4 Statistical techniques

this chapter covers...

In this chapter we will explain how to calculate key statistical indicators which will help us to analyse past data and help us forecast what may happen in the future.

We will start by examining time series – strings of data that occur over time. We will see how a formula can be used to represent a straight line on a graph (regression analysis), and how this can be used to predict data at various points.

Next we will see how some data moves in regular cycles over time, and how this, together with the underlying trend can be used to develop forecasts. We will show how averaging techniques can be used to detect the trend in given data.

The third section concerns the use of index numbers. These can be used to compare numerical data over time – for example prices of commodities or general price inflation. We will see how to carry out various calculations using index numbers that can be useful.

Finally we will briefly see how index numbers can be used to analyse standard costing variances so that we can determine performance more accurately.

TIME SERIES ANALYSIS

Time series analysis involves analysing numerical trends over a time period. It is often used to examine past and present trends so that future trends can be forecast. The term 'trend analysis' is used to describe the technique that we will now examine. At its simplest the concept is based on the assumption that data will continue to move in the same direction in the future as it has in the past.

Using the sales of a shoe shop as an example we will now look at a range of techniques for dealing with trends.

an identical annual change

A shoe shop 'Comfy Feet' has sold the following numbers of pairs of shoes annually over the last few years:

20-1	10,000
20-2	11,000
20-3	12,000
20-4	13,000
20-5	14,000
20-6	15,000
20-7	16,000

It does not require a great deal of arithmetic to calculate that if the trend continues at the previous rate – an increase of 1,000 pairs a year – then shoe sales could be forecast at 17,000 pairs in 20-8 and 18,000 pairs in 20-9. Of course this is a very simple example, and life is rarely this straightforward. For example, for how long can this rate of increase be sustained?

average annual change

A slightly more complex technique could have been used to arrive at the same answer for the shoe shop. If we compare the number of sales in 20-7 with the number in 20-1, we can see that it has risen by 6,000 pairs. By dividing that figure by the number of times the year changed in our data we can arrive at an average change per year. The number of times that the year changes is 6, which is the same as the number of 'spaces' between the years (or alternatively the total number of years minus 1).

Shown as an equation this becomes:

Average Annual Sales Change =

$$\frac{\text{(Sales in Last Year – Sales in First Year)}}{\text{(Number of Years – 1)}} = \frac{(16{,}000 - 10{,}000)}{(7 - 1)}$$

= + 1,000, which is what we would expect.

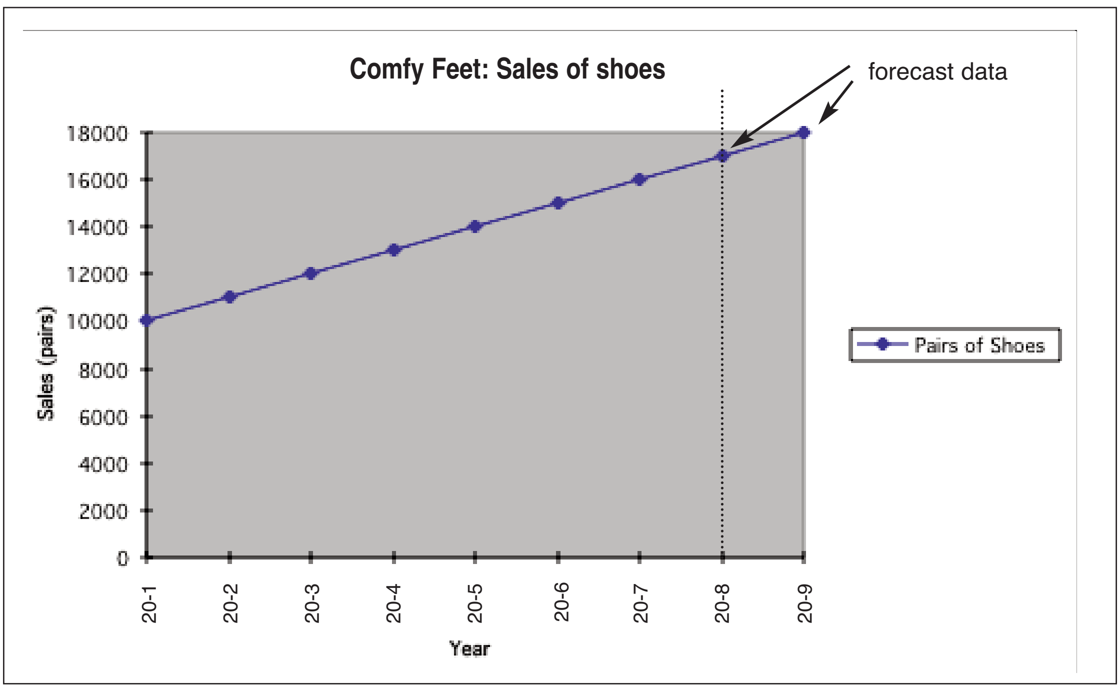
The + 1,000 would then be added to the sales data in 20-7 of 16,000 (the last actual data) to arrive at a forecast of 17,000.

