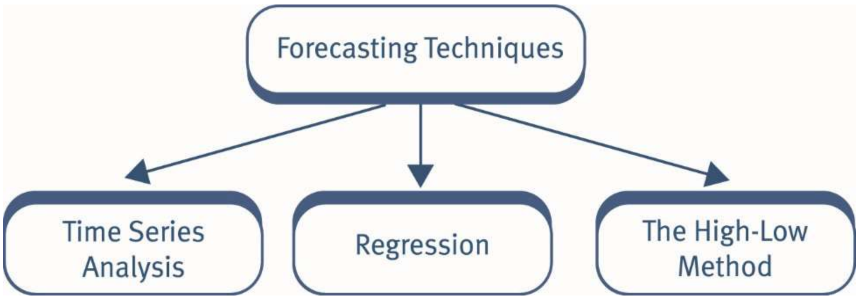
1 Chapter overview diagram



Forecasts in budgeting

Budgets are based on forecasts. Forecasts might be prepared for:

- the volume of output and sales
- sales revenue (sales volume and sales prices)
- costs.

The purpose of forecasting in the budgeting process is to establish realistic assumptions for planning. Forecasts might also be prepared on a regular basis for the purpose of feedforward control reporting.

A forecast might be based on simple assumptions, such as a prediction of a 5% growth in sales volume or sales revenue. Similarly, budgeted expenditure might be forecast using a simple incremental budgeting approach, and adding a percentage amount for inflation on top of the previous year's budget.

On the other hand, forecasts might be prepared using a number of forecasting models, methods or techniques. The reason for using these models and techniques is that they might provide more reliable forecasts.

This chapter describes:

- the high-low method
- the uses of linear regression analysis
- techniques of time series analysis

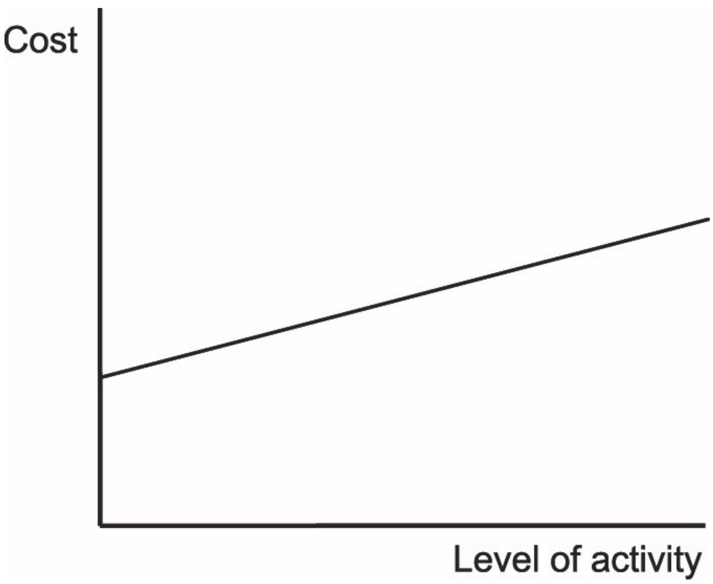
These methods are based on data gathered from the budgeting process (covered in an earlier chapter). As discussed in the earlier chapter this data can come from areas such as historic sales and cost data, economic data and market research. But there is a growing use of big data to support these other sources of data in spotting trends, identifying relationships between sets of data or in forecasting which costs, for example, may change in terms of behaviour in the future.

Forecasting can also be carried out using a diagram (known as a scatter diagram). The data is plotted on a graph. The y-axis represents the dependent variable, i.e. that variable that depends on the other. The x-axis shows the independent variable, i.e. that variable which is not affected by the other variable. From the scatter diagram, the line of best fit can be estimated. The aim is to use our judgement to draw a line through the middle of data with the same slope as the data. Because it is based on judgement it is potentially less accurate than some of the more mathematical approaches used in this chapter.

More complex models might be used in practice, but these are outside the scope of the syllabus.

2 The high-low method

This is a method of breaking semi-variable costs into their two components. A semi-variable cost being a cost which is partly fixed and partly variable.



In the exam in computational questions, semi-variable costs must be broken down into their 2 components using the *high-low method.*

Step 1 Determine the variable costs

It is important that we start with the **highest and lowest output** (activity) and their associated costs.

$$\text{Variable cost per unit} = \frac{\text{Increase in cost}}{\text{Increase in activity}}$$

Choose either the highest or lowest output and multiply it by the variable cost per unit just calculated. This will tell us the total variable costs at that output.

Step 2 Find the fixed cost

A semi-variable cost consists of two components. We have found the variable component. What is left must be the fixed component. If we take the total cost and deduct the variable costs (just calculated) then we are left with the fixed costs.

Step 3 Calculate the expected cost

Once the variable cost per unit and the total fixed costs are known, these can be used to predict future cost levels. The total expected future costs will be:

= total fixed costs (from step 2) + [forecast production (in units) × variable cost per unit (from step 1)]

Example 1

Great Auk Limited has had the following output and cost results for the last 4 years:

	Output units	Cost $
Year 1	5,000	26,000
Year 2	7,000	34,000
Year 3	9,000	42,000
Year 4	10,000	46,000

In year 5 the output is expected to be 13,000 units. Calculate the expected costs.

