Chapter 9: Projecting the Future

Extra questions

1. Are scenario's a better way of thinking about the future than forecasting?

2. Sales for the previous six months have been recorded as follows:

Month	January	February	March	April	May	June
Sales	830	839	843	850	860	861

(i) plot sales against time and comment on any possible relationship
(ii) determine the correlation coefficient and the regression of sales against time
(iii) use your regression to forecast the number of customer complaints in following July, August and September

3. Demand from a business utility has been reported as follows:

Year	**Quarter 1**	**Quarter 2**	**Quarter 3**	**Quarter 4**
1	4634	3317	2372	4256
2	5257	3344	2416	4291
3	5910	3597	2448	4636

(i) Graph this data and comment on the outcome
(ii) Use a suitable moving average to determine trend
(iii) Estimate the seasonal effect using the additive and multiplicative models, and comment on your results
(iv) Forecast demand for the first and second quarters of year 4.

4. A small business makes deliveries to the building trade during a five day working week. You have been given details of the deliveries made over the last three weeks.

Week	Monday	Tuesday	Wednesday	Thursday	Friday
1	23	13	12	15	28
2	24	9	10	17	30
3	22	14	12	18	30

(i) Graph this data and comment on whether there is a distinctive trend
(ii) Calculate an appropriate moving average
(iii) Examine the daily variation using the additive and multiplicative models, and comment on your results
(iv) Predict the number of deliveries to be made in week 4.
(v) How could you improve your predictions

Extra answers

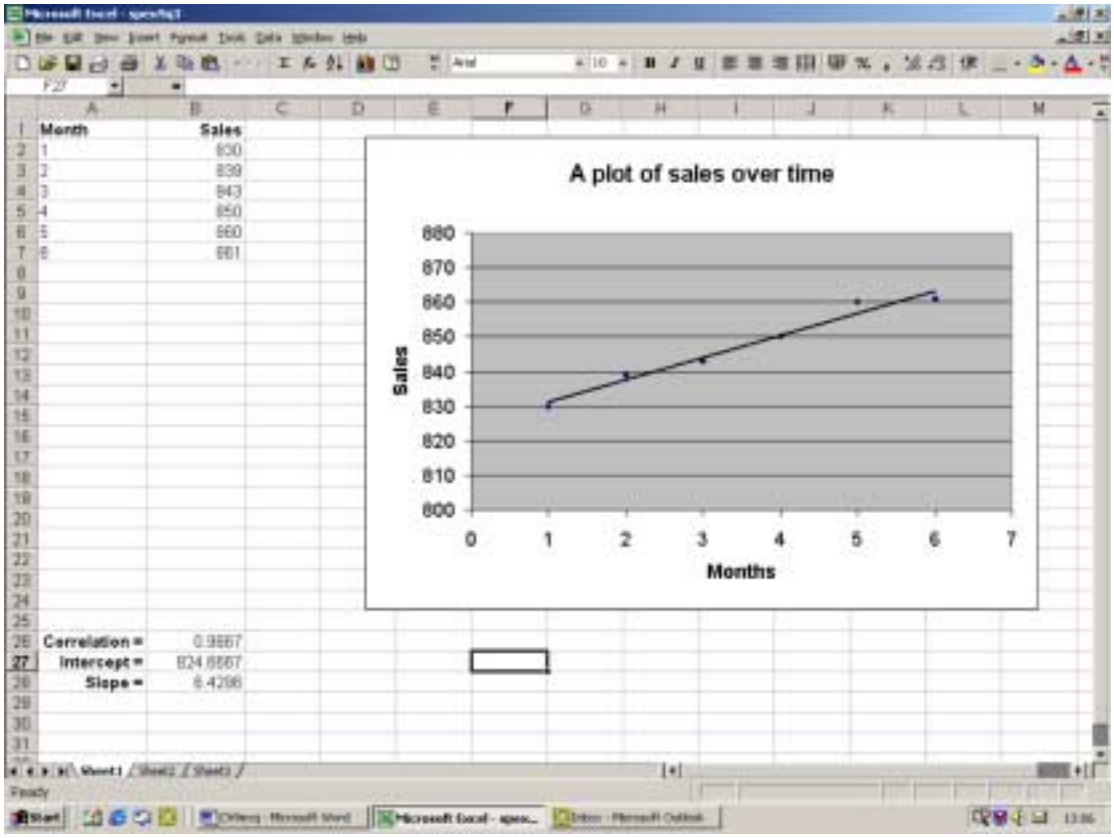
1. Scenarios are a useful way of bringing together a range of thinking about the future. In fact, we usually produce two or more scenarios so that we can contrast alternative 'futures'. Scenarios are based on views, ideas and opinions about the future but are also likely to include facts and figures. We tend to build an optimistic and a pessimistic scenario so that we can look at the best and worst outcomes. A scenario is not a forecast about the future but rather a way of informing management thinking. A good scenario will be internally consistent, even if unlikely, and be seen as plausible.