This technique is useful when all the increases are not quite identical, yet we want to use the average increase to forecast the trend. A negative answer would show that the average change is a reduction, not an increase. We will use this technique when estimating the trend movement in more complicated situations.

This is not the only way that we can estimate the direction that data is moving over time, and it does depend on the data (including especially the first and last points) falling roughly into a straight line. We will note alternative methods that can be used later in this section.

constructing a graph

The same result can be produced graphically. Using the same shoe shop example we can extend the graph based on the actual data to form a forecast line.



If in another situation the actual data does not produce exactly equal increases, the graph will produce the same answer as the average annual change provided the straight line runs through the first and last year's data points.

using a formula

The data in the example could have been expressed in the following formula:

$$y = mx + c$$

where

y is the forecast amount

m is 1,000 (the amount by which the data increases each year)

x is the number of years since the start year (20-1)

c is 10,000 (which is the sales figure in the start year of 20-1)

If we wanted a forecast for the year 20-9, we could calculate it as:

Forecast	=	(1,000 x number of years since 20-1) + 10,000
y (the forecast)	=	(1,000 x 8) + 10,000
	=	18,000, which is what we would expect.

This formula works because the formula is based on the equation of a straight line.

using a formula for more calculations

The formula of a straight line ($y = mx + c$) that we have just used to calculate a forecast for 'y' can also be used to work out other information. The formula always has the following components:

- a fixed value ('c' in the formula $y = mx + c$); this is the point where the straight line starts from
- a gradient value ('m' in the formula); this determines how steep the line is, and whether it is going up (when 'm' is positive) or going down (when 'm' is negative)

The formula can be used (for example) to predict prices, costs or demand. Sometimes the formula is shown in a slightly different style (for example $y = a + bx$), but the components are still the same.

The formula of a straight line ties in with the calculations that we carried out in Chapter 1 for the 'high-low' method of calculating cost behaviour. There the fixed value represented the fixed costs, and the gradient value was the variable cost per unit. You will notice that the calculation methods that we used for analysing costs can also be used for other situations.

We will now use the formula to demonstrate how different elements can be calculated.

practical example

For example, suppose we are told that the price of a component over time is believed to increase based on the formula $Y = a + bX$, where

- Y is the price in £, and
- X is the year number

We are told that in year number 4 the price was £68, and in year number 8 the price was £76.

We would like to calculate '*a*' and '*b*' in the formula, and then use this information to predict the price in year 11.

We can use a calculation similar to the 'high-low' method, to determine how much the price is moving by each year:

	Price		Year	
	£76		8	
	£68		4	
Differences	£8	divided by	4	= £2 per year

This is the 'gradient' amount '*b*', and we can use it to calculate the amount '*a*' by using price information from either of the years that we know. For example, using year 4 data and putting it into the formula gives:

£68 = a + (£2 x 4 [the year number])

£68 = a + £8   So a must be £60

Now we have the full formula that we can use for any year:

Y = £60 + £2 x X

In year 11, this would give a price of:

y = £60 + (£2 x 11)   = £82

Just like in the high-low method, if you are provided with more than two pairs of data, then using the highest and the lowest will probably give the most reliable answer.

We will now use an example to illustrate the use of the formula to predict demand.

Sales of a national daily newspaper have been declining steadily for several years. The demand level is believed to follow the formula Y = a + bX, where Y is the demand in numbers of newspapers, and X is the year number. Calculations have already been carried out to establish the values of 'a' and 'b', which are:

- a is 200,000
- b is -2,500

Note that 'b' is a negative figure, so each year the demand decreases.

You are asked to calculate the expected sales in year 14.

