

# MICROSOFT EXCEL 2007-2010 FORECASTING AND DATA ANALYSIS

# NOTE

Unless otherwise stated, screenshots in this book were taken using Excel 2007 with a blue colour scheme and running on Windows Vista. There may, therefore, be minor visual differences if you are using a different colour scheme, using Excel 2010, or if you are running on a different version of Windows.

Separate screenshots and instructions are given where there is a significant difference between the versions or the operating systems. In all other cases concepts, discussions, procedures and functionality are the same.

# CONTENTS

NOTE	3
CONTENTS	4
LESSON 1 - FORECASTING	7
Concept and Terms	
Linear Regression	9
The Forecast function	9
The Trend function	
The Slope and Intercept Function	
Exponential Regression	
The Growth function	22
Exponential Smoothing	
The Data Analysis Tool Exponential Smoothing	
Naïve forecasting	
Moving Average	
Weighted Moving Average	
The Data Analysis tool Moving Average	35
Seasonal Forecasting	
Exercises	
Exercise 1 Linear Regression	42
Exercise 2 Exponential Regression	43
Exercise 3 Exponential Smoothing forecasting	44
Exercise 4 Naïve forecasting and Moving Average	
Exercise 5 Seasonal forecasting	46
LESSON 2 - MEASURING FORECAST ACCURACY	
Concepts and terms	
Calculate error/deviation	
Calculate absolute error/deviation	49
Calculate percentage error/deviation	51
Calculate absolute percentage error/deviation	52
Calculate square error	53
Calculate standard error	
Calculate MAD or MAE (Mean Absolute Deviation or Mean Absolute Error)	57
Calculate MSQ (Mean Square Error)	58
Calculate MPE (Mean Percentage Error)	58

Calculate MAPE (Mean Absolute Percentage Error):	59
Calculate TSE (Tracking Signal Error)	60
Exercises	
Exercise 1 Error/deviation	62
Exercise 2 Mean errors/deviation	63
LESSON 3 – USING THE SOLVER TO OPTIMISE FORECASTS	64
Concept and Terms	65
Installing the Solver	66
Use the Solver to optimise exponential smoothing forecasts	68
Use the Solver to optimise weighted moving average forecasts	
Use the Solver to optimise seasonal forecasts	72
Exercises	75
Exercise 1 Optimising exponential smoothing forecasts using the Solver	
Exercise 2 Optimising weighted 3 periods moving average using the Solver	
Exercise 3 Optimising seasonal forecasts using the Solver	
LESSON 4 - SHOWING TRENDS AND FORECASTS USING CHARTS	
Concepts and terms	
Choose the right chart type	
Create Trendlines	
Choosing the best trendline for your data	
Visualise forecasts and forecast errors in a chart	
Exercises	
Exercise 1 Adding trendlines	
Exercise 2 Trendline types	
Exercise 3 Visualising forecasts and errors	
LESSON 5 – COMPARING FORECASTING METHODS AND MODELS	
Concept and Terms	
LESSON 6 – FORECASTING USING WHAT-IF ANALYSIS	
Concepts and terms	
The Scenarios Manager	
the Goal Seek tool	103
the Data Table tool	
Exercises	
Exercise 1 Forecasting using scenarios	107
Exercise 2 Forecasting using goal seek	108
Exercise 3 Forecasting using data tables	109

LESSON 7 - CORRELATION COEFFICIENT	
Concepts and terms	
the Correl function	
The Data Analysis Tool Correlation	113
Create a scatter chart to Display Correlation Coefficient	
EXERCISE	119
Using Correl function and the data analysis tool Correlation	119
LESSON 8 – BREAK-EVEN ANALYSIS	
Concepts and terms	121
Calculate Break-even	
Visualise break-even using scatter chart	123
Use Scenarios and the goal seek tool to calculate break-even	
EXERCISE	
Calculating break-even	
LESSON 9 – DATA ANALYSIS TOOLS	129
Concepts and terms	
Descriptive Statistics	130
Histogram	
Regression	
Sampling	
Rank & Percentile	
APPENDIX A – INSTALLING DATA ANALYSIS TOOLPAK TO EXCEL	
Installing Data analysis toolpak	
APPENDIX B – TEXT FUNCTIONS	
Concept and Terms	
Use the Right, Left, and Mid functions	
Use the Concatenate function	
Use the Len function	
Use the Find function	
Use nested text functions	156
INDEX	

# **LESSON 1 - FORECASTING**

In this lesson, you will learn how to:

- Work with Linear Regression
  - o Use the Forecast function
  - o Use the **Trend** function
  - Use the **Slope** and **Intercept** Function
- Work with Exponential Regression
  - o Use the Growth function
- Use Exponential smoothing
- Use Data Analysis Tool Exponential Smoothing
- Use naïve forecasting
- Use Moving Average to forecast
- Use weighted Moving Average to forecast
- Use the Data Analysis tool Moving Average
- Work with Seasonal Forecasting

# **CONCEPT AND TERMS**

## Discussion

Forecasting is required in many situations to be able to do effective and efficient planning. A future electricity demands forecast requires to planning building new power stations; scheduling staff in a call centre next week requires forecasts of call volume; just imaging how much forecasting the planners behind London 2012 Olympic Games must have done. Forecasts can be required years in advance, or only a few minutes beforehand. Whatever the circumstances or time horizons involved, accurate forecasts are essential part of planning.

Often in forecasting, a key step is knowing when something can be forecast accurately, and when forecasts are no better than tossing a coin. Good forecasts capture the genuine patterns and relationships which exist in the historical data, but do not replicate past events that will not occur again.

In all environments where numbers are collected and people make use of these numbers the ability to forecast or extrapolate data may be required. It doesn't really matter if you are talking about sales figures, expenses, man-hours, growth, market shares etc. to create a budget you need to forecast. To be able to forecast in Excel you must have historical data. In this workbook time series data is used for the forecasts. The periods can be quarters, months, minutes, hours, and years. The predictability of an event or a quantity depends on several factors including:

- How well you understand the factors that contribute to it;
- How much data are available;
- Whether the forecasts can affect the thing you are trying to forecast.

It is not possible to forecast everything. It is easy to forecast the time of the sunrise tomorrow, but it is impossible to forecast tomorrow's lottery numbers and difficult to forecast, who is going to win this year's European Song Contest

Can you trust a forecast created using Excel?

In Excel you have different methods to calculate a forecast, but Excel can only base the calculations on known data. You can use What-if analysis tools to manipulate your forecasts based on knowledge you have about the future (you will get a new product line, you have to close down 5 stores, you will spend money on marketing).

In forecasting you are going to look at the trends that the data have and use these trends to help forecast future values or values outside the measured data. The trends can also be used to infill data where data is missing in the collected data. You will also forecast seasonal data and also look at data which are not suitable for forecasting.

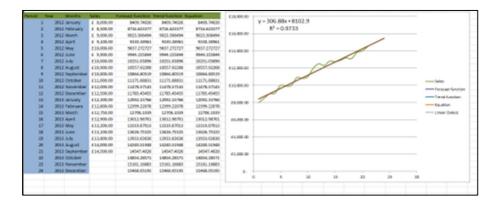
# LINEAR REGRESSION

## Discussion

Linear Regression analysis is a statistical technique for estimating the relationships among variables. In other words how do the sales figures change over time?

If the goal is prediction, or forecasting, linear regression can be used to fit a predictive model to an observed data set of y and x values or known actual data (y) over time (x) (time series data). After developing such a model, if an additional value of x (a new period) is then given without its accompanying value of y, the fitted model can be used to make a prediction of the value of y.

The sales figures (y) are known for a number of periods (x) it makes it possible forecasting sales (y) for future periods (x).



In Excel the linear regression can be calculated using the **Forecast** function, The **Trend** function, the **Fill-Handle**, by calculating the equation:  $\mathbf{Y} = \mathbf{mX} + \mathbf{c}$ , and by adding a **Trendline** to a chart.

The Data Analysis Tool **Regression** is an analysis tool to return important information working with linear regression such as the **Slope**, the **Y-Interceptor**, **R-square**, and other statistical useful information. The different terms will be explained later in this workbook.

You can also calculate the **Slope** and the Y **Interceptor** using the functions **Slope** and **Intercept**.

## THE FORECAST FUNCTION

## Discussion

Microsoft Excel provides a variety of functions you can use to calculate forecasts. One of them is the **Forecast** function. The **Forecast** function can calculate trend, a linear

forecast, or linear regression for as many future periods needed based on known actual data from previous periods.

The **Forecast** function consists of three required arguments, in the following order: **X**, **Known\_y's**, and **Known\_x's**. **X** is the period for which you want to calculate the forecast. **Known\_y's** is the array with the known values. **Known\_x's** is the array with the known periods (must be a numeric range and not dates, months or years).

	А	В	С	D	E	F
4		Period	Month	Sales	Forecast	
5		1	Jan-12	£ 1,200,000.00	=FORECAST(B5,\$D\$5:\$	D\$14,\$B\$5:\$B\$14)
6		2	Feb-12	£ 1,350,000.00		
7		3	Mar-12	£ 1,280,000.00		
8		4	Apr-12	£ 1,300,000.00		
9		5	May-12	£ 1,278,000.00		
10		6	Jun-12	£ 1,300,000.00		
11		7	Jul-12	£ 1,300,000.00		
12		8	Aug-12	£ 1,400,000.00		
13		9	Sep-12	£ 1,400,000.00		
14		10	Oct-12	£ 1,500,000.00		
15		11	Nov-12			
16		12	Dec-12			
17		13	Jan-13			
18	Function	Arguments				? <b>X</b>
19	FOREC	AST				
20	1 OILC	x	DE	=	= 1	
21			B5			
22		Known_y's	\$D\$5:\$D\$14		= {1200000;1350000;128000	00;130000
23		Known_x's	\$8\$5:\$8\$14	=	= {1;2;3;4;5;6;7;8;9;10}	
24					= 1230654.545	
25	Calculate	es, or predicts,	a future value	along a linear trend by using	existing values.	
26			Known_		y or range of numeric data. T	he variance of
27				Known_x's must not be	zero.	
28						
29	Formula	result = 1230	654,545			
30	1 ornala	1200	0011010			
31	Help on t	his function			OK	Cancel
22		-				

- 1. To use a **Forecast** function, first create a data range containing known factual data and responding periods.
- 2. Click in the cell where you want to place the function.
- 3. Click on the **Formulas** tab.
- 4. In the Function Library group, click on the Insert Function button.



- 5. In the Insert function dialog box, locate **Statistical** category in the **Or select a category:** box.
- 6. Click on Forecast.
- 7. Click on the **OK** button.

nsert Function			? 💌
Search for a function:			-
Type a brief descripti Go	on of what you want to	do and then click	Go
Or select a category:	Statistical	Sele	ct statistical
elect a function:			ŀ
F.TEST FISHER FISHERINV FORECAST		1 Select Foreca	et 🔲
FREQUENCY GAMMA.DIST GAMMA.INV			
FORECAST(x,known Calculates, or predicts values.	n <b>_y's,known_x's)</b> ;, a future value along a	linear trend by using ex	isting
Help on this function		ОК	Click OK

- 8. In the Function Arguments dialog box, click in the X box.
- 9. Enter the cell reference for the cell with the period information.
- 10. In the **Known\_y's** box, select the cells containing the known values.
- 11. Make the cell references absolute (Press F4 or add the \$ signs).
- 12. In the **Known\_x's** box, select the cells containing the known periods.
- 13. Make the cell references absolute (Press F4 or add the \$ signs).
- 14. Click **OK**.