Inflation may be ignored.

The high-low method with stepped fixed costs

Sometimes fixed costs are only fixed within certain levels of activity and increase in steps as activity increases (i.e. they are stepped fixed costs).

The high/low method can still be used to estimate fixed and variable costs. Simply choose two activity levels where the fixed cost remains unchanged.

Adjustments need to be made for the fixed costs based on the activity level under consideration.

Illustration

An organisation has the following total costs at three activity levels:

Activity level (units)	4,000	6,000	7,500
Total cost	$40,800	$50,000	$54,800

Variable cost per unit is constant within this activity range and there is a step up of 10% in the total fixed costs when the activity level exceeds 5,500 units.

What is the total cost at an activity level of 5,000 units?

Calculate the variable cost per unit by comparing two output levels where fixed costs will be the same:

Variable cost per unit = [(54,800 – 50,000)/(7,500 – 6,000)] = $3.20

Total fixed cost above 5,500 units = [54,800 – (7,500 × 3.20)] = $30,800

Total fixed cost below 5,500 units = 30,800/110 × 100 = $28,000

Total cost for 5,000 units = [(5,000 × 3.20) + 28,000] = $44,000

3 Regression analysis

The high-low method only takes account of two observations – the highest and the lowest. To take account of all observations a more advanced calculation is used known as **linear regression** which uses a formula to estimate the linear relationship between the variables as follows:

The equation of a straight line is:

$$y = a + bx$$

where y = dependent variable
a = intercept (on y-axis)
b = gradient
x = independent variable

and $$b = \frac{n\Sigma xy - \Sigma x\Sigma y}{n\Sigma x^2 - (\Sigma x)^2}$$

where n = number of pairs of data

and $$a = \bar{y} - b\bar{x}$$

Example 2

Marcus Aurelius is a small supermarket chain that has 6 shops. Each shop advertises in their local newspapers and the marketing director is interested in the relationship between the amount that they spend on advertising and the sales revenue that they achieve. She has collated the following information for the 6 shops for the previous year:

Shop	**Advertising expenditure**	**Sales revenue**
	$000	$000
1	80	730
2	60	610
3	120	880
4	90	750
5	70	650
6	30	430

She has further performed some calculations for a linear regression calculation as follows:

- the sum of the advertising expenditure (x) column is 450
- the sum of the sales revenue (y) column is 4,050
- when the two columns are multiplied together and summed (xy) the total is 326,500
- when the advertising expenditure is squared (x2) and summed, the total is 38,300, and
- when the sales revenue is squared (y2) and summed, the total is 2,849,300.

Calculate the line of best fit using regression analysis.

Expandable Text

Advertising expenditure $000	**Sales** $000			
x	y	xy	x^2	y^2
80	730	58,400	6,400	532,900
60	610	36,600	3,600	372,100
120	880	105,600	14,400	774,400
90	750	67,500	8,100	562,500
70	650	45,500	4,900	422,500
30	430	12,900	900	184,900
450	4,050	326,500	38,300	2,849,300

Interpretation of the line

Mathematical interpretation (No good! No marks!)

If x = 0, then y = 300 and then each time x increases by 1 y increases by 5

Business interpretation (This is what the examiner wants.)

If no money is spent on advertising then sales would still be $300,000. Then for every additional $1 increase in advertising sales revenue would increase by $5.

Linear regression in budgeting

Linear regression analysis can be used to make forecasts or estimates whenever a linear relationship is assumed between two variables, and historical data is available for analysis.

Two such relationships are:

- **A time series and trend line.** Linear regression analysis is an alternative to calculating moving averages to establish a trend line from a time series. (Time series is explained later in this chapter)
  - The independent variable (x) in a time series is time.
  - The dependent variable (y) is sales, production volume or cost etc.
- **Total costs, where costs consist of a combination of fixed costs and variable costs** (for example, total overheads, or a semi-variable cost item). Linear regression analysis is an alternative to using the high-low method of cost behaviour analysis. It should be more accurate than the high-low method, because it is based on more items of historical data, not just a 'high' and a 'low' value.
  - The independent variable (x) in total cost analysis is the volume of activity.
  - The dependent variable (y) is total cost.
  - The value of a is the amount of fixed costs.
  - The value of b is the variable cost per unit of activity.

Regression analysis is concerned with establishing the relationship between a number of variables. We are only concerned here with linear relationships between 2 variables.

When a linear relationship is identified and quantified using linear regression analysis, values for a and b are obtained, and these can be used to make a forecast for the budget. For example:

- a sales budget or forecast can be prepared, or
- total costs (or total overhead costs) can be estimated, for the budgeted level of activity.

Forecasting

The regression equation can be used for predicting values of y from a given x value.