If we insert the known data into the formula, we can calculate the demand for year 14 as follows:

$$Y = 200{,}000 – (2{,}500 \times 14) \quad Y = 165{,}000$$

linear regression

In the last section on time series analysis we saw that when some historical data moves in a consistent and regular way over time we can use it to help estimate the future trend of that data. We also saw that in these circumstances the data can be represented by

- a straight line on a graph, and / or
- an equation of the line in the form $y = mx + c$

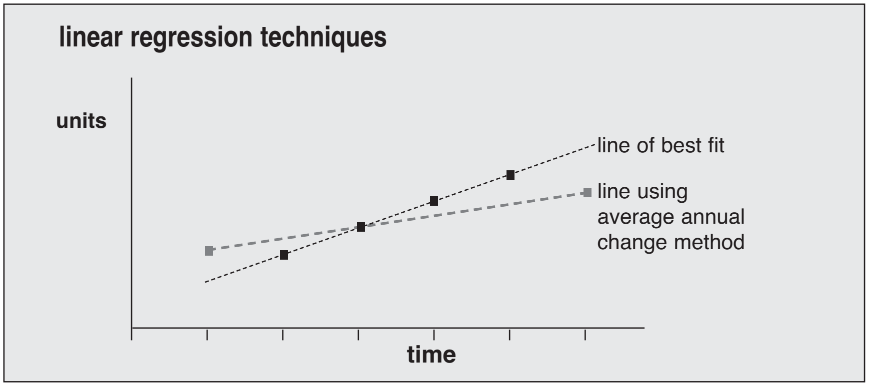
to help us develop the trend.

Linear regression is the term used for the techniques that can be used to determine the line that best replicates that given data. You should be aware of the techniques in general terms, and be able to appreciate their usefulness. You may be given historical data or the equation of a line and asked to use it to generate a forecast.

Where data exactly matches a straight line (as with the 'Comfy Feet' data) there is no need to use any special techniques. In other situations the following could be used:

- **Average annual change**. This method was described earlier, and is useful if we are confident that the first and last points (taken chronologically since we are looking at data over time) are both representative. It will smooth out any minor fluctuations of the data in between. We will see this method used in the 'Seasonal Company' case study later in this chapter.

- **Line of best fit**. Where the data falls only roughly into a straight line, but the first and last points do not appear to be very representative the average annual change method would give a distorted solution. Here a line of best fit can be drawn onto the data points on a graph that will form a better estimate of the movement of the data. The graph on the next page illustrates a situation where the line of best fit would provide a better solution than the average annual change method.



- **Least squares method**. This is a mathematical technique for developing the equation of the most appropriate line. It is more accurate than drawing a line of best fit onto a graph by eye, but the calculations involved are outside the scope of this book.

In the following example the regression line has already been calculated, and is used to forecast the cost of materials.

practical example

A colleague has calculated the least squares regression line (the line of best fit) as

$y = 15.75 + 1.65x$

where y is the cost per kilogram in £ and x is the period. April X5 is period 32.

You are asked to forecast the cost per kilogram for July X5.

The figures are inserted into the formula as follows (July X5 is period 35)

$y = 15.75 + (1.65 \times 35)$

Forecast cost per kilogram (y) = £73.50

All linear regression techniques assume that a straight line is an appropriate representation of the data. When looking at time series this means that we are assuming that the changes in the data that we are considering (known as the dependent variable) are in proportion to the movement of time (the independent variable). This would mean that we are expecting (for example) the sales level to continually rise over time. When we use time series analysis later in the book we must remember that sometimes data does not travel forever in a straight line, even though they may do so for a short time. For example share prices on the stock market do not continue to go up (or down) steadily, but often move in a more erratic way.

TIME SERIES ANALYSIS AND SEASONAL VARIATIONS

There are four main factors that can influence data which is generated over a period of time:

- **The underlying trend**

  This is the way that the data is generally moving in the long term. For example the volume of traffic on our roads is generally increasing as time goes on.

- **Long term cycles**

  These are slow moving variations that may be caused by economic cycles or social trends. For example, when economic prosperity generally increases this may increase the volume of traffic as more people own cars and fewer use buses. In times of economic depression there may be a decrease in car use as people cannot afford to travel as much or may not have employment which requires them to travel.

- **Seasonal variations**

  This term refers to regular, predictable cycles in the data. The cycles may or may not be seasonal in the normal use of the term (eg Spring, Summer etc). For example traffic volumes are always higher in the daytime, especially on weekdays, and lower at weekends and at night.

- **Random variations**

  All data will be affected by influences that are unpredictable. For example flooding of some roads may reduce traffic volume along that route, but increase it on alternative routes. Similarly the traffic volume may be influenced by heavy snowfall.