		A E	3	С		D	E	F
	4	Per	iod	Month	S	ales	Forecast	
	5		1	Jan-12	£ 1	,200,000.00	=FORECAST(B5,\$	D\$5:\$D\$14,\$B\$5:\$B\$14
	6		2	Feb-12	£ 1	,350,000.00		
	7		3	Mar-12	£ 1	,280,000.00		
	8		4	Apr-12	£ 1	,300,000.00		
	9		5	May-12	£ 1	,278,000.00		
	10		6	Jun-12	£ 1	,300,000.00		
	11		7	Jul-12	£ 1	,300,000.00		
	12		8	Aug-12	£ 1	,400,000.00		
	13		9	Sep-12	£ 1	,400,000.00		
	14		10	Oct-12	£ 1	,500,000.00		
	15		11	Nov-12				
	16		12	Dec-12				
	17		13	Jan-13				
	18	Function Argu	ments				1	? 🔀
	19	FOR	mento					
	20	FOR ASI						
			x			Enter n		
Enter known f	actual	data	_y's	\$D\$5:\$D\$14			- [120000, p30000,	1280000;130000
		Jown	n_x's	\$8\$5:\$8\$14			= {1;2	er known neri
	24						= 12306	er known neri
	25	Calculates, or pr	redicts, a	a future value	along a linea	r trend by usin	g existing values.	
	26			Known	x's is the in	dependent arra	y or range of numeric of	data. The variance of
	27			_		x's must not be		
	28							
	29	Formula result =	= 12304	54 545				
	30	i ormula result =	- 12300	5713				CIL-1-
	31	Help on this fun	ction				OK	Click
	91							

15. Copy down the **Forecast** function to get the forecast for known periods and unknown periods.

Period	Month		Sales		Forecast
1	Jan-12	£	1,200,000.00	£	1,230,654.55
2	Feb-12	£	1,350,000.00	£	1,252,909.09
3	Mar-12	£	1,280,000.00	£	1,275,163.64
4	Apr-12	£	1,300,000.00	£	1,297,418.18
5	May-12	£	1,278,000.00	£	1,319,672.73
6	Jun-12	£	1,300,000.00	£	1,341,927.27
7	Jul-12	£	1,300,000.00	£	1,364,181.82
8	Aug-12	£	1,400,000.00	£	1,386,436.36
9	Sep-12	£	1,400,000.00	£	1,408,690.91
10	Oct-12	£	1,500,000.00	£	1,430,945.45
11	Nov-12			£	1,453,200.00
12	Dec-12			£	1,475,454.55

The forecast function is built in the **Fill handle**. Select the known periods' factual data and drag down the **Fill handle** and the **Fill** handle will forecast the unknown periods.

Period	Month		Sales		Forecast
1	Jan-12	£	1,200,000.00	£	1,243,381.82
2	Feb-12	£	1,500,000.00	£	1,255,030.30
3	Mar-12	£	1,180,000.00	£	1,266,678.79
4	Apr-12	£	1,300,000.00	£	1,278,327.27
5	May-12	£	1,278,000.00	£	1,289,975.76
6	Jun-12	£	1,100,000.00	£	1,301,624.24
7	Jul-12	£	1,300,000.00	£	1,313,272.73
8	Aug-12	£	1,200,000.00	£	1,324,921.21
9	Sep-12	£	1,400,000.00	£	1,336,569.70
10	Oct-12	£	1,500,000.00	£	Drag fill handle
11	Nov-12			£	
12	Dec-12			£	1,371,515.15

Period	Month		Sales		Forecast
1	Jan-12	£	1,200,000.00	£	1,243,381.82
2	Feb-12	£	1,500,000.00	£	1,255,030.30
3	Mar-12	£	1,180,000.00	£	1,266,678.79
4	Apr-12	£	1,300,000.00	£	1,278,327.27
5	May-12	£	1,278,000.00	£	1,289,975.76
6	Jun-12	£	1,100,000.00	£	1,301,624.24
7	Jul-12	£	1,300,000.00	£	1,313,272.73
8	Aug-12	£	1,200,000.00	£	1,324,921.21
9	Sep-12	£	1,400,000.00	£	1,336,569.70
10	Oct-12	£	1,500,000.00	£	1,348,218.18
11	Nov-12	£	1,359,866.67	£	1,359,866.67
12	Dec-12	£	1,371,515.15	£	1,371,515.15
				<b></b>	

If you compare the result using the fill handle in the Sales column and using the **Forecast** function in the Forecast column you can see that both methods will return the same result for November and December. Exactly as the **Forecast** function the fill handle can predict as many future periods needed based on known actual data.

# THE TREND FUNCTION

## **Discussion**

The **Trend** can calculate trend, a linear forecast, or linear regression for as many future periods needed based on data from previous periods.

The **Trend** function is an array function and the steps to use it are different from "normal" functions in Excel. The whole range where you want the result to be displayed must be selected and after the needed arguments have been entered the function dialog box the keys **Ctrl Shift Enter** must be pressed instead of pressing **Enter**. Then the function will return the result for the whole range in the selected range.

The **Trend** function consists of one required argument and three optional arguments, in the following order: **Known\_y's**, **Known\_x's**, **New\_x's**, and **Const**. **Known\_y's** is the array with the known values. **Known\_x's** is the array with the known periods (must be a numeric range and not dates, months or years). **New\_x's** is the array with future periods if the **Trend** function is used for forecasting. **Const** is a logical value specifying whether to force the constant **c** (the Y interceptor) to equal 0. In other words by forcing the Y interceptor to equal 0 the trendline will have a start from 0,0 (X=0 and y=0).

## Procedures

5

6

7

8

9

10

11

12

13

14

15

16

	A	B	С	D
1	Forecasting	[		
2				
3				
	Period	Month	Sales	Trend

1,200,000.00

1,350,000.00

1,280,000.00

1,300,000.00

1,278,000.00

1,300,000.00

1,300,000.00

1,400,000.00

1,400,000.00

1,500,000.00

1. To use a **Trend** function, first create a data range containing known factual data and responding periods.

2. Select the range where you want the result of the function.

Jan-12 f

Feb-12 f

Mar-12 £

Apr-12 £

May-12 f

Jun-12 £

Jul-12 £

Aug-12 f

Sep-12 f

Oct-12 f

Nov-12

Dec-12

3. Click on the Formulas tab.

1

3

4

5

6

7

8

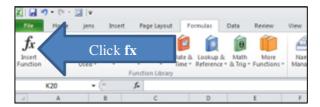
9

10

11

12

4. In the Function Library group, click on the Insert Function button.



- 5. In the Insert function dialog box, locate **Statistical** category in the **Or select a category:** box.
- 6. Click on **Trend**.
- 7. Click on the **OK** button.

	TREN	D •	0	$X \checkmark f_x =$		
Â.	A	В		С	D	Insert Function
1	Forecasting					
2						Search for a function:
3						Type a brief description of what you want to do and the rick Go
4	Period	Month		Sales	Trend	Go
5	1	Jan-12	£	1,200,000.00	-	Or select a gategory: Statistical Select statistical
5	2	Feb-12	£	1,350,000.00		Select a function:
7	3	Mar-12	£	1,280,000.00		T.INV
8	4	Apr-12	£	1,300,000.00		T.INV.2T
9	5	May-12	£	1,278,000.00		T.TEST TRENO Select Trend
.0	6	Jun-12	£	1,300,000.00		TRIMMEAN Select I rend
11	7	Jul-12	£	1,300,000.00		VAR.P
12	8	Aug-12	£	1,400,000.00		VAR.S
.3	9	Sep-12	£	1,400,000.00		TREND(known_y's,known_x's,new_x's,const)
L4	10	Oct-12	£	1,500,000.00		Returns numbers in a linear trend matching known data points, using the least squares method.
.5	11	Nov-12				squares metriou.
16	12	Dec-12				
17						
18						
19						Help on this function OK Clici
20						

- 8. In the Function Arguments dialog box, click in the Known\_y's box.
- 9. Select the cells containing the known values.
- 10. In the **Known\_x's** box, select the cells containing the known periods.
- 11. Press Ctrl Shift Enter.

The array functions will add the result to the whole selected array and will look different in the formula bar. Excel will display the formula enclosed in curly brackets { }.

	D5	•	. (	<i>f</i> <sub>x</sub> {=T	REND	(C5:C14,A5:A14)	}
- 24	A	В		С		D	
1	Forecasting						
2							
3							
	Period	Month		Sales		Trend	
4							
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	
9	5	May-12	£	1,278,000.00	£	1,319,672.73	
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	
15	11	Nov-12					
16	12	Dec-12					

#### If the Trend function is used for forecasting:

### **Procedures**

1. To use a **Trend** function for forecasting, first create a data range containing known factual data and responding periods and add the periods for which you want to forecast.

	- 24	Α	В		С	D
	1	Forecasting	3			
	2					
	3					
		Period	Month		Sales	Trend
	4					
	5	1	Jan-12	£	1,200,000.00	
	6	2	Feb-12	£	1,350,000.00	
	7	3	Mar-12	£	1,280,000.00	
	8	4	Apr-12	£	1,300,000.00	
	9	5	May-12	£	1,278,000.00	
	10	6	Jun-12	£	1,300,000.00	
	11	7	Jul-12	£	1,300,000.00	
	12	8	Aug-12	£	1,400,000.00	
	13	9	Sep-12	£	1,400,000.00	
	14	10	Oct-12	£	1,500,000.00	
Period 11 and 12	5	11	Nov-12			
	16	12	Dec-12			

#### 2. Select the range where you want the result of the function.

3. Click on the Formulas tab.

4. In the Function Library group, click on the Insert Function button.



- In the Insert function dialog box, locate Statistical category in the Or select a category: box.
- 6. Click on Trend.
- 7. Click on the **OK** button.
- 8. In the Function Arguments dialog box, click in the Known\_y's box.
- 9. Select the cells containing the known values.
- 10. In the **Known\_x's** box, select the cells containing the known periods.
- 11. In the **New\_x's box**, select the cells containing the unknown periods.
- 12. Press Ctrl Shift Enter.

	A	8		¢		0	E	F	G		н
	Forecasting										
							Function Arguments				
	Period	Month		Sales		Trend	TREND				
ſ	2	Jan-12	٤	1,200,000.00	٤	1,230,654.55	Known_y's	CSIC34		- {120	9000; 1359000; 1289000; 139900.
	2	Feb-12	٤	1,350,000.00	٤	1,252,909.09	Known sis	45:414		- (22	3;4;5;6;7;0;9;30)
	3	Mar-12	£	1,280,000.00	6	1,275,163.64					
	4	Apr-12	£	1,300,000.00	£	1,297,418.18	hev_xx	A15:A16		<ul> <li>{11;1</li> </ul>	12)
	5	May 12	£	1,278,000.00	£	1,519,672.73	Const		18	· logic	al
	6	Jun-12	٤	1,300,000.00	£	1,541,927.27				- 1140	12001 1475454, 546454651
	7	Jul-12	£	1,300,000.00	£	1,364,181.82	Returns numbers in a linear tren	I matching longue date	mints using the la		
	8	Aug-12	£	1,400,000.00	£	1,386,436.36					
	9	5ep-12	٤	1,400,000.00	٤	1,438,690.91				uses for N	hich you want TREND to return
l	30	Oct-12	٤	1,500,000.00		1,430,945.45		correspond	ng y-values.		
I	11	Nov-12			-TREN	0(05:014,45:434,4					
I	12	Dec-12					Formula result = £				1,453,290.0
						1	Formula result = E				1,403,200.0
							Help on this function				OK Cancel

The **Trend** function will return exactly the same result as the forecast function and as the **Forecast** function able to forecast as many future periods needed.