Example 2 – CONTINUED

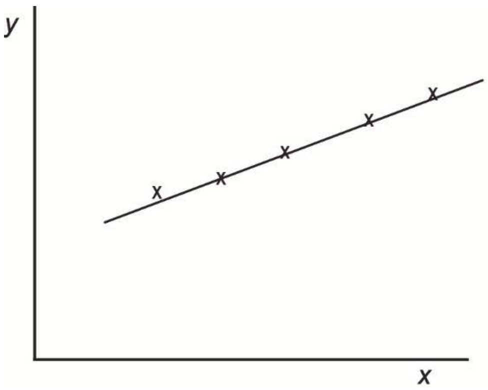
Marcus Aurelius has just taken on 2 new stores in the same area and the predicted advertising expenditure is expected to be $150,000 for one store and $50,000 for the other.

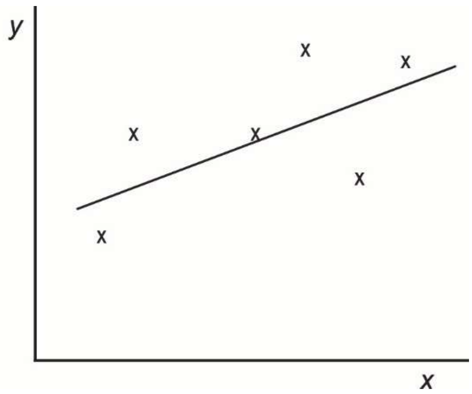
(a) Calculate the predicted sales revenues.

(b) Explain the reliability of the forecasts.

Correlation

Regression analysis attempts to find the linear relationship between two variables. Correlation is concerned with establishing how strong the relationship is.





Clearly in the first diagram, the regression line would be a much more useful predictor than the regression line in the second diagram.

Degrees of correlation

Two variables might be:

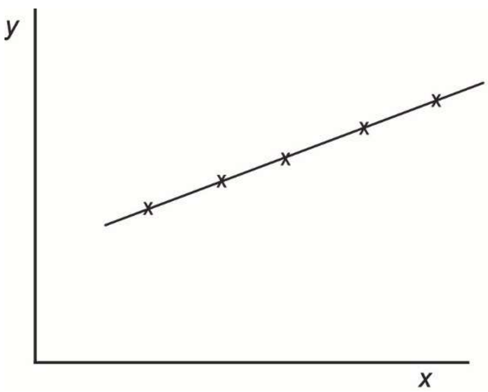
(a) perfectly correlated

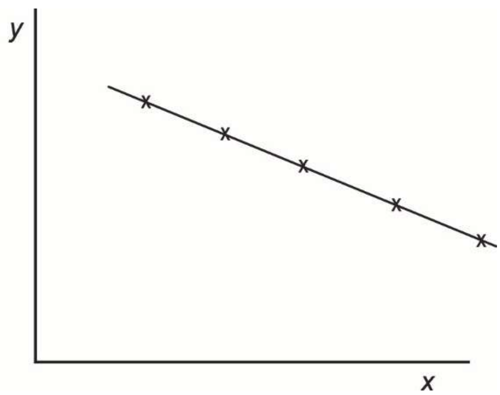
(b) partly correlated

(c) uncorrelated.

Different types of correlation explained

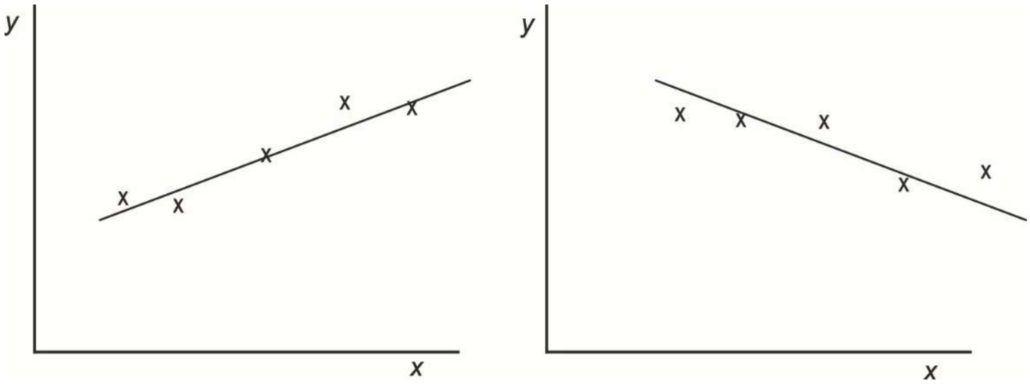
Perfect correlation





All the pairs of values lie on a straight line. There is an exact linear relationship between the two variables.

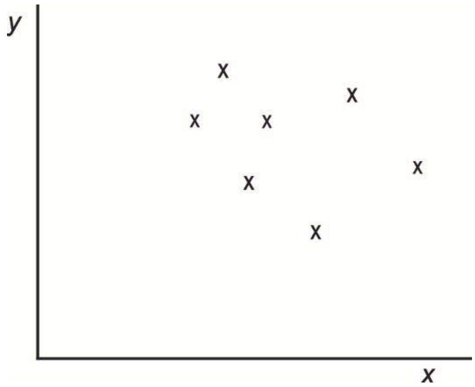
Partial correlation



In the first diagram there is not an exact relationship, but low values of x tend to be associated with low values of y, and high values of x tend to be associated with high values of y.