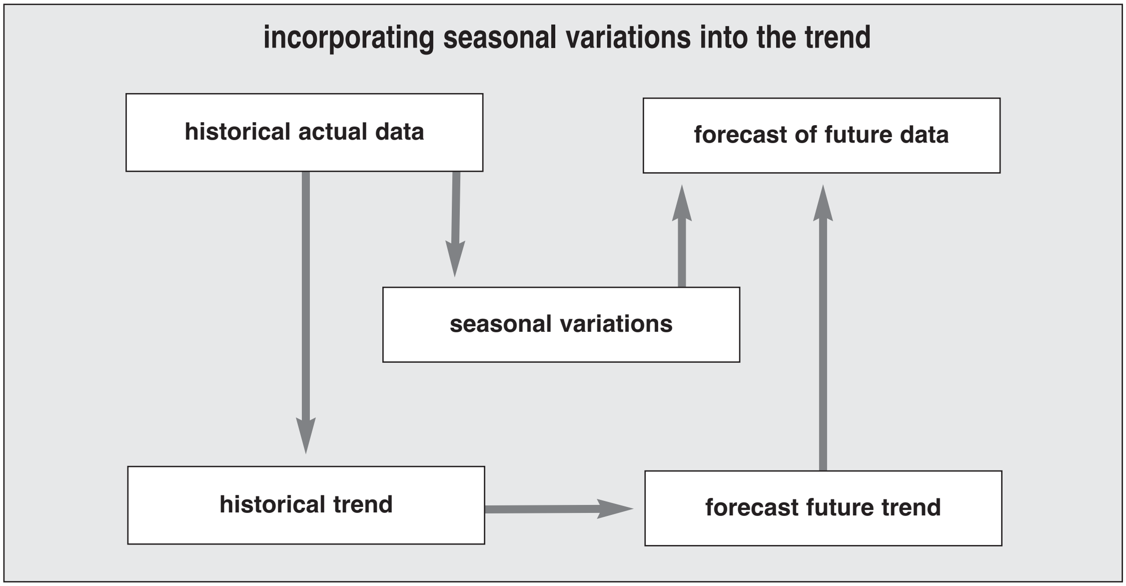
The type of numerical problems that you are most likely to face will tend to ignore the effects of long-term cycles (which will effectively be considered as a part of the trend) and random variations (which are impossible to forecast). We are therefore left with analysing data into underlying trends and seasonal variations, in order to create forecasts.

The technique that we will use follows the process in the diagram on the next page.

The process is as follows:

1. The historical actual data is analysed into the historical trend and the seasonal variations.
2. The historical trend is used to forecast the future trend, using the techniques examined in the last section.

3 The seasonal variations are incorporated with the forecast future trend to provide a forecast of where the actual data will be in the future.



forecasting using deseasonalised data

If we know (or can estimate fairly accurately) the seasonal variations, then we can use this information together with actual data to work out what the trend is. The term 'deseasonalised data' means data from which the seasonal variations have been stripped away – in other words the trend. We can then extrapolate this trend. This means forecasting how the trend will move in the future.

The seasonal variations for unit sales of a product have been calculated to be the following percentages of the underlying trend:

Quarter 1	–15%
Quarter 2	+25%
Quarter 3	+10%
Quarter 4	–20%

In year 5 the actual unit sales results are as follows:

Quarter 1	42,500
Quarter 2	75,000
Quarter 3	77,000
Quarter 4	64,000

From these figures we can calculate the 'deseasonalised' data – the trend figures. We need to be careful because the seasonal variations are calculated as percentages of the trend.

Quarter 1 The trend must be greater than 42,500 by 15% of the trend.

Therefore 42,500 must equal 85% of the trend

Trend = 42,500 x 100 / 85 = 50,000

Quarter 2 The trend must be lower than 75,000 by 25% of the trend.

Therefore 75,000 must equal 125% of the trend

Trend = 75,000 x 100 / 125 = 60,000

Using the same logic:

Quarter 3 Trend = 77,000 x 100 / 110 = 70,000

Quarter 4 Trend = 64,000 x 100 / 80 = 80,000

Having identified the trend for year 5 as 50,000, 60,000, 70,000 and 80,000 we can see that it is rising by 10,000 units per quarter. Therefore the forecast for year 6 can be worked out as follows:

Year 6	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Extrapolated Trend	90,000	100,000	110,000	120,000
Seasonal Variations	–15%	+25%	+10%	–20%
Forecast	76,500	125,000	121,000	96,000

In a task the analysis of actual data may have been carried out already, or you may be asked to carry out the analysis by using 'moving averages'. If you are using moving averages it is important that:

- your workings are laid out accurately
- the number of pieces of data that are averaged corresponds with the number of 'seasons' in a cycle
- where there is an even number of 'seasons' in a cycle a further averaging of each pair of averages takes place

moving averages

A moving average is the term used for a series of averages calculated from a stream of data so that:

- every average is based on the same number of pieces of data, (eg four pieces of data in a 'four point moving average'), and
- each subsequent average moves along that data stream by one piece of data so that compared to the previous average it
  - uses one new piece of data and
  - abandons one old piece of data.