A good scenario is likely to use certain forecasts and develop ideas about the implications. In this sense, scenarios and forecasts are complementary. A scenario will seem more plausible if it uses accepted forecasting methods. A forecast will be a more effective management tool if the impact of a changing environment is also considered.

2. To use linear regression we let the sequential months January to June take the values 1 to 6 (but could use any other incremental run of numbers):

Month	1	2	3	4	5	6
Sales	830	839	843	850	860	861

The graph plotting (part i) and the determination of the correlation coefficient and regression coefficients (part ii) is shown on the following spreadsheet:



The correlation coefficient of 0.9867 suggests a strong positive relationship that could be described by a straight line. We have also added the trend line which can be found in the Excel Chart menu. The regression equation is $y = 824.7 + 6.4x$. In this case we have rounded to one decimal place because we will want these sales forecasts to be in whole numbers.

(iii) to forecast sales in July, August and September we would let $x = 7$, 8 and 9.

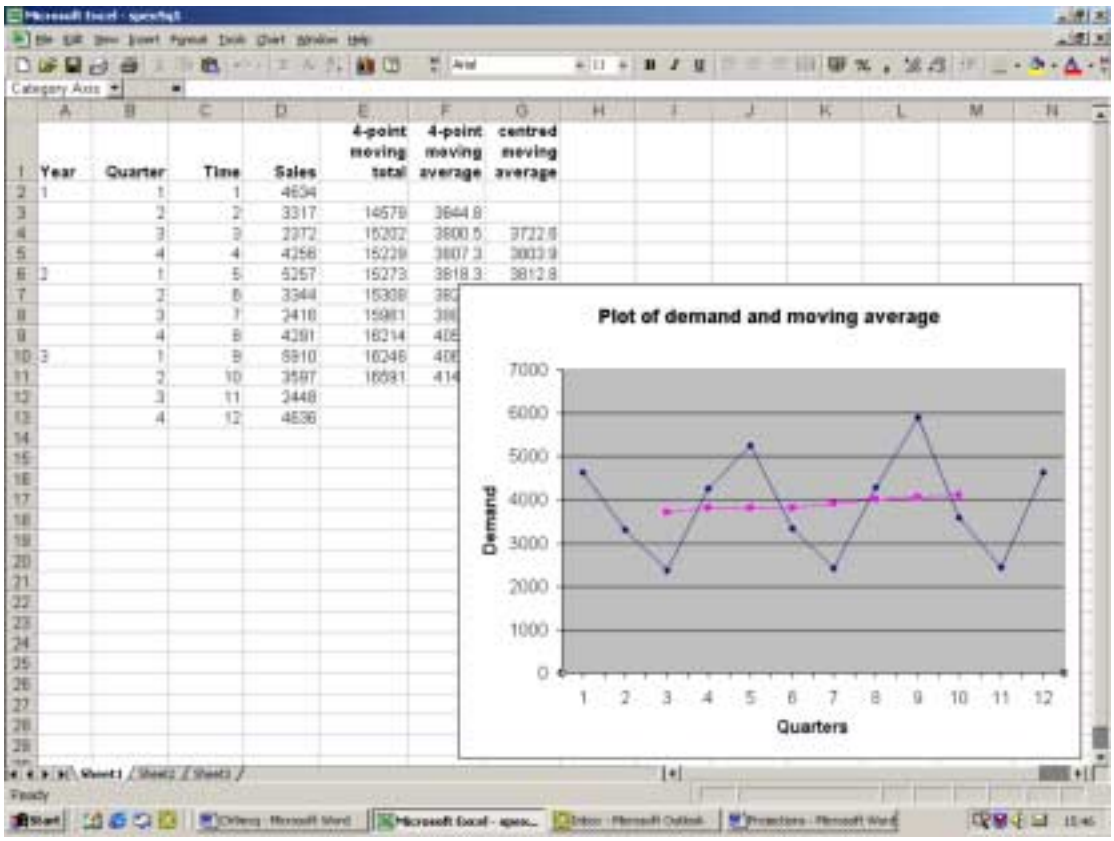
Forecast for July ($x = 7$): $y = 824.7 + 6.4 \times 7 = 869.5$