In the second diagram again there is not an exact relationship, but low values of x tend to be associated with high values of y and vice versa.

No correlation



The values of the two variables seem to be completely unconnected.

Positive and negative correlation

Correlation can be positive or negative.

Positive correlation means that high values of one variable are associated with high values of the other and that low values of one are associated with low values of the other.

Negative correlation means that low values of one variable are associated with high values of the other and vice versa.

The correlation coefficient

The degree of correlation can be measured by the Pearsonian correlation coefficient, r (also known as the product moment correlation coefficient).

r must always be between –1 and +1.

If r = 1, there is perfect positive correlation

If r = 0, there is no correlation

If r = –1, there is perfect negative correlation

For other values of r, the meaning is not so clear. It is generally taken that if r > 0.8, then there is strong positive correlation and if r < –0.8, there is strong negative correlation, however more meaningful information can be gathered from calculating the coefficient of determination, r^2.

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{\left(n\sum x^2 - \left(\sum x\right)^2\right)\left(n\sum y^2 - \left(\sum y\right)^2\right)}}$$

The coefficient of determination

This measures how good the estimated regression equation is, designated as r^2 (read as r-squared). The higher the r-squared, the more confidence one can have in the equation. Statistically, the coefficient of determination represents the proportion of the total variation in the y variable that is explained by the regression equation. It has the range of values between 0 and 1.

For example, if we read the following statement "factory overhead is a function of machine-hours with $r^2 = 0.80$," can be interpreted as "80% of the total variation of factory overhead is explained by the machine hours and the remaining 20% is accounted for by something other than machine-hours." The 20% is referred to as the error term.

Limitations of simple linear regression

(1) Assumes a linear relationship between the variables.

(2) Only measures the relationship between two variables. In reality the dependent variable is affected by many independent variables.

(3) Only interpolated forecasts tend to be reliable. The equation should not be used for extrapolation.

(4) Regression assumes that the historical behaviour of the data continues into the foreseeable future.

(5) Interpolated predictions are only reliable if there is a significant correlation between the data.

Interpolation and extrapolation

(1) If the value of x is within the range of our original data, the prediction is known as Interpolation.

(2) If the value of x is outside the range of our original data, the prediction is known as Extrapolation.

In general, interpolation is much safer than extrapolation.

4 Adjusting forecasts for inflation

The accuracy of forecasting is affected by the need to adjust historical data and future forecasts to allow for price or cost inflation.

- When historical data is used to calculate a trend line or line of best fit, it should ideally be adjusted to the same index level for prices or costs. If the actual cost or revenue data is used, without adjustments for inflation, the resulting line of best fit will include the inflationary differences.
- When a forecast is made from a line of best fit, an adjustment to the forecast should be made for anticipated inflation in the forecast period.

Example 3

Production overhead costs at company BW are assumed to vary with the number of machine hours worked. A line of best fit will be calculated from the following historical data, with costs adjusted to allow for cost inflation over time.

Year	Total production overheads $	Number of machine hours	Cost index
20X1	143,040	3,000	192
20X2	156,000	3,200	200
20X3	152,320	2,700	224
20X4	172,000	3,000	235

Required:

(a) Reconcile the cost data to a common price level, to remove differences caused by inflation.

(b) If the line of best fit, based on current (20X4) prices, is calculated as:

$y = 33{,}000 + 47x$

where y = total production overhead costs in $ and x = the number of machine hours:

calculate the expected total overhead costs in 20X5 if expected production activity is 3,100 machine hours and the expected cost index is 250.

The high-low method with inflation

The high low method may be distorted in the presence of inflation. The best technique is to strip out the inflation, perform the technique as usual and then re-apply the inflation.

Illustration

A hotel cleaning department uses a combination of salaried staff (which are a fixed cost paid an annual fixed salary) supplemented at busy periods (such as at the weekend) with part-time staff (seen to be a variable cost). It has gathered the following information on wage cost over the last two months.

	Visitors	Total wages ($)
Month 1	260	7,600
Month 2	300	8,610

Month 2 corresponded with a wage review. At the start of that month all staff received a 5% pay rise.

The restaurant wants to determine the estimated wage cost for the next month when it is expected to have 340 visitors.

Solution

Firstly we should strip out the 5% inflation included in the Month 2 cost so that the uninflated wage cost would be $8,200 (i.e. $8,610/1.05).

Now we can apply the usual high-low technique:

Variable cost per visitor = [(8,200 – 7,600)/(300 – 260)] = $15

Monthly fixed costs = [$7,600 – (260 × $15)] = $3,700

Now we can inflate these estimates for the Month 2 pay rise:

Revised variable cost per visitor = $15 × 1.05 = $15.75

Revised total fixed cost = $3,700 × 1.05 = $3,885

The total estimated cost for 340 visitors will be:

= $3,885 + (340 × $15.75) = $9,240.

5 Time series analysis

A time series is a series of figures recorded over time, e.g. unemployment over the last 5 years, output over the last 12 months, etc.

A time series is often shown graphically as a histogram.

Examples of a time series

Examples of time series might include the following:

- quarterly sales revenue totals over a number of years
- annual overhead costs over a number of years
- daily production output over a month.