This is easier to calculate than it sounds! For example, suppose we had a list of six pieces of data relating to the factory output over two days where a three-shift pattern was worked as follows:

Day 1	Morning Shift	14 units
	Afternoon Shift	20 units
	Night Shift	14 units
Day 2	Morning Shift	26 units
	Afternoon Shift	32 units
	Night Shift	26 units

If we thought that the shift being worked might influence the output, we could calculate a three-point moving average, the workings would be as follows:

First moving average:	(14 + 20 + 14) ÷ 3	= 16
Second moving average:	(20 + 14 + 26) ÷ 3	= 20
Third moving average:	(14 + 26 + 32) ÷ 3	= 24
Fourth moving average	(26 + 32 + 26) ÷ 3	= 28

Notice how we move along the list of data. In this simple example with six pieces of data we can't work out any more three-point averages since we have arrived at the end of the numbers after only four calculations.

Here we chose the number of pieces of data to average each time so that it corresponded with the number of points in a full cycle. By choosing a three-point moving average that corresponded with the number of shifts we always had **one** example of the output of **every** type of shift in our average. This means that any influence on the average by including a night shift (for example) is cancelled out by also including data from a morning shift and an afternoon shift.

We must be careful to always work out moving averages so that exactly one complete cycle is included in every average. The number of 'points' is chosen to suit the data.

When determining a trend line, each average relates to the data from its mid point, as the following layout of the figures just calculated demonstrates.

		Output	Trend (Moving Average)
Day 1	Morning Shift	14 units	
	Afternoon Shift	20 units	16 units
	Night Shift	14 units	20 units
Day 2	Morning Shift	26 units	24 units
	Afternoon Shift	32 units	28 units
	Night Shift	26 units	

This means that the first average that we calculated (16 units) can be used as the trend point of the afternoon shift on day 1, with the second point (20 units) forming the trend point of the night shift on day 1. The result is that we:

- know exactly where the trend line is for each period of time, and
- have a basis from which we can calculate 'seasonal variations'

Even using our limited data in this example we can see how seasonal variations can be calculated. **A seasonal variation is simply the difference between the actual data at a point and the trend at the same point**. This gives us the seasonal variations shown in the following table, using the figures already calculated.

		Output	Trend	Seasonal Variation
Day 1	Morning Shift	14 units		
	Afternoon Shift	20 units	16 units	+ 4 units
	Night Shift	14 units	20 units	- 6 units
Day 2	Morning Shift	26 units	24 units	+ 2 units
	Afternoon Shift	32 units	28 units	+ 4 units
	Night Shift	26 units		

The seasonal variation for the afternoon shift, calculated on day 1, is based on the actual output being 4 units greater than the trend at the same point (20 minus 16 units).

Case Study

THE AVERAGE COMPANY
MOVING AVERAGES AND FORECASTS

The Average Company has sales data that follows a 3 period cycle. The sales units shown in the table below have been compiled from actual data in periods 11 to 19.

Period	Actual Data	3 Point Moving Averages (Trend)	Seasonal Variations
11	7,650		
12	7,505		
13	7,285		
14	7,590		
15	7,445		
16	7,225		
17	7,530		
18	7,385		
19	7,165		

required

(a) Using a 3 point moving average, calculate the trend figures and the seasonal variations

(b) Extrapolate the trend to periods 20 to 25, and using the seasonal variations forecast the sales units for those periods

solution

(a) The 3 point moving averages can be calculated for each period except the first and the last. The seasonal variations are calculated as (actual data – trend).

Period	Actual Data	3 Point Moving Averages (Trend)	Seasonal Variations
11	7,650		
12	7,505	7,480	+25
13	7,285	7,460	–175
14	7,590	7,440	+150
15	7,445	7,420	+25
16	7,225	7,400	–175
17	7,530	7,380	+150
18	7,385	7,360	+25
19	7,165		

(b) The trend calculated from 3 point moving averages can be seen to be reducing by 20 each period, and so can be easily extrapolated.

The seasonal variations operate on a 3 period repeating cycle, so can be inserted.

The forecast data is then calculated as (extrapolated trend + seasonal variations).