## THE SLOPE AND INTERCEPT FUNCTION

## Discussion

Ŵ

To make it easy to calculate the trend or forecast equation  $\mathbf{Y} = \mathbf{mX} + \mathbf{c}$  you need the slope and y interceptor.

First the equation:

Y = mX + c

Where:

**Y** is the unknown measure (the value you want to forecast)

 $\boldsymbol{X}$  is the X value (the period in time series data) for which you want to know the value of Y

Where:

**m** is the gradient of the line or the slope

Where:

**c** is the Y interceptor of the line (or Y value when there is no X value or X =0)

The slope equation looks like this:

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

The **Slope** function consists of two required arguments, in the following order: **Known\_y's**, and **Known\_x's**. **Known\_y's** is the array with the known values. **Known\_x's** is the array with the known responding periods (must be a numeric range and not dates, months or years).

- 1. Select the cell where the result is to be displayed.
- 2. Click on the **Formulas** tab.
- 3. In the **Function Library** group, click on the **Insert Function** button.
- 4. In the Insert function dialog box, locate **Statistical** category in the **Or select a category:** box.
- 5. Click on Slope.
- 6. Click on the OK button.
- 7. In the **Known\_y's** box, select the cells containing the known values.

9. Click on the **OK** button.

- 8. In the **Known\_x's** box, select the cells containing the responding known periods.
- ▼ ( × ✓ fx =SLOPE(C5:C14,A5:A14) SLOPE A Forecasting Period Sales =mx+h 1,200,000.00 Function Arguments Jan-12 f ? 1,350,000.00 Feb-12 SLOPE 1,280,000.00 Mar-12 f Apr-12 1 300 000 00 y's C5:C14 = {1200000;1350000;1280000;1300000; May-12 £ 1,278,000.00 = {1;2;3;4;5;6;7;8;9;10} Known\_x's A5:A14 Jun-12 £ 1,300,000.00 10 11 12 13 14 15 16 17 1,300,000.00 1,400,000.00 Jul-12 = 22254.54545 Returns the slope of the linear regression line through the given data points. Aug-12 f Sep-12 f Oct-12 f 1.400.000.00 Known\_x's is the set of independent data points and can be numbers or names, arrays, or references that contain numbers. 1,500,000.00 11 Nov-12 12 Dec-12 Formula result = 22254.54545 =SLOPE(C5:C14,A5:A14) OK Cancel Help on this function
- The **Intercept** function consists of two required arguments, in the following order: **Known\_y's**, and **Known\_x's**. **Known\_y's** is the array with the known values. **Known\_x's** is the array with the known responding periods (must be a numeric range and not dates, months or years).

- 1. Select the cell where the result is to be displayed.
- 2. Click on the Formulas tab.
- 3. In the **Function Library** group, click on the **Insert Function** button.
- 4. In the Insert function dialog box, locate **Statistical** category in the **Or select a category:** box.
- 5. Click on Intercept.
- 6. Click on the OK button.
- 7. In the **Known\_y's** box, select the cells containing the known values.
- 8. In the **Known\_x's** box, select the cells containing the responding known periods.
- 9. Click on the **OK** button.

	SLO		1	X V fr -INTER	EPT(CS:C14,AS:					
	A	8		c	D	E		F	G	н
1	Forecastin	c								
2										
5					Function Arou	manhs				- 7- 💌
	Period	Month		Sales	1					
4					INTERCEPT					
5	1	Jan-12	٤	1,200,000.00		Known_y's	C5:C14		- 12	{1200000; 1350000; 1280000; 130000
5	2	Feb-12	6	1,350,000.00					- 12	1-22-45-6-20-0-10
7	3	Mar-12	٤	1,280,000.00		Known_x's	M3:A14		(- H)	(1;2;3;4;5;6;7;8;9;10)
1	4	Apr-12	٤	1,300,000.00					-	1208400
9	5	May-12	£	1,278,000.00	Calculates the p	point at which a lin	e vil intersect ti	he y-axis by usin	g a best-ft re	egression line plotted through the known
0	6	Jun-12	£	1,500,000.00	x-values and y-	values.				
1	7	Jul-12	6	1,300,000.00		Kee	we a's is the i	independent set	of observatio	ons or data and can be numbers or name
2	8	Arag-12	£	1,400,000.00				, or references		
5	9	Sep-12	٤	1,400,000.00						
4	10	Oct-12	£	1,500,000.00						
5	11	Nov-12			Formula result	- 1208400				
6	12	Dec-12								
17					Help on this fur	1000				OK Cancel
8		Slope		22254.54545						
9		Y intercept	-INT	ERCEPT(CS:C54,A5:A14)						
20										

The **Slope** and **Y interceptor** can now be used to calculate the trend and forecast using the trend/forecast equation:

- 1. Select the cell where the result is to be displayed.
- 2. Type =( click in the cell with the **slope**. Press F4 to lock the cell reference.
- 3. Type \* click in the cell with the period number (x). Type )
- 4. Type + click in the cell with **y interceptor**. Press F4 to lock the cell reference.
- 5. Press enter.
- 6. Copy down the equation.

	SLO	PE 👻	· (• × ✓ f*	=(\$C\$18*A5)+\$C\$19
	A	В	С	D
1	Forecastin	g		
2				
3				
	Period	Month	Sales	y=mx+b
4		a		
5	1	Jan-12	£ 1,200,000.	00 =(\$C\$18*A5)+\$C\$19
6	2	Feb-12	£ 1,350,000.	00
7	3	Mar-12	£ 1,280,000.	00
8	4	Apr-12	£ 1,300,000.	00
9	5	May-12	£ 1,278,000.	00
10	6	Jun-12	£ 1,300,000.	00
11	7	Jul-12	£ 1,300,000.	00
12	8	Aug-12	£ 1,400,000.	00
13	9	Sep-12	£ 1,400,000.	00
14	10	Oct-12	£ 1,500,000.	00
15	11	Nov-12		
16	12	Dec-12		
17				
18		Slope	22254.54	545
19		Y Intercept	12084	400

The **Forecast** function, the **Trend** function and the trend/forecast equation will return exactly the same result. It does not really matter which method used. The equation can be used to calculate the forecast for as many future periods needed.

	A	В		С		D		E		F
1	Forecastin	g								
2										
3										
	Period	Month		Sales		y=mx+b	Fo	recast function		Trend function
4										
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	£	1,230,654.55	£	1,230,654.55
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	£	1,252,909.09	£	1,252,909.09
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	£	1,275,163.64	£	1,275,163.64
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	£	1,297,418.18	£	1,297,418.18
9	5	May-12	£	1,278,000.00	£	1,319,672.73	£	1,319,672.73	£	1,319,672.73
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	£	1,341,927.27	£	1,341,927.27
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	£	1,364,181.82	£	1,364,181.82
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	£	1,386,436.36	£	1,386,436.36
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	£	1,408,690.91	£	1,408,690.91
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	£	1,430,945.45	£	1,430,945.45
15	11	Nov-12			£	1,453,200.00	£	1,453,200.00	£	1,453,200.00
16	12	Dec-12			£	1,475,454.55	£	1,475,454.55	£	1,475,454.55
17										
18		Slope		22254.54545						
19		Y Intercept		1208400						

# **EXPONENTIAL REGRESSION**

## Discussion

Sometimes the growth in a model is not linear, but it is exponential. If the growth is exponential Excel has forecasting tools to replace the **Forecast** and **Trend** function.

In the example below the sales has an exponential growth rate. The **Forecast** function forecasts period 11 to 2005333.333. This is not a realistic forecast, because the known sales for period 10 are already £ 2,200,000.00.

orecasting							
Period	Month		Sales	Forecast function	,500,000.00 1		
1	Jan-12	£	200,000.00	-131636.3636			
2	Feb-12	£	220,000.00	82060.60606	,000,000.00	/	
3	Mar-12	£	280,000.00	295757.5758			
4	Apr-12	£	350,000.00	509454.5455	,500,000.00		
5	May-12	£	500,000.00	723151.5152			
6	Jun-12	£	650,000.00	936848.4848	,000,000.00		Sales
7	Jul-12	£	900,000.00	1150545.455			Forecast func
8	Aug-12	£	1,300,000.00	1364242.424	E500,000.00		
9	Sep-12	£	1,700,000.00	1577939.394			
10	Oct-12	£	2,200,000.00	1791636.364	£		
11	Nov-12			2005333.333	0 2 4 6 8 10	12 14	
12	Dec-12			2219030.303	E500,000.00		

In this section you will see how you can forecast an exponential growth.

## **THE GROWTH FUNCTION**

## **Discussion**

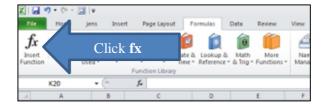
The **Growth** function can calculate exponential growth and an exponential growth forecast. The **Growth** function is an array function and the steps to use it are different from "normal" functions in Excel. The whole range where you want the result to be displayed must be selected and after the needed arguments have been entered the **Growth** function dialog box the keys **Ctrl Shift Enter** must be pressed instead of pressing **Enter**. Then the function will return the result for the whole range in the selected range.

The **Growth** function consists of one required argument and three optional arguments, in the following order: **Known\_y's**, **Known\_x's**, **New\_x's**, and **Const**. **Known\_y's** is the array with the known values. **Known\_x's** is the array with the known periods (must be a numeric range and not dates, months or years). **New\_x's** is the array with future periods if the **Growth** function is used for forecasting. **Const** is a logical value specifying whether to force the constant **c** (the Y interceptor) to equal 0. In other words by forcing the Y interceptor to equal 0 the trendline will have a start from 0,0 (X=0 and y=0).Procedures

	Deried	Month		Calac
5	Period	Month		Sales
6	1	Jan-12	£	200,000.00
7	2	Feb-12	£	220,000.00
8	3	Mar-12	£	280,000.00
9	4	Apr-12	£	350,000.00
10	5	May-12	£	500,000.00
11	6	Jun-12	£	650,000.00
12	7	Jul-12	£	900,000.00
13	8	Aug-12	£	1,300,000.00
14	9	Sep-12	£	1,700,000.00
15	10	Oct-12	£	2,200,000.00
16	11	Nov-12		
17	12	Dec-12		

1. To use a **Growth** function, first create a data range with factual known data and responding periods.

- 2. Select the array where you want the result of the function.
- 3. Click on the **Formulas** tab.
- 4. In the **Function Library** group, click on the **Insert Function** button.



- In the Insert function dialog box, locate Statistical category in the Or select a category: box.
- 6. Click on Growth.
- 7. Click on the **OK** button.

1	A	В		С	D	E	F	G	H	1		J	K
1						Insert Fu	nction					6	2
2	Forecasting												
3						Search fo	or a function:						
4							brief descrip	tion of what	you want to	do and en	n dick	G	io
5	Period	Month		Sales	Growth function	Go							
6	1	Jan-12	£	200,000.00	=	Or sele	ct a <u>c</u> ategory	: Statistical		S	lelec	t st	atist
7	2	Feb-12	£	220,000.00		Select a f	unction:						
8	3	Mar-12	£	280,000.00		GAMM							-
9	4	Apr-12	£	350,000.00		GAMM. GEOM	ALN.PRECISE						
10	5	May-12	£	500,000.00		GROW	πн		S	elect	Gro	wtł	า
11	6	Jun-12	£	650,000.00		HARM	EAN OM.DIST				010		-
12	7	Jul-12	£	900,000.00		INTER							-
13	8	Aug-12	£	1,300,000.00				y's,known_					
14	9	Sep-12	£	1,700,000.00		Returns	s numbers in a	an exponentia	l growth tre	end matching	, known d	ata poir	nts.
13 14 15 16 17 18 19	10	Oct-12	£	2,200,000.00									
16	11	Nov-12											
17	12	Dec-12											
18						Help on t	his function			O	к	<ul> <li>C</li> </ul>	
19													

- 8. In the Function Arguments dialog box, click in the Known\_y's box.
- 9. Select the cells containing the known values.
- 10. In the **Known\_x's** box, select the cells containing the known periods.
- 11. Press Ctrl Shift Enter.