Where the item being measured is subject to 'seasonal' variations, time series measurements are usually taken for each season. For example, if sales volume varies in each quarter of the year, a time series should be for quarterly sales. Similarly, if the sales in a retail store vary according to the day of the week, a time series might measure daily sales.

A time series has 4 components:

(1) The trend (T)

(2) Seasonal variations (S)

(3) Cyclical variations (C)

(4) Residual variations (R)

We are primarily interested in the first two – the trend and the seasonal variation.

Time series analysis is a term used to describe techniques for analysing a time series, in order to:

- identify whether there is any **underlying historical trend** and if there is, measure it
- use this analysis of the historical trend to forecast the trend into the future
- identify whether there are any **seasonal variations** around the trend, and if there is measure them
- apply estimated seasonal variations to a trend line forecast in order to prepare a forecast season by season.

In other words, a trend over time, established from historical data, and adjusted for seasonal variations, can then be used to make predictions for the future.

The trend

Most series follow some sort of long term movement – upwards, downwards or sideways. In time series analysis the trend is measured.

Seasonal variations

Seasonal variations are short-term fluctuations in value due to different circumstances which occur at different times of the year, on different days of the week, different times of day, etc. Some examples might be:

- Ice cream sales are highest in summer
- Sales of groceries are highest on Saturdays
- Traffic is greatest in the morning and evening rush hours.

Illustration 1

A business might have a flat trend in sales, of $1 million each six months, but with sales $150,000 below trend in the first six months of the year and $150,000 above trend in the second six months. In this example, the sales would be $850,000 in the first six months of the year and $1,150,000 in the second six months.

- If there is a straight-line trend in the time series, seasonal variations must cancel each other out. The total of the seasonal variations over each cycle should be zero.
- Seasonal variations can be measured:
  - in units or in money values, or
  - as a percentage value or index value in relation to the underlying Trend

Cyclical and residual factors

Cyclical variations

Cyclical variations are medium-term to long term influences usually associated with the economy. These cycles are rarely of consistent length. A further problem is that we would need 6 or 7 full cycles of data to be sure that the cycle was there.

Residual or random factors

The residual is the difference between the actual value and the figure predicted using the trend, the cyclical variation and the seasonal variation, i.e. it is caused by irregular items, which could not be predicted.

Calculation of the trend

There are three main methods of finding the underlying trend of the data:

(1) Inspection. The trend line can be drawn by eye with the aim of plotting the line so that it lies in the middle of the data.

(2) Least squares regression analysis. The x axis represents time and the periods of time are numbers, e.g. January is 1, February is 2, March is 3, etc.

(3) Moving averages. This method attempts to remove seasonal or cyclical variations by a process of averaging.

Calculating a moving average

A moving average is in fact a series of averages, calculated from time series historical data.

- The first moving average value in the series is the average of the values for time period 1 to time period n. (So, if n = 4, the first moving average in the series would be the average of the historical values for time period 1 to time period 4.)
- The second moving average value in the series is the average of the values for time period 2 to time period (n + 1). (So, if n = 4, the second moving average in the series would be the average of the historical values for time period 2 to time period 5.)
- The third moving average value in the series is the average of the values for time period 3 to time period (n + 2). (So, if n = 4, the third moving average in the series would be the average of the historical values for time period 3 to time period 6.)

The moving average value is associated with the mid-point of the time periods used to calculate the average.

The moving average time period

When moving averages are used to estimate a trend line, an important issue is the choice of the number of time periods to use to calculate the moving average. How many time periods should a moving average be based on?

There is no definite or correct answer to this question. However, where there is a regular cycle of time periods, it would make sense to calculate the moving averages over a full cycle.

- When you are calculating a moving average of daily figures, it is probably appropriate to calculate a seven-day moving average.
- When you are calculating a moving average of quarterly figures, it is probably appropriate to calculate a four-quarter moving average.
- When you are calculating a moving average of monthly figures, it might be appropriate to calculate a 12-month moving average, although a shorter-period moving average might be preferred.

The seasonal variation

Once the trend has been found, the seasonal variation can be determined. A seasonal variation means that some periods are better than average (the trend) and some worse. Then the model can be used to predict future values.

Measuring seasonal variations

The technique for measuring seasonal variations differs between an additive model and a multiplicative model. The additive model method is described here.

- Seasonal variations can be estimated by comparing an actual time series with the trend line values calculated from the time series.
- For each 'season' (quarter, month, day etcetera), the seasonal variation is the difference between the trend line value and the actual historical value for the same period.
- A seasonal variation can be calculated for each period in the trend line. When the actual value is higher than the trend line value, the seasonal variation is positive. When the actual value is lower than the trend line value, the seasonal variation is negative.
- An average variation for each season is calculated.
- The sum of the seasonal variations has to be zero in the additive model. If they do not add up to zero, the seasonal variations should be adjusted so that they do add up to zero.
- The seasonal variations calculated in this way can be used in forecasting, by adding the seasonal variation to the trend line forecast if the seasonal variation is positive, or subtracting it from the trend line if it is negative.