Forecast for August ($x = 8$): $y = 824.7 + 6.4 \times 8 = 875.9$

Forecast for September ($x = 9$): $y = 824.7 + 6.4 \times 9 = 882.3$

In this case we would forecast for sales of 870 in July, 876 in August and 882 in September.

3. A spreadsheet has been used to plot the data and calculate the moving average.



Year	Quarter	Time	Sales	4-point moving total	4-point moving average	centred moving average
1	1	1	4634			
	2	2	3317	14579	3644.8	
	3	3	2372	15202	3800.5	3722.6
	4	4	4256	15229	3807.3	3803.9
2	1	5	5257	15273	3818.3	3812.8
	2	6	3344	15309	3827	
	3	7	2410	15981	3995	
	4	8	4391	16214	4053	
3	1	9	5810	16246	4062	
	2	10	3597	16581	4145	
	3	11	2448			
	4	12	4536			

(i) Demand is at its lowest in the third quarter of the year (the Summer) and towards the end of the year. Demand is at its highest in the first quarter (coldest quarter) of the year.

(ii) and (iii) The calculations for the trend, and the additive and multiplicative models are shown below:

Year	Quarter	Time	Sales	4-point moving total	4-point moving average	centred moving average	Seasonal effect (A-T)	Seasonal effect (A/T)
1	1	1	4634					
	2	2	3317	14579	3644.8			
	3	3	2372	15202	3800.5	3722.6	-1351	0.64
	4	4	4256	15229	3807.3	3803.9	452	1.12
2	1	5	5257	15273	3818.3	3812.8	1444	1.38
	2	6	3344	15308	3827.0	3822.6	-479	0.87
	3	7	2416	15961	3990.3	3908.6	-1493	0.62
	4	8	4291	16214	4053.5	4021.9	269	1.07
3	1	9	5910	16246	4061.5	4057.5	1853	1.46
	2	10	3597	16591	4147.8	4104.6	-508	0.88
	3	11	2448					
	4	12	4636					

The seasonal differences for the additive model (A-T):

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1			-1351	452
2	1444	-479	-1493	269
3	1853	-508		
Total	3297	-987	-2844	721
Average	1648.5	-493.5	-1422	360.5

The sum of these averages is 1648.5 – 493.5 - 1422 360.5 = 93.5 and not zero. We therefore need to adjust these averages downwards by –23 (93.5/4 rounded).

