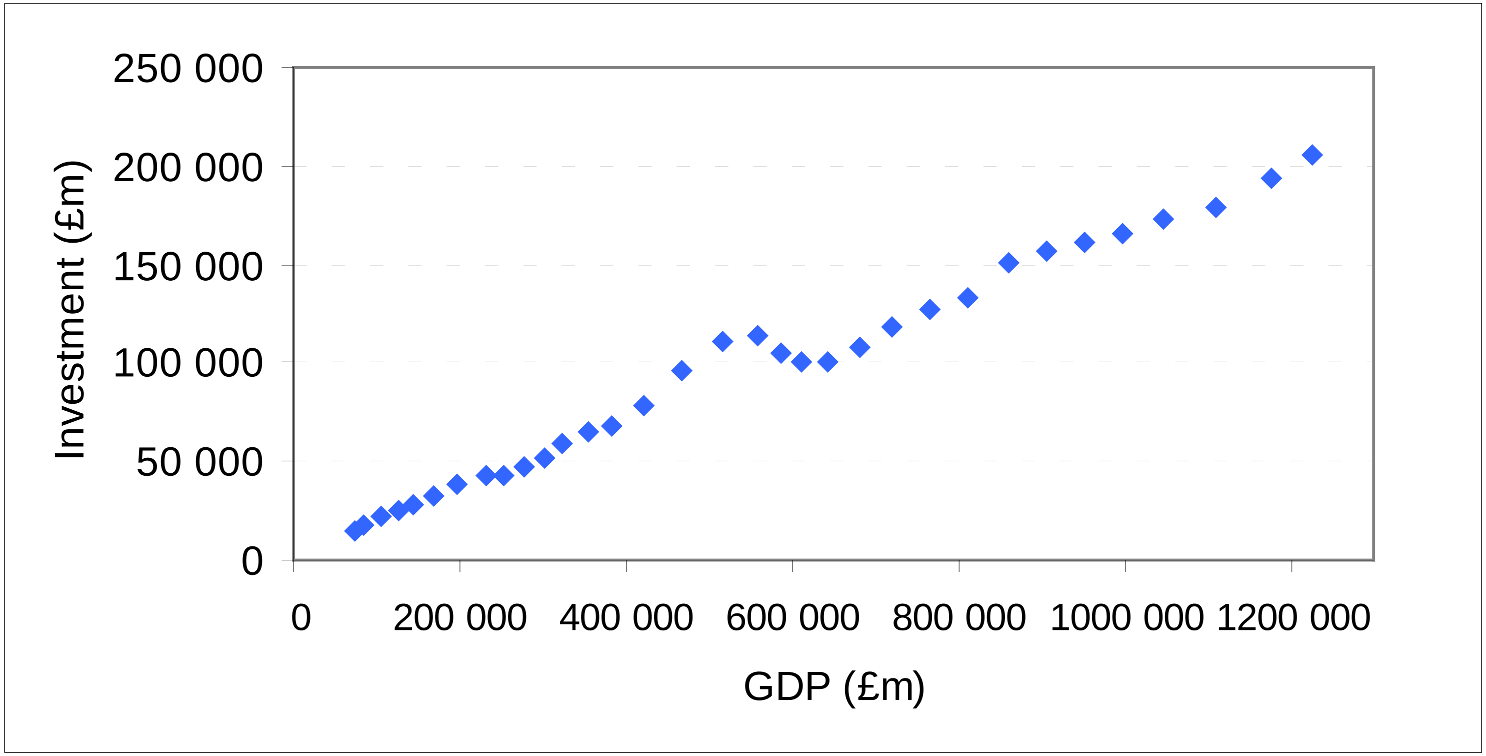

Figure 1.24 Scatter diagram of investment (vertical axis) against GDP (horizontal axis) (nominal values)

Bivariate data (continued)

- High values of Investment seem associated with high values of GDP, there is a close relationship

- As both variables are growing over time, later observations are at the top right of the graph, but this does not have to be so

- Both variables are influenced by inflation, so it might be better to graph the real series, after adjusting for inflation…