Period	Forecast Data	Extrapolated Trend	Seasonal Variations
20	7,470	7,320	+150
21	7,325	7,300	+25
22	7,105	7,280	-175
23	7,410	7,260	+150
24	7,265	7,240	+25
25	7,045	7,220	-175

INDEX NUMBERS

Index numbers are used to assist in the comparison of numerical data over time. A commonly used index is the Retail Price Index that gives an indication of inflation by comparing the cost of a group of expenses typically incurred by households in the UK from year-to-year. There are many other types of index numbers that have been created for specific purposes, for example:

- the average wage rate for a particular job, or for all employment
- the average house price either by region or throughout the UK
- the market price of shares (eg the FTSE 100 index)
- the quantities of specific items that are sold or used (eg litres of unleaded petrol)
- the quantities of a group of items that are sold or used (eg litres of all motor fuel)
- the manufactured cost of specific items or a range of items (sometimes called 'factory gate' prices)

Many government indices and other indicators are available at www.gov.uk/government/statistics. If you have the opportunity, have a look at the enormous range of data that can either be downloaded free, or can be purchased in government publications.

When using published statistics it is important to make sure that they are specific enough to be useful for your purpose. For example, data on the growth in the population of the West of England will be of limited use if you are trying to forecast the sales in a bookshop in Taunton. Of far more use would be details of proposed housing developments within the immediate area, including the numbers of new homes and the type of households that form the developers' target market.

leading and lagging indicators

Some indicators can be classified as 'leading' indicators, whilst others are known as 'lagging' indicators. This means that some indicators naturally give advance warning of changes that may take place later in other indicators. For example an index that monitors the prices of manufactured goods ('factory gate' prices) will react to changes before they have filtered through to retail price indices. The index of 'factory gate' prices can therefore be considered to be a 'leading' indicator of retail prices, and give early warning of implications to industrial situations.

In a similar way, an index recording the volume of manufactured output from factories will lag behind an index measuring the volume of purchases of raw materials made by industrial buying departments.

weightings of indices

Those indices that are based on information from more than one item will use some form of weighting to make the results meaningful.

For example while an index measuring the retail price of premium grade unleaded petrol is based on a single product and therefore needs no weighting, this would not be true for a price index for all vehicle fuel. In this case it will require a decision about how much weight (or importance) is to be placed on each component of the index. Here the relative quantities sold of types of fuel (for example unleaded petrol and diesel) would be a logical way to weight the index. This would ensure that if petrol sales were double those for diesel, any price changes in petrol would have twice the impact on the index than a price change in diesel.

As the purchasing habits of consumers change, then the weighting and composition of complicated indices like the Retail Price Index and the Consumer Price Index are often changed to reflect this. This will include changes to the weighting of certain items, for example due to the increase in the proportion of household expenditure on holidays. It can also involve the addition or deletion of certain items entirely (for example the inclusion of certain fast foods). You may have seen news items from time to time about the revision of items contained within the RPI or CPI as consumers' tastes change.

calculations using index numbers

Whatever type of index we need to use, the principle is the same. The index numbers represent a convenient way of comparing figures.

For example, the RPI was 82.61 in January 1983, and 245.8 in January 2013. This means that average household costs had nearly tripled in the 30 years between. We could also calculate that if something that cost £5.00 in January 1983 had risen exactly in line with inflation, it would have cost £14.88 in January 2013. This calculation is carried out by:

$$\textit{historical price} \quad \times \quad \frac{\textit{index of time converting to}}{\textit{index of time converting from}}$$

$$\text{ie} \quad £5.00 \quad \times \quad (245.8 \div 82.61) \quad = \quad £14.88$$

$$\text{This is an increase of} \quad \frac{(£14.88 - £5.00)}{£5.00} \times 100 \quad = \quad 197.6\%$$

You may be told that the 'base year' for a particular index is a certain point in time. This is when the particular index was 100. For example the current RPI index was 100 in January 1987.

Index numbers referring to costs or prices are the most commonly used ones referred to in the unit studied in this book. If we want to use cost index numbers to monitor past costs or forecast future ones, then it is best to use as specific an index as possible. This will then provide greater accuracy than a more general index.

For example, if we were operating in the food industry, and wanted to compare our coffee cost movements with the average that the industry had experienced, we should use an index that analyses coffee costs in the food industry. This would be much more accurate than the RPI, and also better than a general cost index for the food industry.

practical example

The following table shows the actual material costs for January for years 20X2 to 20X5, together with the relevant price index.

Period	Actual costs *(£)*	Cost index	Costs at January 20X2 prices
January 20X2	129,300	471	
January 20X3	131,230	482	
January 20X4	135,100	490	
January 20X5	136,250	495	

Required: Restate all the actual costs at January 20X2 prices, to the nearest £.

Solution

Period	Actual costs *(£)*	Cost index	Costs at January 20X2 prices
January 20X2	129,300	471	129,300
January 20X3	131,230	482	128,235
January 20X4	135,100	490	129,861
January 20X5	136,250	495	129,644

Case Study

TURNER LIMITED: ADJUSTING TO REAL TERMS

Sales revenue and Net Profit figures are given for Turner Ltd for the five years ended 31 December 20-1 to 20-5. A suitable index for Turner Ltd's industry is also given.