Quarter	Average	Adjustment	Seasonal effect
1	1648.5	-23	1625.5
2	-493.5	-23	-516.5
3	-1422	-23	-1445
4	360.5	-23	337.5

The seasonal differences for the multiplicative model (A/T):

Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4
1			0.64	1.12
2	1.38	0.87	0.62	1.07
3	1.46	0.88		
Total	2.84	1.75	1.26	2.19
Average	1.42	0.875	0.63	1.095

These averages sum approximately to 4 (as required) and no further adjustment is really necessary.

(iv) To forecast demand in the first and second quarters of year 4 we do need values from the extended trend line. These can be found by regression or by some other method of extending the trend line.

Regression gave a trendline value of 4267 for the first quarter of year 4 and 4322 for the second quarter of year 4

Forecasts using the additive and multiplicative model:

The additive model

Year	Quarter	Trend (y)	Seasonal effect	Forecast (trend + seasonal)
4	1	4267	1648.5	5915.5
	2	4322	-493.5	3828.5

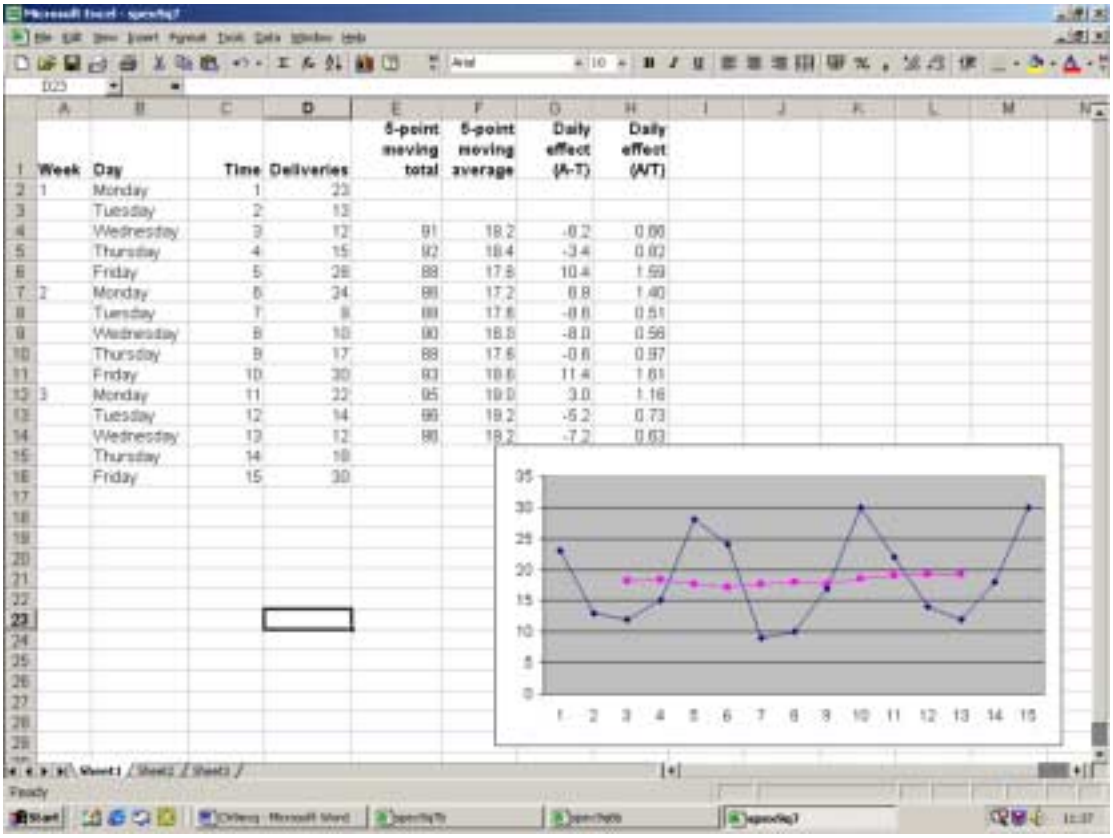
The multiplicative model

Year	Quarter	Trend (y)	Seasonal effect	Forecast (trend × seasonal)
4	1	4267	×1.42	6059.14
	2	4322	×0.875	3781.75

As you can see the forecasted values from these two models are different. There is value in having the results from both models and they can both be informative. Variance as we would expect is greater with the multiplicative model. The graph is more suggestive of the multiplicative model (variation becoming greater) and we should be guided by this.