Slide 1.48

Real investment vs real GDP

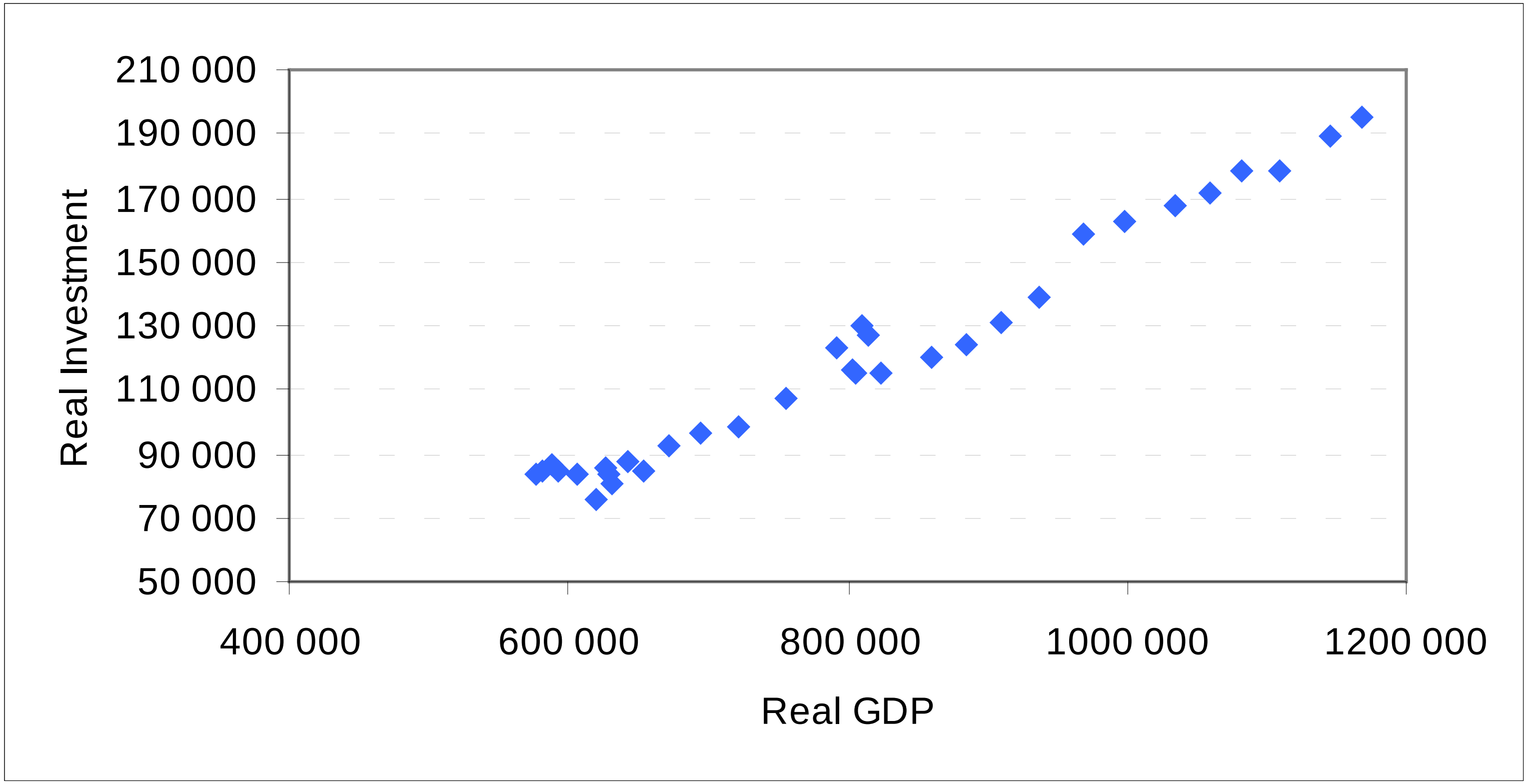

Figure 1.25 The relationship between real investment and real output

Summary

- Slightly different graphical and numerical techniques are used for time series data
- A variety of time series charts are available, both for single and multiple series
- The mean and variance are both useful descriptive devices, but it makes more sense to apply them to the growth rate, rather than the level, of a trended variable
- Data transformations can be useful, e.g. taking logs or differences, and deflating to real terms