	20-1	20-2	20-3	20-4	20-5
Sales revenue (£000s)	435	450	464	468	475
Net Profit (£000s)	65	70	72	75	78
Industry Index	133	135	138	140	143

required

Calculate the sales revenue and profit in terms of year 20-5 values and comment on the results.

solution

To put each figure into 20-5 terms, it is divided by the index for its own year and multiplied by the index for 20-5, ie 143. For example:

Sales revenue Year 20-1 $\frac{435}{133} \times 143 = 467.7$

Sales revenue Year 20-2 $\frac{450}{135} \times 143 = 476.7$ and so on.

In year 20-5 terms:

	20-1	20-2	20-3	20-4	20-5
Sales revenue (£000s)	467.7	476.7	480.8	478.0	475.0
Net Profit (£000s)	69.9	74.1	74.6	76.6	78.0

The adjusted figures compare like with like in terms of the value of the pound, and the Net Profit still shows an increasing trend throughout, but the sales revenue decreases in the last two years.

creation of an index

You may be required to create an index from given historical data, and we will now see how this is carried out.

Suppose that you are provided with the following prices for one unit of a certain material over a period of time:

Month	Jan	Feb	March	April	May	June
Price	£29.70	£30.00	£28.30	£30.09	£31.00	£31.25

The first thing to do is to decide which point in time is to be the base point – the price at this point will be 100 in our new index. In this example we will first use January as our base point, but later we will see how another date could have been chosen.

Next, the price of another date (we'll use February) is divided by the price at the base point. The result is then multiplied by 100 to give the index at that point (ie February):

(£30.00 / £29.70) x 100 = 101.01

Note that the index number is not an amount in £s, it is just a number used for comparison purposes. In this example we've rounded to 2 decimal places – and we will need to be consistent for the other figures.

If we carry out the same calculation for the March price we get the following:

(£28.30 / £29.70) x 100 = 95.29

Notice that here the answer is less than 100, which makes sense because the price in March is lower than the price in January. Checking that each index number is the expected side of 100 (ie higher or lower) is a good idea and will help you to detect some arithmetical errors.

The full list of index numbers is as follows – make sure that you can arrive at the same figures.

Month	Jan	Feb	March	April	May	June
Price	£29.70	£30.00	£28.30	£30.09	£31.00	£31.25
Index	100.00	101.01	95.29	101.31	104.38	105.22

We could have chosen a different date to act as our base point – if we chose March, then the calculation for January would have been:

(£29.70 / £28.30) x 100 = 104.95

Then the full list of index numbers would have been as follows:

Month	Jan	Feb	March	April	May	June
Price	£29.70	£30.00	£28.30	£30.09	£31.00	£31.25
Index	104.95	106.01	100.00	106.33	109.54	110.42

Again, make sure that you could arrive at the same figures.

Don't forget that although we have used the creation of a price index in the above example, you could also be asked to create an index from any suitable historical data. Whatever the type of data, the arithmetic required is the same.

USING INDEX NUMBERS TO ANALYSE VARIANCES

When standard costing is being used, standards for material prices will have been set based on expected costs. This will often be based on an expected level of a price index for that material (if there is one available). If the price index for the material changes significantly then we can calculate what the standard would be if it was based on the index (the 'revised' standard price). We can then see how that impacts on any price variance that has been calculated.

Once we have worked out what the 'revised' standard price would be, we can then calculate the part of a price variance explained by the index change as:

the original standard cost of the actual material	*minus*	the revised standadr cost of the actual material

The remainder of the original variance would be the part not explained by the change in price index.

The following case study illustrates the process.

Case Study

ANALYSIS LIMITED
REVISED STANDARD PRICE

Analysis Limited operates a standard costing system and uses a raw material that is a global commodity. The standard price was set based upon a market price of £950 per kilo when the relevant price index was 315.

In April the price index was 330. The quantity of material purchased and used was 128 kilos, which cost £125,000.

required

- Calculate the material price variance, based on the original standard
- Calculate what the 'revised' standard price per kilo would be, based on the change in the index, to the nearest £
- Analyse the material price variance into the part explained by the change in the index, and the remainder.

solution

- The material price variance is

  (£950 x 128 kilos) - £125,000 = £3,400 adverse
- The 'revised' standard price per kilo would be:

  £950 x 330 / 315 = £995 to the nearest £
- The part of the price variance explained by the index change:

  (£950 x 128 kilos) – (£995 x 128 kilos) = £5,760 adverse

The remainder of the variance is therefore:

£3,400 adverse minus £5,760 adverse = £2,260 favourable

In this situation the price actually paid for material is lower than would be expected from the change in the index.