When a multiplicative model is used to estimate seasonal variations, the seasonal variation for each period is calculated by expressing the actual sales for the period as a percentage value of the moving average figure for the same period.

Forecasting using time series analysis

Once we have the trend and the seasonal variation, the variations can be added on to the trend to find the actual result:

Actual/Prediction = T + S + C + R

In exam questions we would not be required to calculate the cyclical variation, and the random variations are by nature random and cannot be predicted and also ignored. The equation simplifies to:

Prediction = T + S

Example of the calculation

A small business operating holiday homes in Scotland wishes to forecast next year's sales for the budget, using moving averages to establish a straight-line trend and seasonal variations. Next year is 20Y0. The accountant has assumed that sales are seasonal, with a summer season and a winter season each year. Seasonal sales for the past seven years have been as follows:

	Sales	
	Summer	**Winter**
	$000	$000
20X4	124	70
20X5	230	180
20X6	310	270
20X7	440	360
20X8	520	470
20X9	650	

Required:

(a) Calculate a trend line based on a two-season moving average.

(b) Use the trend line to calculate the average increase in sales each season.

(c) Calculate the adjusted seasonal variations in sales.

(d) Use this data to prepare a sales forecast for each season in 20Y0.

Solution

(a)

Season and year	Actual sales	Two-season moving total	Seasonal moving average	Centred moving average (Trend)	Seasonal variation
	(A)			(B)	= (A) – (B)
	$000	$000	$000	$000	$000
Summer 20X4	124				
		194	97		
Winter 20X4	70			123.5	– 53.5
		300	150		
Summer 20X5	230			177.5	+ 52.5
		410	205		
Winter 20X5	180			225.0	– 45.0
		490	245		
Summer 20X6	310			267.5	+ 42.5
		580	290		
Winter 20X6	270			322.5	– 52.5
		710	355		
Summer 20X7	440			377.5	+ 62.5
		800	400		
Winter 20X7	360			420.0	– 60.0
		880	440		
Summer 20X8	520			467.5	+ 52.5
		990	495		
Winter 20X8	470			527.5	– 57.5
		1,120	560		
Summer 20X9	650				

The trend line is shown by the centred moving averages.

(b) The average increase in sales each season in the trend line is:
($527,500 – $123,500)/8 seasons = $50, 500 each season

(c) Seasonal variations need to add up to zero in the additive model. The seasonal variations calculated so far are:

Year	**Summer**	**Winter**
	$000	$000
20X4		– 53.5
20X5	+ 52.5	– 45.0
20X6	+ 42.5	– 52.5
20X7	+ 62.5	– 60.0
20X8	+ 52.5	– 57.5
Total variations	+ 210.0	– 268.5

	Summer	Winter	Total
Number of measurements	4	5	
Average seasonal variation	+ 52.5	– 53.7	– 1.2
Reduce to 0 (share equally)	+ 0.6	+ 0.6	+ 1.2
Adjusted seasonal variation	+ 53.1	– 53.1	0.0

The seasonal variations could be rounded to + $53,000 in summer and – $53,000 in winter.

(d) To predict the sales in 20Y0 we first need to extrapolate the trend line into 20Y0 and then adjust it for the expected seasonal variation

	Expected trend (W1)	Adjusted seasonal variation	Forecast sales
Summer 20X9	578.0		
Winter 20X9	628.5		
Summer 20Y0	679.0	+ 53.0	732.0
Winter 20Y0	729.5	– 53.0	676.5

Workings

(W1)

If the actual trend in Winter 20X8 was 527.5, then we can expect the next trend figure to be 578 (527.5 plus the average increase in trend calculated in part (b) of 50.5). We can continue this process for each trend figure over the next few periods.

Advantages and disadvantages

The advantages of forecasting using time series analysis are that:

- forecasts are based on clearly-understood assumptions
- trend lines can be reviewed after each successive time period, when the most recent historical data is added to the analysis; consequently, the reliability of the forecasts can be assessed
- forecasting accuracy can possibly be improved with experience.