4. In this example, the natural period of variation is the 5 day working week. The moving average will be based on 5 periods and given the odd number we will not need to take the additional step to centre the data.

(i), (ii) and (iii). The graph, determination of trend and the variation using the additive and multiplicative models are shown on the following spreadsheet:



The daily differences for the additive model (A-T):

Week	Monday	Tuesday	Wednesday	Thursday	Friday
1			-6.2	-3.4	10.4
2	6.8	-8.6	-8.0	-0.6	11.4
3	3.0	-5.2	-7.2		
Total	9.8	-13.8	-21.4	-4.0	21.8
Average	4.9	-6.9	-10.7	-2.0	10.9

The sum of these averages is 4.9 – 6.9 –10.7 – 2.0 +10.9 = -3.8 and not zero. We therefore need to adjust these averages upwards by 0.76 (-3.8/5).

Day	Average	Adjustment	Seasonal effect
Monday	4.9	+ 0.76	5.66
Tuesday	-6.9	+ 0.76	-6.14
Wednesday	-10.7	+ 0.76	-9.94
Thursday	-2.0	+ 0.76	-1.24
Friday	10.9	+ 0.76	11.66

The seasonal differences for the multiplicative model (A/T):

Week	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
1			0.66	0.82	1.59
2	1.40	0.51	0.56	0.97	1.61
3	1.16	0.73	0.63		
Total	2.56	1.24	1.85	1.79	3.20
Average	1.28	0.62	0.93	0.90	1.60

The sum of these averages is 1.28 + 0.62 + 0.93 + 0.90 + 1.60 = 5.33 and not 5 as we would expect. We therefore need to adjust these averages downwards by 0.938 (5/5.33).

Day	Average	Adjustment	Seasonal effect
Monday	1.28	× 0.938	1.20
Tuesday	0.62	× 0.938	0.58
Wednesday	0.93	× 0.938	0.87
Thursday	0.90	× 0.938	0.84
Friday	1.60	× 0.938	1.50

(iv) To predict deliveries in week 4, we can add the expected deliveries for each of the days. The trendline is extended for this purpose. Our predicted values, using regression are:

Year	Day	Forecast
4	Monday	19.37
	Tuesday	19.51
	Wednesday	19.65
	Thursday	19.79
	Friday	19.93

Forecasts using the additive and multiplicative model:

The additive model

Week	Day	Trend (y)	Seasonal effect	Forecast (trend + seasonal)
4	Monday	19.37	5.66	25.03
	Tuesday	19.51	-6.14	13.37
	Wednesday	19.65	-9.94	9.71
	Thursday	19.79	-1.24	18.55
	Friday	19.93	11.66	31.59

In this case with predicted daily sales of 25, 13, 10, 19 and 32 we would forecast demand for the week to be 99.

The multiplicative model

Week	Day	Trend (y)	Seasonal effect	Forecast (trend × seasonal)
4	Monday	19.37	× 1.20	23.24
	Tuesday	19.51	× 0.58	11.32
	Wednesday	19.65	× 0.87	17.10
	Thursday	19.79	× 0.84	16.62
	Friday	19.93	× 1.50	29.90

In this case with predicted daily sales of 23, 11, 17, 17 and 30 we would forecast a demand for the week of 98.

We do expect to see differences between the models but both are offering a similar guide to the coming week.

(v) To make predictions with these models we are only extending the trends observed over time. To improve the modelling we would like to include additional information. It could be that the number of deliveries depends on other factors, like the level of activity within the trade or the weather. It would helpful to have more detailed market research information.