	GROWTH	+ (* X ·	<	5-680WT	H(C6:C15,A6:A15)											
1	A	8		с	D	E	E F G H I							K	L	M
1																
2	Forecasting					Function A	(response)	-		-						7 83
3						GROWTH										
4						GRUMIN										
5	Period	Month		Sales	Growth function			wa_y's								2,350000;50
6	1	Jan-12	£	200,000.00	C15,46:A15)		10	own_x's	AS:A15			<b>5</b>	- (	(123)45	成7,8(9,30)	
7	2	Feb-12	£	220,000.00		Nexusis						56	- 1	reference		
8	3	Mar-12	6	280,000.00		Const S -						- 1	Insign			
9	4	Apr-12	٤	350,000.00												
30	5	May-12	٤	500,000.00		Erberts ou	nhers in an	records 1	al growth the	red math	tena konor	n data one		198276.2	0499714[22]	3283.999854
11	6	Jun-12	£	650,000.00							-					
12	7	Jul-12	£	900,000.00				Rep 1	Magara a	an opeo b"m"x,	AD BTUDE	ar range th	at yo a san	ne size as i	lady know in t Crown_y's.	the relationship y
13	8	Aug-12	6	1,300,000.00												
14	9	Sep-12	٤	1,700,000.00												
15	10	Oct-12	٤	2,200,000.00		Formula res	ut = 355	176.1477								
16	11	Nov-12				Help on the	function							ſ	OK.	Cancel
17	12	Dec-12								_			_	-		

The array functions will add the result to the whole selected array and will look different in the formula bar. Excel will display the formula enclosed in curly brackets { }.

	D6	▼ (*		fx {=GROWTH	H(C6:C15,A6:A15)}
1	Α	В		С	D
1	-				
2	Forecasting				
3					
4					
5	Period	Month		Sales	Growth function
6	1	Jan-12	£	200,000.00	168276.1477
7	2	Feb-12	£	220,000.00	223281.9099
8	3	Mar-12	£	280,000.00	296267.8428
9	4	Apr-12	£	350,000.00	393111.2678
10	5	May-12	£	500,000.00	521610.673
11	6	Jun-12	£	650,000.00	692113.7004
12	7	Jul-12	£	900,000.00	918350.4078
13	8	Aug-12	£	1,300,000.00	1218538.906
14	9	Sep-12	£	1,700,000.00	1616852.406
15	10	Oct-12	£	2,200,000.00	2145365.805
16	11	Nov-12			
17	12	Dec-12			

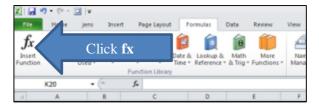
The Growth function p	procedures if it is used for forecasting:
-----------------------	---

#### **Procedures**

1. To use a **Growth** function for forecasting first create a data range with factual known data and responding periods. Add the periods for the future you want to forecast.

	1	А	В		С	D
	1					
	2	Forecasting				
	3					
	4					
	5	Period	Month		Sales	Growth function
	6	1	Jan-12	£	200,000.00	168276.1477
	7	2	Feb-12	£	220,000.00	223281.9099
	8	3	Mar-12	£	280,000.00	296267.8428
	9	4	Apr-12	£	350,000.00	393111.2678
	10	5	May-12	£	500,000.00	521610.673
	11	6	Jun-12	£	650,000.00	692113.7004
	12	7	Jul-12	£	900,000.00	918350.4078
	13	8	Aug-12	£	1,300,000.00	1218538.906
	14	9	Sep-12	£	1,700,000.00	1616852.406
	15	10	Oct-12	£	2,200,000.00	2145365.805
a 11 and 12	16	11	Nov-12			
s 11 and 12	17	12	Dec-12			

- 2. Select the array where you want the result of the function.
- 3. Click on the Formulas tab.
- 4. In the **Function Library** group, click on the **Insert Function** button.



Periods

- In the Insert function dialog box, locate Statistical category in the Or select a category: box.
- 6. Click on **Growth**.
- 7. Click on the **OK** button.
- 8. In the Function Arguments dialog box, click in the Known\_y's box.
- 9. Select the cells containing the known values.
- 10. In the **Known\_x's** box, select the cells containing the known periods.
- 11. In the **New\_x's box**, select the cells containing the unknown periods.
- 12. Press Ctrl Shift Enter.

	GROWTH	• (* X ·	~	GROWT	I(C6:C15,A6:A15,A1	IE:A17)										
14	A	8		C	D	E	F	G	н	1	J		¢	L	м	,
1																
2	Forecasting					_						_	_			_
3						Function	Arguments								P P	-
4						GROWTH										- 1
5	Period	Month		Sales	Growth function		Kas	own_y's	C8/C15		(Sec.)	- (20)	000;2	20090; 299000	0;250000;50.	
6	1	Jan-12	6	200,000.00	168275.1477	Known_xis			A6:A15			<ul> <li>(1:23:4:56:78(9:10)</li> </ul>				
7	2	Feb-12	£	220,000.00	223281.9099				KIA:RA			- (1);				
8	3	Mar-12	6	290,000.00	296267.8428	-		elser1		1		-				
9	4	Apr-12	£	350,000.00	393111.2678			Canst			1.	• 100	cae.			
10	5	May-12	6	500,000.00	521610.673								6638.1	\$8132963,37	77141.96412	-
11	6	Jun-12	£	650,000.00	692113.7004	Returns n	mbers in an	exponent	al graves trend	natching know	in dela po	rits.				
12	7	Jul-12	£	900,000.00	918350.4078				lew_x's are re	sv x-values fo	r which you	u want G	IOW7H	to return con	responding	
13	8	Aug-12	£	1,300,000.00	1218538.905				y-cal.	ei.						
34	9	Sep-12	£	1,700,000.00	1616852.406											-
15	10	Oct-12	£	2,200,000.00	2145365.805	Pormula re	nuit = 204	6638.581								
16	11	Nov-12			=GROWTH(C8:C15,									OK	Cancel	
17	12	Dec-12				Help on the function OK Cano					carce					
15																_

If you compare the **Growth** function with the **Forecast** function in a chart it is obvious that in this example you get a much more accurate forecast using the **Growth** function.

Forecasting		-		-		-		
								\$4,000,000.00
Period	Month		Sales	Ge	owth function	Fo	recast function	
1	Jan-12	£	200,000.00	£	168,276.15	-£	131,636.36	£3,500,000.00
2	Feb-12	£	220,000.00	6	223,281.91	٤	82,060.61	£8,000,000.00
3	Mar-12	£	280,000.00	6	296,267.84	£	295,757.58	£2,500,000.00
4	Apr-12	£	350,000.00	6	393,111.27	£	509,454.55	tales
5	May-12	٤	500,000.00	6	521,610.67	£	723,151.52	£2,000,000,00
6	Jun-12	£	650,000.00	6	692,113.70	£	935,848.48	£1,500,000,00
7	Jul-12	£	900,000.00	6	918,350.41	£	1,150,545.45	Porecast function
8	Aug-12	£	1,300,000.00	6	1,218,538.91	£	1,364,242,42	£1,000,000.00
9	Sep-12	£	1,700,000.00	6	1,616,852.41	£	1,577,939.39	6500,000.00
10	Oct-12	£	2,200,000.00	£	2,145,365.81	٤	1,791,636.36	the second se
11	Nov-12			6	2,845,638.58	£	2,005,333.33	
12	Dec-12			£	3,777,141.96	£	2,219,030.30	-6300,000.00 0 5 10 15

## **EXPONENTIAL SMOOTHING**

## Discussion

Exponential smoothing is another method to forecast actual time series data. The method uses a percentage of the previous period's actual data and a percentage of the previous period's forecast. The model can easily be adjusted to increase the accuracy when more actual data is known. When the model is created you need to decide a percentage (also called Alpha). May be you decide to set Alpha to 30%. Then the exponential smoothing forecast will use 30% of the previous period actual data and 70% of the previous forecast to forecast the next period. Because exponential smoothing is calculated from the previous period's forecast you must guess the first forecast or use the actual known value as forecast value. Exponential smoothing can only predict one future period because you need the previous period's actual known data.

Later you will see how you can use error measurement calculations and the **Solver** tool to increase the accuracy when you are working with exponential smoothing.

#### The math:

F=forecast

t=period

D=demand or actual known data

# F<sub>t+1</sub>=alpha \* D<sub>t</sub> + (1-alpha) \* F<sub>t</sub>

## Example:

Alpha = 30%

Previous forecast = 9000

Previous actual known data = 8000

	F7	• (	f,	=\$F\$2*E6	+(1-\$F\$2)*F6	
	А	В	С	D	E	F
1	Exponenti	ial smoothing				Alpha
2						30%
3						
4						
5		Period	Year	Months	Sales	Exponential smoothing
6		1	2012	January	£ 8,000.00	£ 9,000.00
7		2	2012	February	£10,000.00	£ 8,700.00
8		3	2012	March	£ 9,000.00	
9		4	2012	April	£ 8,000.00	
10		5	2012	May	£10,000.00	
11		6	2012	June	£ 9,000.00	
12		7	2012	July	£10,000.00	
13		8	2012	August	£11,000.00	
14		9	2012	September	£10,000.00	
15		10	2012	October	£ 9,000.00	
16		11	2012	November	£12,000.00	
17		12	2012	December	£11,000.00	

- 1. Guess forecast for the first period or if you have data from the previous period use them as forecast for the previous period.
- 2. Select the cell where the result is to be displayed.
- 3. Type = select the cell with alpha. Type \* select the cell with previous known actual data.
- 4. Type + (1- select the cell with alpha value )\* select the cell with last forecast.
- 5. Press enter.

	F7	• (	fs	=\$F\$2*E6	+(1-\$F\$2)*F6	
	А	В	С	D	E	F
1	Exponenti	ial smoothing				Alpha
2						30%
3						
4						
5		Period	Year	Months	Sales	Exponential smoothing
6		1	2012	January	£ 8,000.00	£ 9,000.00
7		2	2012	February	£10,000.00	£ 8,700.00
8		3	2012	March	£ 9,000.00	
9		4	2012	April	£ 8,000.00	
10		5	2012	May	£10,000.00	
11		6	2012	June	£ 9,000.00	
12		7	2012	July	£10,000.00	
13		8	2012	August	£11,000.00	
14		9	2012	September	£10,000.00	
15		10	2012	October	£ 9,000.00	
16		11	2012	November	£12,000.00	
17		12	2012	December	£11,000.00	

# THE DATA ANALYSIS TOOL EXPONENTIAL SMOOTHING

Instead of doing the calculations yourself you can use the Data analysis tool **Exponential Smoothing**. You can find it by selecting the Data Analysis command from the Analysis group at the far right end of the data ribbon. Select **Exponential Smoothing** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

After you have entered all necessary information into the **Exponential Smoothing** dialog box, you can get the result in the output range.