Chapter Summary

- A time series is formed by data that occurs over time. If the data increases or decreases regularly (in a 'straight line') then it can be represented by a formula. The formula can then be used to predict the data at various points.
- Some data moves in regular cycles over time, and the distances that the data is from the underlying trend are known as seasonal variations. Information about the underlying trend and the seasonal variations can be used to forecast data.
- Moving averages can be used to split data into the trend and the seasonal variations.
- Index numbers can be used to compare numerical data over time. Examples of the use of index numbers are for prices of commodities or general price inflation.
- Index numbers can be used to analyse standard costing variances so that we can determine performance more accurately.

Key Terms

time series analysis	the examination of historical data that occurs over time, often with the intention of using the data to forecast future data
trend	the underlying movement in the data, once seasonal and random movements have been stripped away
seasonal variations	regular variations in data that occur in a repeating pattern
extrapolation of data	using information about a known range of data to predict data outside the range (for example in the future)
deseasonalised data	data that has had seasonal variations stripped away
linear regression	using a mathematical formula to demonstrate the movement of data over time. This technique is sometimes used to help forecast the movement of the trend
index numbers	a sequence of numbers used to compare data, usually over a time period

Activities

4.1 Sales (in units) of a product are changing at a steady rate and don't seem to be affected by any seasonal variations. Use the data given for the first three periods to forecast the sales for periods 4 and 5.

Period	**1**	**2**	**3**	**4**	**5**
Sales (units)	212,800	210,600	208,400		

4.2 Sales (in units) of a product are changing at a broadly steady rate and don't seem to be affected by any seasonal variations. Use the average change in the data given for the first five periods to forecast the sales for periods 6 and 7.

Period	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Sales (units)	123,400	123,970	124,525	125,085	125,640		

4.3 The table below shows the last three months cost per kilo for material Beta, together with estimated seasonal variations:

Month	**Jan**	**Feb**	**March**	**April**	**May**
Actual Price £	6.80	6.40	7.00		
Seasonal Variation £	+0.40	–0.10	+0.40	–0.30	–0.40
Trend £					

- Calculate the trend figures for January to March, and extrapolate them to April and May.
- Forecast the actual prices in April and May

4.4 Computer modelling has been used to identify the regression formula for the monthly total of a specific indirect cost as

Y = £13.20 x + £480.00

Where y is total monthly cost

And x is monthly production in units

Calculate the total monthly cost when output is

- 500 units, and
- 800 units

State whether the total cost behaves as a

- Fixed cost, or
- Variable cost, or
- Semi-variable cost, or
- Stepped cost.

4.5 The regression formula for monthly sales of a certain product (in units) has been identified as:

$Y = 1{,}200 + 13X$

Where Y is total monthly sales, and X is the month number.

January 20X9 was month 30

Forecast the monthly sales in August 20X9

4.6 A company has sales data that follows a 3 period cycle. The sales units shown in the table below have been compiled from actual data in periods 30 to 36.

Period	**Actual Data**	**3 Point Moving Averages (Trend)**	**Seasonal Variations**
30	3,500		
31	3,430		
32	3,450		
33	3,530		
34	3,460		
35	3,480		
36	3,560		
37			
38			
39			
40			

Complete the table to show your responses to the following:

(a) Using a 3 point moving average, calculate the trend figures and the seasonal variations for periods 31 to 35

(b) Extrapolate the trend to periods 37 to 40, and using the seasonal variations forecast the sales units for those periods

4.7 The table below shows details of 5 unrelated materials. Complete the blank parts of the table. Show all figures to 2 decimal places.

Material	**Old Price** £	**New Price** £	**New price as index number with old price as base**	**% increase in price**
A	2.13	2.16		
B	10.25	11.00		
C	3.60	3.75		
D	240.00		105.00	
E	68.00		124.00	

4.8 The table below shows details regarding purchases of a specific material. Complete the table to show the actual cost per kilo (to the nearest penny) and create an index based on the cost per kilo with January as the base, to the nearest whole number.

	January	**February**	**March**
Total cost £	20,000	24,000	25,000
Total quantity	2,000 kilos	2,200 kilos	2,140 kilos
Cost per kilo £			
Cost index			

4.9 The standard price for material M was set at £3.00 per kilo, based on a price index of 155.3. During April, 15,000 kilos of material M costing £58,500 was purchased and used. The price index in April was 179.7

Complete the following table, showing amounts to the nearest £:

	Amount £	**Adverse / Favourable**
Material price variance		
Part of variance explained by change in index		