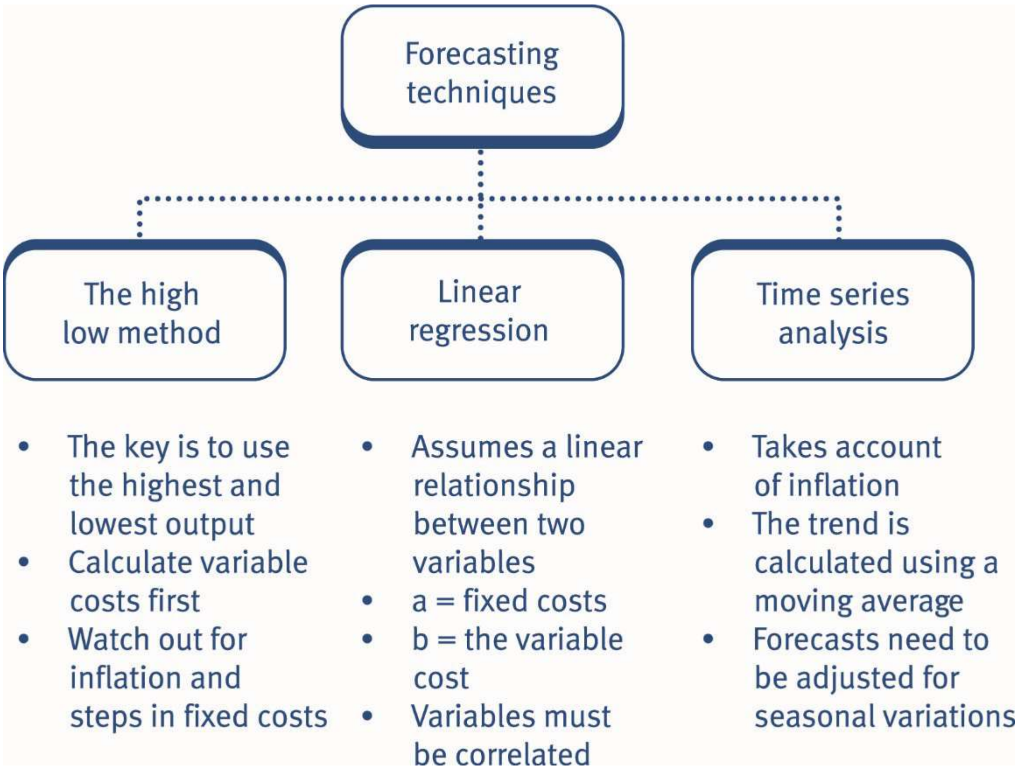
The disadvantages of forecasting with time series analysis are that:

- there is an assumption that what has happened in the past is a reliable guide to the future
- there is an assumption that a straight-line trend exists
- there is an assumption that seasonal variations are constant, either in actual values using the additive model (such as dollars of sales) or as a proportion of the trend line value using the multiplicative model.

None of these assumptions might be valid.

However, the reliability of a forecasting method can be established over time. If forecasts turn out to be inaccurate, management might decide that they are not worth producing, and that different methods of forecasting should be tried. On the other hand, if forecasts prove to be reasonably accurate, management are likely to continue with the same forecasting method.

6 Chapter summary



7 Practice questions

Test your understanding 1

The following extract is taken from the production cost budget of S Limited:

Production (units)	2,000	3,000
Production cost ($)	11,100	12,900

The budget cost allowance for an activity level of 4,000 units would be $_______.

Test your understanding 2

The following data have been extracted from the budget working papers of BL Limited.

Production volume	*1,000*	*2,000*
	$/unit	$/unit
Direct materials	4.00	4.00
Direct labour	3.50	3.50
Production overhead – department 1	6.00	4.20
Production overhead – department 2	4.00	2.00

Identify the total fixed cost and variable cost per unit (circle the correct figure in each column)

Total fixed cost	**Variable cost per unit**
3,600	7.50
7,600	9.90

Test your understanding 3

A company will forecast its quarterly sales units for a new product by using a formula to predict the base sales units and then adjusting the figure by a seasonal index.

The formula is BU = 4,000 + 80Q

Where BU = Base sales units and Q is the quarterly period number.

The seasonal index values are:

Quarter 1	+196
Quarter 2	-848
Quarter 3	-212
Quarter 4	+864

Identify the forecast increase in sales units from Quarter 3 to Quarter 4:

A 25%

B 80 units

C 100 units

D 1,156 units

Test your understanding 4

W plc is preparing its budgets for next year.

The following regression equation has been found to be a reliable estimate of W plc's deseasonalised sales in units:

y = 10x + 420

Where y is the total sales units and x refers to the accountancy period. Quarterly seasonal variations have been found to be:

Q1	Q2	Q3	Q4
+75	+188	–38	–225

In accounting period 33 (which is quarter 4) identify the forecast seasonally adjusted sales units:

A 525

B 589

C 750

D 975

Test your understanding 5

A company has achieved the following sales levels of its key product, article B, over the last four years:

	Sales of article B ('000 units)			
	Q1	Q2	Q3	Q4
20X3	24.8	36.3	38.1	47.5
20X4	31.2	42.0	43.4	55.9
20X5	40.0	48.8	54.0	69.1
20X6	54.7	57.8	60.3	68.9

Using linear regression numbering 20X3 Q1 as t = 1, through to 20X6 Q4 as t = 16, and letting x = t and y = T

The trend equation is:

T = 28.54 + 2.3244t

Required:

The forecast sales of B in Quarter 3 of 20X7 are ________ (in '000 units and rounded to one decimal place)

Test your understanding answers

Example 1

Step 1: Calculate the variable cost per unit

$$\text{Variable cost per unit} = \frac{\text{Increase in cost}}{\text{Increase in level of activity}}$$

$$= \frac{\$46,000 - \$26,000}{10,000 \text{ units} - 5,000 \text{ units}}$$

$$= \$4 \text{ per unit}$$

Step 2: Find the fixed cost

The fixed cost can be determined either at the high level or the low level.