You can specify the following items in the **Exponential Smoothing** parameters dialog box:

Parameter	Description
Input Range	The array where you have the data you want to examine
Damping factor	The damping factor is (1 – alpha) so to get an alpha value of 30% (30% of the last period actual data and 70% of the last forecast) 0.7 or 70% must be entered

Labels	If labels are selected in the input range the box must be ticked
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook
Chart Output	Tick the box to get a chart output
Standard Errors	Tick the box to get calculated standard errors

When you have finished entering the information click OK and you will get the output.

## **Procedures**

- 1. To use the **Exponential Smoothing** tool, first click the Data tab.
- 2. In the Analysis group, click the Data Analysis button.
- 3. Select **Exponential Smoothing** from the list and click **OK**.

Data Analysis	8 8	
<u>A</u> nalysis Tools	ОК	Click OK
Anova: Single Factor Anova: Two-Factor With Replication Anova: Two-Factor Without Replication Correlation Covariance Descriptive Statistics	Cancel	
F-Test Two-Sample for Varia	ONENTIAL SMOOTH	IING
Fourier Analysis Histogram	-	

4. Select the Input Range and select the desired options.

	N7	• (	· 5.	e .				
A	A	В	С	D	E	F	G	н
L	Exponent	ial smoothing				Alpha		
2						30%		
3								
8								
5		Period		Months	Sales	Exponential smoothing	Absolute deviation/error	Percentage deviation/erro
5		1		January	£ 8,000.00			
1		2		February	£ 10,000.00			
1		3		March	€ 9,000.00			
		4		April	£ 8,000.00	(		
0		5			£10,000.00	Exponential Smo	othing	-7
1		6		June	£ 9,000.00	Input		COK OK
2		7	2012		£ 10,000.00	[nput Range:	\$2.\$5:\$2.\$25	Cancel
3		8		August	£11,000.00	Demping factor:	0.7	Canon
4		9		September	€ 10,000.00	🖉 Labels		Belp
5		10		October	£ 9,000.00	Output options		
6		11		November	£12,000.00	Qutput Range:	\$F\$6	<b>1</b>
7		12		December	£11,000.00	New Worksheet	Phy:	
8		13		January	£10,000.00	New Workbook		
9		14		February	£11,000.00	2 ghart Output	Standard Error	
0		15		March	€ 12,000.00	(K) (Vart corpor	S Standard Drive	· ·
1		16		April	£10,000.00			
2		17			£11,000.00			
3		18		June	£10,000.00			
4		19			£12,000.00			
5		20		August	€ 11,000.00			
6	_	21		September	£10,000.00			
7		22		October				
8		23		November				
9		24	2013	December				

5. Click OK

## The output

Period	Yes	Marths	54/45	type	nertial smoothing	Standard Dvor				
	1	2012 Jamuery	€ 8,000.00		APL/A	ety/A			Exponential Smoothing	
	2	2012 February	€13,000.00	٤	8,808.80	etq/A		£14,000.00 m		
	3	2012 March	€ 3,000.00	٤	8,808.00	ets/A				
		2012 April	€ 8,000.00	٤	8,728.80	#hij/A				
	5	2012 May	£18,000.00	٤	8,504.00		1249	£11,800.00 ·		
	6	2013 June	£ 9,000.00	6	8,952.80		995			
	7	2013 July	618,000.00	6	8,966.96		929	610 800.00		
		2013 August	611,000.00	6	\$,376.87		2050	1.00.000.000		
	9	2013 September	618,000.00	6	\$,793.81		1160		1 the second sec	
	20	2013 Oxtober	£ 9,000.00	6	8,855.67		1166	E8,000.00		
	21	2013 November	€ 12,000.00	6	9,598.87		1117	1		
	32	2012 December	€ 11,000.00	ε.	10,313.28		3479	\$ FE.000.00 -		A748
	33	2013 January	€13,000.00	٤.	10,323.49		1525	rejado da		forecest.
	34	2013 Pebruary	€11,000.00	٤	10,398.45		3472			
	25	2013 March	€12,000.00	٤	16,356-51		535	64,000.00		
	35	2013 April	€13,000.00	٤	10,505.56		999			
	17	2013 May	€11,000.00	٤	10,892.89		3375			
	38	2013 June	£13,000.00	٤	10,754.85		3035	£2,000.00 -		
	29	2013 July	€12,000.00	٤.	10,548,42		790			
	20	2013 August	€11,000.00	٤	10,904.59		909			
	21	2013 September	618,000.00	6	10,909.22		952	1	1 2 5 4 5 6 7 8 9 30 11 12 15 14 15 16 17 18 29 30 21	
	22	2013 October							Cuta Point	
	22	2013 November								
	34	2013 December								

Let us have a look at the output. You got the exponential smoothing forecast not for the first period as mentioned before you must have data from the previous period to work with exponential smoothing. Then you got standard error calculated based on the average from the previous 3 periods. That is why the standard error results starts from period 5. The error calculations are very important to make sure that the forecast is as accurate as possible and to make sure that you are using the right forecasting model. Later in this workbook you will see examples calculating forecast errors. The chart option was selected so you also got a chart in the output showing the factual known data and the exponential smoothing trend.

# **NAÏVE FORECASTING**

## Discussion

The Naïve Forecast definition:

Estimating technique in which the last period's actuals are used as this period's forecast, without adjusting them or attempting to establish causal factors. You are just using the last period's figures. The naïve forecast is normally not very accurate but can be useful to understand and develop other forecasting models. Because the last period is used it is only possible to forecast one future period.

- 1. Select the cell where the result is to be displayed.
- 2. Type = and select the actual value from the previous period
- 3. Press enter.

Period	Month		Sales		Naïve Forecast
1	Jan-12	£	1,200,000.00		
2	Feb-12	£	1,350,000.00	£	1,200,000.00
3	Mar-12	£	1,280,000.00	£	1,350,000.00
4	Apr-12	£	1,300,000.00	£	1,280,000.00
5	May-12	£	1,278,000.00	£	1,300,000.00
6	Jun-12	£	1,300,000.00	£	1,278,000.00
7	Jul-12	£	1,300,000.00	£	1,300,000.00
8	Aug-12	£	1,400,000.00	£	1,300,000.00
9	Sep-12	£	1,400,000.00	£	1,400,000.00
10	Oct-12	£	1,500,000.00	£	1,400,000.00
11	Nov-12			£	1,500,000.00
12	Dec-12				

## **MOVING AVERAGE**

## Discussion

The Moving Average forecast is based on the average of known values from a number of periods. Let us first have a look at the math. If I want to forecast April using three months moving average the formula will look like this:

"April" = 
$$\frac{\text{"January"} + \text{"February"} + \text{"March"}}{3}$$

More scientific way at looking at the equation

$$\mathbf{F}_{\mathrm{T+1}} = \frac{\mathbf{A}_{\mathrm{t}} + \mathbf{A}_{\mathrm{t-1}} + \mathbf{A}_{\mathrm{t-2}}}{\mathbf{3}}$$

Where **F** is the forecast **T** the period **A** the actual value divided with three because you are using the previous three periods.

The equation will look like this if you want a two period moving average:

$$\mathbf{F}_{\mathrm{T+1}} = \frac{\mathbf{A}_{\mathrm{t}} + \mathbf{A}_{\mathrm{t-1}}}{\mathbf{2}}$$

The equation will look like this if you want a twelve period moving average:

$$F_{T+1} = \frac{A_{t} + A_{t-1} + A_{t-2} + A_{t-3} + A_{t-4} + A_{t-5} + A_{t-6} + A_{t-7} + A_{t-8} + A_{t-9} + A_{t-10} + A_{t-11} + A_{t-12}}{12}$$

The two months Moving Average forecast is based on 2 months known values. It can be the two previous month's values or it can be based on two months the year before whatever gives the most accurate forecast.

If you forecast one period using the average of the previous two periods you will only be able to forecast one future period. If you use the average of two periods one period back, you can forecast two future periods using this method etc...

In the example below (Moving Average (two periods) Previous two periods) the forecast for March is the average of January and February. You can forecast November but not December with this method. You need to know the November sales first. In the example (Moving Average (two periods) one period back) the forecast for April is also the average of January and February. Here you can forecast December because it is the average of September and October.

Month		Sales	Movin	g Average (2 periods)	Moving	Average (2 periods)
				Last 2 periods	1	period back
Jan-12	£	1,200,000.00				
Feb-12	£	1,350,000.00				
Mar-12	£	1,280,000.00	£	1,275,000.00		
Apr-12	£	1,300,000.00	£	1,315,000.00	£	1,275,000.00
May-12	£	1,278,000.00	£	1,290,000.00	£	1,315,000.00
Jun-12	£	1,300,000.00	£	1,289,000.00	£	1,290,000.00
Jul-12	£	1,300,000.00	£	1,289,000.00	£	1,289,000.00
Aug-12	£	1,400,000.00	£	1,300,000.00	£	1,289,000.00
Sep-12	£	1,400,000.00	£	1,350,000.00	£	1,300,000.00
Oct-12	£	1,500,000.00	£	1,400,000.00	£	1,350,000.00
Nov-12			£	1,450,000.00	£	1,400,000.00
Dec-12					£	1,450,000.00

The three months Moving Average forecast is based on three months known values. You can use moving average forecast based on as many periods you need to get the most accurate forecast.

## **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type =average(
- 3. Type the argument, or select the cells you want to insert in the function (the values for the periods).
- 4. Type ) closing bracket.
- 5. Press enter.

# WEIGHTED MOVING AVERAGE

## **Discussion**

Another Excel forecasting option is the Weighted Moving Average. The Weighted Moving Average is nearly the same as the Moving Average except that it assumes that the most recent periods are the best predictors. Each period that is used for the forecast is given a weighting. The largest weighting is assigned to the most recent period. Each preceding period is successively less and less.

For example, during the calculation of a three-period Weighted Moving Average, the most recent three periods are used. The results from the previous period might be given the weight of three, the middle period might be assigned a weight of two, and the 3rd most distant period might be assigned a weight of one.

The formula for the Weighted Moving Average is as follows:

Forecast (period four) = ((weight of period three \* Value of period three) + (weight of period two \* Value of period two) + (weight of period one \* Value of period one) / (weight of period three + weight of period two + weight of period one)

#### The example below:

Forecast April=((3\*210)+(2\*180)+(1\*200))/(1+2+3)=(630+360+200)/6=1180/6=198.3

Month	Sales	Weighted Movingaverage 3 periods
Jan-12	£ 200.	.00 1
Feb-12	£ 180	.00 2
Mar-12	£ 210	.00 3
Apr-12	£ 170	.00
May-12	£ 215	.00
Jun-12	£ 190	.00
Jul-12	£ 210	.00
Aug-12	£ 180	.00
Sep-12	£ 220	.00
Oct-12	£ 210	.00
Nov-12		
Dec-12		

- 1. Select the cell where the result is to be displayed.
- Type =((weight value\*period value)+(next weight value\*next period value))/sum of weight values.
- 3. Press enter.

D8 •		✓ ∫ <sub>x</sub> =((C7*\$D\$7)+(C6*\$D\$6)+(C5*\$D\$5))/				*\$D\$5))/6	
	Α	В		С		D	
1	Forecasting	l .					
2							
3							
	Period Month		Sales		Wei	ghted Movingaverage 3	
4						periods	
5	1	Jan-12	£	1,200,000.00		1	
6	2	Feb-12	£	1,350,000.00		2	
7	3	Mar-12	£	1,280,000.00		3	
8	4	Apr-12	£	1,300,000.00	£	1,290,000.00	
9	5	May-12	£	1,278,000.00	£	1,301,666.67	
10	6	Jun-12	£	1,300,000.00	£	1,285,666.67	
11	7	Jul-12	£	1,300,000.00	£	1,292,666.67	
12	8	Aug-12	£	1,400,000.00	£	1,296,333.33	
13	9	Sep-12	£	1,400,000.00	£	1,350,000.00	
14	10	Oct-12	£	1,500,000.00	£	1,383,333.33	
15	11	Nov-12			£	1,450,000.00	
16	12	Dec-12					

In the example above the weight for January, February, and March are typed in D5, D6, and D7, in D8 (the forecast for April) the formula.

The weight is often a percentage. May be 10% for period 1, 30% for period 2, and 60% for period 3. The formula will now look like this. Forecast (period 4) = ((weight of period 3 \* Value of period 3) + (weight of period 2 \* Value of period 2) + (weight of period 1 \* Value of period 1).

# THE DATA ANALYSIS TOOL MOVING AVERAGE

## Discussion

In Excel you can also find a data analysis tool **Moving Average**. Select the **Data Analysis** command from the Analysis group at the far right end of the data ribbon. Select **Moving Average** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

The Data Analysis tool **Moving Average** is not a forecasting tool but a way to smooth data to easier spot the trends.

When you calculated moving average earlier in this book you did it for forecasting by using the equation:

$$\mathbf{F}_{\mathrm{T+1}} = \frac{\mathbf{A}_{\mathrm{t}} + \mathbf{A}_{\mathrm{t-1}} + \mathbf{A}_{\mathrm{t-2}}}{\mathbf{3}}$$

The equation for the data analysis tool **Moving Average** tool is:

"March" = 
$$\frac{\text{"January"} + \text{"February"} + \text{"March"}}{3}$$

or

$$SD_{T} = \frac{A_{t} + A_{t-1} + A_{t-2}}{3}$$

After you have entered all necessary information into the **Moving Average** dialog box, you can get the result in the output range.

Parameter	Description
Input Range	The array where you have the data you want to examine
Labels	If labels are selected in the input range the box must be ticked
Interval	Enter how many periods you want to use
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook
Chart Output	Tick the box to get a chart output
Standard Errors	Tick the box to get calculated standard errors

You can specify the following items in the **Moving Average** dialog box:

When you have finished entering the information click OK and you will get the output.

- 1. To use the **Moving Average** tool, first click the Data tab.
- 2. In the Analysis group, click the Data Analysis button.

3. Select **Moving Average** from the list and click OK.

Data Analysis	? <b>*</b>	
<u>A</u> nalysis Tools	ОК	
Descriptive Statistics Exponential Smoothing F-Test Two-Sample for Variances Fourier Analysis Histogram	Cancel	Click OK
Moving Average Random Number Generation Rank and Percentile Regression Sampling	Select MOVING AVERAGE	

4. Select the Input Range and select the desired options.

1	B	C	D	E	F	G	H
1	g						
2							
3							
	Month	Sales		Moving Average			?
4				Input			
5	Jan-12	£ 1,200,000.00		Input Range:	\$C\$4:\$C\$14		
6	Feb-12	£ 1,350,000.00				Can	e
7	Mar-12	£ 1,280,000.00		Labels in First Rov			
8	Apr-12	£ 1,300,000.00		Interval:	3	Hel	p
9	May-12	£ 1,278,000.00		Interval.	3		
10	Jun-12	£ 1,300,000.00		Output options			
11		£ 1,300,000.00		Output Range:	\$D\$6	<b>1</b>	
12		£ 1,400,000.00		New Worksheet Ply:	40 401		
13		£ 1,400,000.00					
14		£ 1,500,000.00		New Workbook			
15	Nov-12			Chart Output	Standard 8	Frrors	
16	Dec-12						
17							
	Dec-12			Chart Output	☑ <u>S</u> tandard I	Errors	

5. Click OK

### The output

	A	В		C		D	E	F		G
1	Forecasting									
2										
3										
	Period	Month		Sales	Mo	ving Average	Standard Error			
4										
5	1	Jan-12		1,200,000.00		#N/A	#N/A			
6	2	Feb-12		1,350,000.00		#N/A	#N/A			
7	3	Mar-12			£	1,276,666.67	#N/A			
8	4	Apr-12			£	1,310,000.00	#N/A			
9	5	May-12		1,278,000.00		1,286,000.00	7640.050417			
10	6	Jun-12			£	1,292,666.67	8520.128672			
11	7	Jul-12			£	1,292,666.67	7562.088679			
12	8	Aug-12			£	1,333,333.33	38952.96309			
13	9	Sep-12		1,400,000.00		1,366,666.67	43240.92712			
14	10	Oct-12	£	1,500,000.00	£	1,433,333.33	57735.02692			
15	11	Nov-12								
16	12	Dec-12								
17										
18						Moving A	verage			
19	£1.60	0,000.00								
20	22,00	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,								
21										
22	£1,40	0,000.00 -	1							
23						No. of Concession, Name				
24	£1,20	0,000.00 💉								
25										
26	£1,00	0,000.00 -								
27	E80	0,000.00 -								
28	Va 100	0,000.00								Actual
29										Forecast
30	£60	0,000.00 -								
31										
32	£40	0,000.00 -								
33										
34	£20	0,000.00 -								
35										
36										
37		£- +	2	2 3	4	5	6 7	8	9 1	
38		1	2	4 3	4			ŏ	9 1	J
39						Data Po	DINT			
35										

Let us have a look at the output. You got the **Moving Average** output not for the first 2 periods as mentioned before you must have data from the previous 2 periods to work with 3 months moving average. Then you got standard error calculated based on the average from 3 moving average periods. That is why the standard error results starts from period 5. The error calculations are very important to see how accurate the moving average tool is. Later in this work book you will see examples calculating errors. The chart option was selected so you also got a chart in the output showing the factual known data and the moving average result.

# **SEASONAL FORECASTING**

### Discussion

If you have seasonal actual data (each year you are selling more in December and June or another seasonal pattern) you can use seasonal forecasting to forecast future data. A

weight can be added to the periods to increase the accuracy of the forecast. If you use the **Forecast** function to calculate a linear forecast you can see periods over forecast and under forecast. In the example below you have seasonal known actual data. The forecast for quarter 1 is above actual data, the forecast for quarter 2 is above actual data, the forecast for quarter 4 is above actual data.

Period	Quarter	Year	Data	For	ecast	Seasonal Index	Seasonal Forecast
1	quarter 1	2006	10	0	108.84	0.9	97.96
2	quarter 2	2006	8	2	111.21	0.7	77.85
3	quarter 3	2006	18	0	113.58	1.5	170.37
4	quarter 4	2006	11	0	115.95	0.9	104.36
5	quarter 1	2007	11	0	118.32	0.9	106.49
6	quarter 2	2007	9	5	120.69	0.7	84.48
7	quarter 3	2007	17	3	123.06	1.5	184.59
8	quarter 4	2007	11	0	125.43	0.9	112.88
9	quarter 1	2008	11	0	127.80	0.9	115.02
10	quarter 2	2008	7	9	130.17	0.7	91.12
11	quarter 3	2008	20	0	132.53	1.5	198.80
12	quarter 4	2008	12	0	134.90	0.9	121.41
13	quarter 1	2009	12	0	137.27	0.9	123.55
14	quarter 2	2009	9	8	139.64	0.7	97.75
15	quarter 3	2009	21	5	142.01	1.5	213.02
16	quarter 4	2009	13	5	144.38	0.9	129.94
17	quarter 1	2010	14	0	146.75	0.9	132.07
18	quarter 2	2010	9	8	149.12	0.7	104.38
19	quarter 3	2010	21	7	151.49	1.5	227.23
20	quarter 4	2010	13	5	153.86	0.9	138.47
21	quarter 1	2011			156.23	0.9	140.60
22	quarter 2	2011			158.60	0.7	111.02
23	quarter 3	2011			160.96	1.5	241.45
24	quarter 4	2011			163.33	0.9	147.00

Add an index value (a weight) to each quarter to get a more accurate forecast. In this example the periods are quarters (4 periods groups). The sum of the index values must be 4 (12 if you are working with months etc.).

The index value multiplied by the forecast value should be very close to actual data (the index for period 1 (quarter 1 2006) must be a value multiplied by 108.84 gives a result close to 100 (the actual known value)). Later you will see how you can use error measurement calculations and the **SOLVER** tool to increase the accuracy when you are working with seasonal historical data. In the example above the seasonal index for quarter 1 is set to 0.9, set to 0.7 for quarter 2, set to 1.5 for quarter 3, and set to 0.9 for quarter 4.

To get the seasonal forecast you just have to multiply the seasonal index value by the **Forecast** function's forecast and if you compare the actual data with the seasonal forecast you will see that the seasonal forecast is much more accurate than the **Forecast** function's forecast.

### **Procedures**

- 1. Forecast the actual data using the Forecast function .
- 2. Compare actual data with the **Forecast** function's calculated forecast data period by period to spot any seasonal trends.
- 3. Add a seasonal index which sum should be the same as number of periods (4 if you are working with quarters, 12 if you are working with months etc.).

	F3	• (*	$f_x$	=SUM(F7:	-10)		
	А	В		С	D	E	F
1							
2							Seasonal index sum
3			Sum	of seasor	al index		4
4							
5							
6	Period	Quarter		Year	Data	Forecast	Seasonal Index
7	1	quarter 1		2006	100	108.84	0.9
8	2	quarter 2		2006	82	111.21	0.7
9	3	quarter 3		2006	180	113.58	1.5
10	4	quarter 4		2006	110	115.95	0.9
11	5	quarter 1		2007	110	118.32	
12	6	quarter 2		2007	95	120.69	
13	7	quarter 3		2007	173	123.06	
14	8	quarter 4		2007	110	125.43	

- 4. Add the seasonal index values to the rest of the quarters.
- 5. Select the cell where you want the next index value for quarter 1 and type = click on the cell with the quarter 1 seasonal index.

	CORRE	L ▼( × ✓ f*	=F7			
	А	В	С	D	E	F
1						
2						Seasonal index sum
3						4
4						
5						
6	Period	Quarter	Year	Data	Forecast	Seasonal Index
7	1	quarter 1	2006	100	108.84	0.9
8	2	quarter 2	2006	82	111.21	0.7
9	3	quarter 3	2006	180	113.58	1.5
10	4	quarter 4	2006	110	115.95	0.9
11	5	quarter 1	2007	110	118.32	=F7
12	6	quarter 2	2007	95	120.69	
13	7	quarter 3	2007	173	123.06	
14	8	quarter 4	2007	110	125.43	
15	9	quarter 1	2008	110	127.80	
16	10	quarter 2	2008	79	130.17	
17	11	quarter 3	2008	200	132.53	
18	12	quarter 4	2008	120	134.90	

6. Drag the fill-handle down to copy and paste the seasonal index value to the rest of the quarters.

- 7. Select the cell where the result is to be displayed.
- 8. Multiply the **Forecast** function's forecast with the seasonal index.