	High level	**Low level**
	$	$
Semi-variable cost	46,000	26,000
Variable costs		
$4 per unit × 10,000 units	40,000	
$4 per unit × 5,000 units		20,000
Fixed cost	6,000	6,000

Step 3: Calculate the expected cost

Therefore cost for 13,000 units = (13,000 units × $4 per unit) + $6,000 = $58,000

Example 2

$$b = \frac{n\Sigma xy - \Sigma x \Sigma y}{n\Sigma x^2 - (\Sigma x)^2}$$

$$= \frac{6 \times 326{,}500 - 450 \times 4{,}050}{6 \times 38{,}300 - 450^2}$$

$$= \frac{136{,}500}{27{,}300} = 5$$

$$a = \bar{y} - b\bar{x}$$

$$a = \frac{4{,}050}{6} - 5 \times \frac{450}{6} = 300$$

The regression equation is $y = 300 + 5x$

Example 2 – CONTINUED

(a)

	$000
Sales revenue = $300k + (5 × $150k) =	1,050
Sales revenue = $300k + (5 × $50k) =	550

(b) The second prediction is the more reliable as it involves interpolation. The first prediction goes beyond the original data upon which the regression line was based and thus assumes that the relationship will continue on in the same way, which may not be true.

Example 3

(a) As the line of best fit is based on 20X4 prices, use this as the common price level. Costs should therefore be adjusted by a factor:

$$\frac{\text{Index level to which costs will be adjusted}}{\text{Actual index level of costs}}$$

Year	Actual overheads	Cost index	Adjustment factor	Costs at 20X4 price level
	$			$
20X1	143,040	192	× 235/192	175,075
20X2	156,000	200	× 235/200	183,300
20X3	152,320	224	× 235/224	159,800
20X4	172,000	235	× 235/235	172,000

(b) If the forecast number of machine hours is 3,100 and the cost index is 250:

Forecast overhead costs = [$33,000 + ($47 × 3,100 hours)] × (250/235)

= $178,700 × (250/235)

= $190,106

Test your understanding 1

The high-low method

Step 1 Calculate the variable cost per unit

$$\text{Variable cost per unit} = \frac{\text{Increase in cost}}{\text{Increase in level of activity}}$$

$$= \frac{\$12{,}900 - \$11{,}100}{3{,}000 \text{ units} - 2{,}000 \text{ units}}$$

$$= \$1.80 \text{ per unit}$$

Step 2 Find the fixed cost

A semi-variable cost has only got 2 components – a fixed bit and a variable bit. We now know the variable part. The bit that's left must be the fixed cost. It can be determined either at the high level or the low level.

	High level	**Low level**
	$	$
Semi-variable cost	12,900	11,000
Variable part		
$1.80/unit × 3,000 units	5,400	
$1.80/unit × 2,000 units		3,600
Fixed cost	7,500	7,500

Therefore cost for 4,000 units = 4,000 units × $1.80 per unit + $7,500 = $**14,700.**

Test your understanding 2

We know the cost per unit. We need to multiply by the number of units so that we can find the total cost for 1,000 units and 2,000 units. Then we can apply the high-low method.

Production volume	**1,000**	**2,000**
	$/unit	$/unit
Direct materials	4.00	4.00
Direct labour	3.50	3.50
Production overhead – department 1	6.00	4.20
Production overhead – department 2	4.00	2.00
	17.50	13.70
× No of units	× 1,000	× 2,000
Total cost	17,500	27,400

Now we can do the high-low method.

The high-low method

Step 1 Calculate the variable cost per unit

$$\text{Variable cost per unit} = \frac{\text{Increase in cost}}{\text{Increase in level of activity}}$$

$$= \frac{\$27,400 - \$17,500}{2,000 \text{ units} - 1,000 \text{ units}}$$

$$= \textbf{\$9.90 per unit}$$

Step 2 Find the fixed cost

A semi-variable cost has only got 2 components – a fixed bit and a variable bit. We now know the variable part. The bit that's left must be the fixed cost. It can be determined either at the high level or the low level.

	High level	**Low level**
	$	$
Semi-variable cost	27,400	17,500
Variable part		
$9.90/unit × 2,000 units	19,800	
$9.90/unit × 1,000 units		9,900
Fixed cost	**7,600**	7,600

Test your understanding 3

D

Sales in quarter 3 (Q = 3)		
Base = 4,000 + (80 × 3)	=	4,240
Seasonal adjustment		–212
Actual sales	=	4,028
Sales in quarter 4 (Q = 4)		
Base = 4,000 + (80 × 4)	=	4,320
Seasonal adjustment		+864
Actual sales	=	5,184
Overall increase in sales	=	5,184 – 4,028 = 1,156 units

Test your understanding 4

A

y = 10x + 420

We are told that x refers to the accountancy period, which is 33, therefore:

y = 420 + (33 × 10) = 750

This is the trend, however and we need to consider the seasonal variation too. Accounting period 33 is quarter 4. Quarter 4 is a bad quarter and the seasonal variation is –225, therefore the expected results for period 33 are 225 less than the trend.

Expected sales = 750 – 225 = 525 units

Test your understanding 5

72.7

In 20X7, t takes values 17 to 20. Quarter 3 will correspond to a t value of 19. The forecast sales will be:

Q3 t = 19 T = 28.54 + 2.3244 × 19 = 72.7036