	G7	▼ (*	$f_{x}$	=E7*F7								
	A	В		С	D	E	F	G				
1												
2							Seasonal index sum	1				
3							4					
4												
5												
6	Period	Quarter		Year	Data	Forecast	Seasonal Index	Seasonal Forecast				
7	1	quarter 1		2006	100	108.84	0.9	97.96				
8	2	quarter 2		2006	82	111.21	0.7	77.85				
9	3	quarter 3		2006	180	113.58	1.5	170.37				
10	4	quarter 4		2006	110	115.95	0.9	104.36				
11	5	quarter 1		2007	110	118.32	0.9	106.49				
12	6	quarter 2		2007	95	120.69	0.7	84.48				
13	7	quarter 3		2007	173	123.06	1.5	184.59				
14	8	quarter 4		2007	110	125.43	0.9	112.88				
15	9	quarter 1		2008	110	127.80	0.9	115.02				
16	10	quarter 2		2008	79	130.17	0.7	91.12				
17	11	quarter 3		2008	200	132.53	1.5	198.80				
18	12	quarter 4		2008	120	134.90	0.9	121.41				
19	13	quarter 1		2009	120	137.27	0.9	123.55				
20	14	quarter 2		2009	98	139.64	0.7	97.75				
21	15	quarter 3		2009	215	142.01	1.5	213.02				
22	16	quarter 4		2009	135	144.38						
23	17	quarter 1		2010	140	146.75	0.9	132.07				
24	18	quarter 2		2010	98	149.12						
25	19	quarter 3		2010	217	151.49						
26	20	quarter 4		2010	135	153.86	0.9					
27	21	quarter 1		2011		156.23	0.9	140.60				
28	22	quarter 2		2011		158.60	0.7	111.02				
29	23	quarter 3		2011		160.96		241.45				
30	24	quarter 4		2011		163.33	0.9	147.00				

9. Copy down the calculation.

It can be difficult to spot a seasonal trend in actual data but even that you cannot it is a forecasting model which in many situations is more accurate than other models.

### Exercises

#### Exercise 1 Linear Regression

- 1. Open the file Forecasting and data analysis.
- 2. Open the Forecast Exercises sheet.
- 3. Use the **Forecast** function in F12 to calculate the forecast for the first quarter 2007.
- 4. Copy down the **Forecast** function to get the forecast for the rest of the quarters.
- 5. Select the range G12:G35 and use the **Trend** function to calculate the trend for known actual values (when entered the function arguments remember it is an array function and you must press Ctrl Shift Enter).
- 6. Select the range G36:G39 and use the **Trend** function to forecast the 4 quarters in 2013. Remember to enter the range B36:B39 as the **Trend** function argument **New\_**x's (when entered the function arguments remember it is an array function and you must press Ctrl Shift Enter).
- 7. Select G10 and use the **Slope** function to find the slope.
- 8. Select H10 and use the **Intercept** function to find Y-interceptor.
- Select H12 and calculate the equation for trend and forecast using the slope and Y-interceptor (the equation: Y = mX + c, m is the slope, c is the Yinterceptor, and X is the period).
- 10. Save the file.

#### **Exercise 2 Exponential Regression**

- 1. Open the file Forecasting and data analysis.
- 2. Open the **Forecast Exercises** sheet.
- 3. Select the range Q12:Q27 and use the **Growth** function to calculate the growth for the known actual data for year 2007 to 2010 (when entered the function arguments remember it is an array function and you must press Ctrl Shift Enter).
- 4. Select the range Q28:Q31 and use the **Growth** function to forecast the 4 quarters in 2011. Remember to enter the range L28:L31 as the **Growth** function argument **New\_**x's (when entered the function arguments remember it is an array function and you must press Ctrl Shift Enter).
- 5. Compare the difference between column P (the **Forecast** function) and column Q (the **Growth** function).
- 6. Save the file.

#### Exercise 3 Exponential Smoothing forecasting

- 1. Open the file Forecasting and data analysis.
- 2. Open the Forecast Exercises sheet.
- 3. Enter an alpha value of 50% in G41.
- 4. Enter 120,000 in G45 (you must guess the first period's forecast).
- 5. Select G46 and enter the **Exponential Smoothing** forecast equation =\$G\$41\*E45+(1-\$G\$41)\*G45 (Ft+1=alpha \* Dt + (1-alpha) \* Ft).
- 6. Copy down the equation to forecast period 25 (quarter 1 2013).
- 7. Change the alpha value in G41 and observe the changes in the range G45:G69.
- 8. Click the **Data** tab and click **Data Analysis** in the **Analysis** Group.
- 9. Select Exponential Smoothing.
- 10. Enter the input range \$E\$44:\$E\$68. Damping factor of 0.7 to get an Alpha value of 30%. Tick labels and output range should be \$H\$45. Tick Chart output and standard errors.
- 11. Change Alpha in G41 to 30% and compare the two outputs.
- 12. Save the file.

#### Exercise 4 Naïve forecasting and Moving Average

- 1. Open the file Forecasting and data analysis.
- 2. Open the **Forecast Exercises** sheet.
- 3. Select Q46 and type = O45.
- 4. Drag the fill-handle down to row 69 to copy down the cell content. This is the Naïve forecast which is based on the previous period.
- 5. Select R48 and use the **Average** function to calculate the average of the previous 3 periods known actual figures (=average(O45:O47) and copy down the **Average** function to R69. You now have the 3 periods moving average forecast.
- 6. Enter 10% in S41, enter 20% in S42, and 70% in S43. The sum of the weights must be 100%. You assume that the previous period's actual known value is more important to the forecast than two and three periods back.
- 7. Select S48 and type =\$S\$41\*O45+\$S\$42\*O46++\$S\$43\*O47.
- 8. Copy down the calculation to S69.
- 9. Examine the result. Change the weights in the range S41:S43, but remember that the sum must be 100%. You now have a 3 periods weighted moving average forecast.
- 10. Save the file.

#### **Exercise 5 Seasonal forecasting**

- 1. Open the file Forecasting and data analysis.
- 2. Open the **Forecast Exercises** sheet.
- 3. Examine the values in the range E84:E107. Is there any seasonal patterns? Yes there is. Quarter 4 has the highest sales figures and quarter 3 the lowest.
- 4. Select G84 and enter the weight for the first period. You have to compare the sale in E84 and the forecast in F84. If the forecast is higher than the actual value the weight should be less than 1. The weight = Sales/Forecast function or G84=E84/F84.
- 5. Enter the weights in G85, G86 and G87 (the sum of the weights must equals 4 the number of periods (12 if you are working with months)). Work with 2 decimals and round up or down to make sure that the sum equals number of periods here 4.
- 6. Select G88 and type =G84 and copy down the cell to G111.
- 7. Select H84 and type = G84\*F84.
- 8. Copy down the calculation to H111 and you now have a seasonal forecast.
- 9. Save the file.

## LESSON 2 - MEASURING FORECAST ACCURACY

#### In this lesson, you will learn how to:

- Measure forecast accuracy
- Calculate error/deviation
- Calculate absolute error/deviation
- Calculate percentage error/deviation
- Calculate absolute percentage error/deviation
- Calculate square error
- Calculate standard error
- Calculate MAD or MAE (Mean Absolute Deviation or Error)
- Calculate MSQ (Mean Square Error)
- Calculate MPE (Mean Percentage Error)
- Calculate MAPE (Mean Absolute Percentage Error)
- Calculate TSE (Tracking Signal Error)

### **CONCEPTS AND TERMS**

### Discussion

A key question in any forecasting is how to measure performance. Such measures are very important when you select a forecasting method and create a forecasting model, since you may compare alternatives and choose the method with the highest level of accuracy.

Then, once the method is being used on a regular basis, you need similar measures to tell you whether the forecasts are maintaining their accuracy. If not you will need to get things back on track by putting improvements in place such as more timely data, better statistical methods and may be change forecasting method. To keep up getting more accuracy forecasts you should work with more than one forecasting method so you always can compare the accuracy.

To measure how accurate the forecast is you can use different methods. To be able to compare different forecasting methods you will look at the mean errors but first you will calculate the errors. Later you compare the different forecast methods to find out which one is the most accurate for your data right now, because this can change over time so it is important to use more than one method and keeping up calculate the errors.

### **CALCULATE ERROR/DEVIATION**

#### Discussion

The error or the deviation is the difference between actual value and forecasted value. You can calculate the error or deviation by simple subtract the forecast from the actual. This will give a positive or negative result for each period or tell us if the forecast for each period is over or under actual value.

### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type = select the cell with the actual value type (subtract) select the cell with the forecast value.
- 3. Press enter.

24	A	В		С		D	E
1	Forecasting						
2							
3							
	Period	Month		Sales		Forecast function	Error/Deviation
4						(linear regression)	2 <sup>22</sup>
5	1	Jan-12	£	1,200,000.00	f	1,230,654.55	=C5-D5
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	
9	5	May-12	£	1,278,000.00	£	1,319,672.73	
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	
15	11	Nov-12			£	1,453,200.00	
16	12	Dec-12			£	1,475,454.55	

The calculation will tell us if our forecast is over or under actual value for each period.

. A	Α	В	С	D	E
1	Forecasting	s			
2					
3					
	Period	Month	Sales	Forecast function	Error/Deviation
4				(linear regression)	
5	1	Jan-12	£ 1,200,000.00	£ 1,230,654.55	-£30,654.55
6	2	Feb-12	£ 1,350,000.00	£ 1,252,909.09	£97,090.91
7	3	Mar-12	£ 1,280,000.00	£ 1,275,163.64	£4,836.36
8	4	Apr-12	£ 1,300,000.00	£ 1,297,418.18	£2,581.82
9	5	May-12	£ 1,278,000.00	£ 1,319,672.73	-£41,672.73
10	6	Jun-12	£ 1,300,000.00	£ 1,341,927.27	-£41,927.27
11	7	Jul-12	£ 1,300,000.00	£ 1,364,181.82	-£64,181.82
12	8	Aug-12	£ 1,400,000.00	£ 1,386,436.36	£13,563.64
13	9	Sep-12	£ 1,400,000.00	£ 1,408,690.91	-£8,690.91
14	10	Oct-12	£ 1,500,000.00	£ 1,430,945.45	£69,054.55
15	11	Nov-12		£ 1,453,200.00	
16	12	Dec-12		£ 1,475,454.55	

# **C**ALCULATE ABSOLUTE ERROR/DEVIATION

### Discussion

It is a good idea to calculate absolute error/deviation to get the right picture of the errors. To compare forecast methods the average error/deviation is very important. If you calculate the average from positive and negative errors the result will not be very useful. To calculate the average you need to summarise all the values and then divide the sum with the number of data. You can have negative and positive errors which will neutralise or even out each other and the average result will not tell us anything about the forecast accuracy.

You need to calculate the absolute error/deviation to get a useful result in an average calculation. To calculate absolute values in Excel you can use the **Abs** function. The **Abs** function has only one argument and it is **number**. If you type a number negative or positive the function will always return is as an absolute (positive) value.

To calculate the Absolute Error you need to type =abs(the actual value – the forecast value).

Function Ar	rguments	? 💌
ABS Number	I numbe	21'
Returns the	= absolute value of a number, a number without its sign <b>Number</b> is the real number for w	
Formula resu		OK Cancel

### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type =abs( select the cell with the actual value type (subtract) select the cell with the forecast value ).
- 3. Press enter.

- 21	A	В	С		D	E
1	Forecasting	1				
2						
3						
	Period	Month	Sale	S	Forecast function	Absolute Error/Deviation
4					(linear regression)	
5	1	Jan-12	£ 1,20	£ 00.000,00	1,230,654.55	=abs(C5-D5)
6	2	Feb-12	£ 1,35	£ 00.000.00	1,252,909.09	
7	3	Mar-12	£ 1,28	£ 00.000.00	1,275,163.64	
8	4	Apr-12	£ 1,30	0,000.00 £	1,297,418.18	
9	5	May-12	£ 1,27	8,000.00 £	1,319,672.73	
10	6	Jun-12	£ 1,30	0,000.00 £	1,341,927.27	
11	7	Jul-12	£ 1,30	0,000.00 £	1,364,181.82	
12	8	Aug-12	£ 1,40	0,000.00 £	1,386,436.36	
13	9	Sep-12	£ 1,40	0,000.00 £	1,408,690.91	
14	10	Oct-12	£ 1,50	0,000.00 £	1,430,945.45	
15	11	Nov-12		£	1,453,200.00	
16	12	Dec-12		£	1,475,454.55	

The result of the absolute error/deviation calculation will show the error as a positive value not if the forecast is above or below factual data.

14	A	В		С		D		E
1	Forecasting							
2								
3								
	Period	Month		Sales		Forecast function	A	bsolute Error/Deviation
4						(linear regression)		
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	£	30,654.55
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	£	97,090.91
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	£	4,836.36
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	£	2,581.82
9	5	May-12	£	1,278,000.00	£	1,319,672.73	£	41,672.73
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	£	41,927.27
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	£	64,181.82
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	£	13,563.64
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	£	8,690.91
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	£	69,054.55
15	11	Nov-12			£	1,453,200.00		
16	12	Dec-12			£	1,475,454.55		

## **C**ALCULATE PERCENTAGE ERROR/DEVIATION

### Discussion

It is always useful to get something like forecast accuracy shown as percentage and the percentage error can also help you to decide which forecasting method to use for your data.

### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type = select the cell with the error/deviation and divide it with actual value.
- 3. Press enter.

- 21	A	В		С		D	E	F
1	Forecasting							
2								
3								
4	Period	Month		Sales		Forecast function (linear regression)	Error/Deviation	Percentage Error
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	-30,654.55	=E5/C5
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	97,090.91	
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	4,836.36	
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	2,581.82	
9	5	May-12	£	1,278,000.00	£	1,319,672.73	-41,672.73	
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	-41,927.27	
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	-64,181.82	
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	13,563.64	
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	-8,690.91	
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	69,054.55	
15	11	Nov-12			£	1,453,200.00		
16	12	Dec-12			£	1,475,454.55		

	A	В		С		D	E	F
1	Forecasting							
2								
3								
	Period	Month		Sales		Forecast function	Error/Deviation	Percentage Error
4						(linear regression)		
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	-30,654.55	-2.55%
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	97,090.91	7.19%
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	4,836.36	0.38%
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	2,581.82	0.20%
9	5	May-12	£	1,278,000.00	£	1,319,672.73	-41,672.73	-3.26%
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	-41,927.27	-3.23%
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	-64,181.82	-4.94%
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	13,563.64	0.97%
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	-8,690.91	-0.62%
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	69,054.55	4.60%
15	11	Nov-12			£	1,453,200.00		
16	12	Dec-12			£	1,475,454.55		

## CALCULATE ABSOLUTE PERCENTAGE ERROR/DEVIATION

### **Discussion**

You need the Absolute Percentage Error to be able to calculate Mean Absolute Percentage Error, which are very useful to compare forecasting methods.

### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type = select the cell with the absolute error/deviation and divide it with actual value
- 3. Press enter.

4	A	В		C		D	E	F
1	Forecasting							
2								
3								
4	Period	Month		Sales		Forecast function (linear regression)	Absolute Error/Deviation	Absolute Percentage Error
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	30,654.55	=E5/C5
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	97,090.91	
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	4,836.36	
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	2,581.82	
9	5	May-12	£	1,278,000.00	£	1,319,672.73	41,672.73	
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	41,927.27	
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	64,181.82	
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	13,563.64	
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	8,690.91	
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	69,054.55	
15	11	Nov-12			£	1,453,200.00		
16	12	Dec-12			£	1,475,454.55		

	A	В		C		D	E	F
1	Forecasting							
2								
3								
4	Period	Month		Sales		Forecast function (linear regression)	Absolute Error/Deviation	Absolute Percentage Error
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	30,654.55	2.55%
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	97,090.91	7.19%
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	4,836.36	0.38%
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	2,581.82	0.20%
9	5	May-12	£	1,278,000.00	£	1,319,672.73	41,672.73	3.26%
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	41,927.27	3.23%
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	64,181.82	4.94%
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	13,563.64	0.97%
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	8,690.91	0.62%
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	69,054.55	4.60%
15	11	Nov-12			£	1,453,200.00		
16	12	Dec-12			£	1,475,454.55		

# **C**ALCULATE SQUARE ERROR

### Discussion

A popular way of looking at forecast accuracy is calculating square error. By squaring the deviation the errors will be more obvious and easy to spot. By squaring the deviation the result will always be absolute.

#### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type =( select the cell with the actual value (subtract) the forecast and type ) then type ^ (shift 6) and type 2.

	A	B	C		D	E
	Period	Month	Sales	Fo	precast function	Squared Error
4				(lir	near regression)	
5	1	Jan-12	£ 1,200,000.00	£	1,230,654.55	=(C5-D5)^2
6	2	Feb-12	£ 1,350,000.00	£	1,252,909.09	
7	3	Mar-12	£ 1,280,000.00	£	1,275,163.64	
8	4	Apr-12	£ 1,300,000.00	£	1,297,418.18	
9	5	May-12	£ 1,278,000.00	£	1,319,672.73	
10	6	Jun-12	£ 1,300,000.00	£	1,341,927.27	
11	7	Jul-12	£ 1,300,000.00	£	1,364,181.82	
12	8	Aug-12	£ 1,400,000.00	£	1,386,436.36	
13	9	Sep-12	£ 1,400,000.00	£	1,408,690.91	
14	10	Oct-12	£ 1,500,000.00	£	1,430,945.45	
15	11	Nov-12		£	1,453,200.00	
16	12	Dec-12		£	1,475,454.55	

3. Press enter.

- site	A	В		C		D	E
4	Period	Month		Sales		Forecast function	Squared Error
-						(linear regression)	
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	939701157
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	9426644628
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	23390413.22
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	6665785.124
9	5	May-12	£	1,278,000.00	£	1,319,672.73	1736616198
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	1757896198
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	4119305785
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	183972231.4
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	75531900.83
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	4768530248
15	11	Nov-12			£	1,453,200.00	
16	12	Dec-12			£	1,475,454.55	

The SUMSQ function can also be used to calculate Square Error. Type =sumsq(select the actual data cell – the forecast cell and type ). In the example above =sumsq(C5-D5).

### **CALCULATE STANDARD ERROR**

#### Discussion

Ш

Standard error is a statistical standard for error calculations. You need to summarise the squares of the difference between the three previous known actual periods and the three previous periods forecast and divide the result by three (number of periods) and calculate the square root of the result. You can use the **SQRT** function together with the **SUMXMY2** function to calculate the standard error.

### The SQRT function:

The **SQRT** function returns the square root of a number.

#### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type =SQRT( type a number or select a cell).
- 3. Press **OK** and the function will return the square root.

### The SUMXMY2 function:

The **Sumxmy2** function returns the sum of the square of the difference of two arrays. The function has two arguments **Array\_x** and **Array\_y**. Enter the range for the first array in **Array\_x** and enter the range for the second array in **Array\_y**.

	A	8	0	0	E	F	6	н	1	J	ĸ	L	M	N	0
1															
2															
3		Period	Year	Months	Sales	Forecast	Function Argum	ents.							-9 <b></b>
4		1	2012	January	€ 8,000.00	6 9,119.30	5,00012								
5		2	2012	February	£10,000.00	£ 9,228.07		Array X	E4			s - sco	0		
6		3	2012	March	£ 9,000.00	£ 9,336.84		Array y			-		3.298246		
7		- 4	2012	April	€ 8,000.00	€ 9,445.61			11.4						
8		5	2012	May	£10,000.00	£ 9,554.39	Suns the squares						2828.963		
9		6	2012	June	£ 9,000.00	€ 9,663.16	Suns the squares								
10		7	2012	July	€10,000.00	€ 9,771.93			Arrey_y	is the second or reference to	range or an	ry of values a	and can be a n	unber or na	ne, array,
11			2012	August	£11,000.00	£ 9,880.70				areaene	and the starts				
12		9	2012	Septembr	£10,000.00	£ 9,989.47									
18		30	2012	October	€ 9,000.00	€ 10,098-25	Formula result =	1252829							
14		22	2012	Novembe	£12,000.00	€ 10,207.02	Help on this funct	00					OK		lance
15		12	2012	December	£11,000.00	€ 10,315.79	Case of Lands of Lands								
16		13	2013	January	€10,000.00	€10,424.56									
17		34	2013	February	£11,000.00	€ 10,533.33									
18		15	2013	March	£12,000.00	£ 10,642.11									
19		16	2013	April	€10,000.00	€ 10,750.88									
20		27	2013	May	£11,000.00	£ 10,859.65									
21		18	2013	June	£ 10,000.00	£ 10,968.42									
22		19	2013	July	£12,000.00	€11,077.19									
23		20	2013	August	£11,000.00	£11,185.96									
24		21	2013	Septembs	£ 10,000.00	£11,254.74									
25		22	2013	October		£11,403.51									
26		23	2013	November	r	£11,512.28									
27		24	2013	December		£11,621.05									
28															

#### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type =SUMXMY2( in **Array\_x** enter the range of the first array. In **Array\_y** enter the range of the second range).
- 3. Press OK.

# Use the SQRT function and the SUMXMY2 to calculate standard error

Select the cell where you want the result to be displayed. Start with the **SQRT** function.

	A		C	D	6	1	G	н	1	1	К	L	M	N	0
1															
2			_	_									_		
3		Period	Year	Months	Sales	Forecast	Standar error	Functio	n Argument	3					S
4				2 January		£ 9,119.30		SORT							
5					£10,000.00			Barri				<b>1</b>	umber		
6				2 March		\$ 9,336.84									_
7		-		2 April		£ 9,445.61		Determ	the square ro		-	-			
8		-		May		£ 9,554.39		Pattarte	the square r						
9				2 June		\$ 9,663.16					mber str	enumber for	which you war	it the squar	3001
10		1		2 July		£ 9,771.93		Formula							
11		-		2 August		£ 9,880.70		ranus	report =						
12		-			€ 10,000.00			tiele an	this function				OK		Cancel
13		10		2 October		£10,098.25			_	_			-	_	_
14		11			£12,000.00										
15		13			€11,000.00										
16		13		3 January		£10,424.56									
17		14			£11,000.00										
18		12		8 March	€ 12,000.00	€ 10,642.11									
19		10		April 1											
20		1		s May	£11,000.00	£10,859.65									
21		1/		3 June	€ 10,000.00	£10,968.42									
22		19		1 July	£12,000.00	\$11,077.19									
23		20		S August	£11,000.00	£11,185.56									
24		2			£10,000.00	£11,294.74									
25		2		October		\$11,403.51									
26		2		8 Novembe		£11,512.28									
27		2	4 2013	Decembe	1	£11,621.05									
28															
29															

Nest the **SUMXMY2** function and select the two arrays (the previous three known values in **Array\_x** and the previous three forecast values in **Array\_y**).

	SUMOR	vn2 + (	- x v k -so	AT SUMMERY	2 [C426, 1416	10										
	A	8	C D	E	P	6	н	1	1	ĸ	L	M	N	0	p	0
1																
2		_														
3		Period Ye	wr Months	Sales	Forecast	Standar error	Function	. 47.50	ette i						5.0	-
4		1	2002 January		\$ 9,119.30		8.800	972								
5		2	2012 February	\$ 30,000.00	€ 9,228.07				Arres .x			1927	- (1000.10	inne ann		
6		3	2002 March		\$ 3,335.54							1001				
7		- 4	2012 April	£ 8,000.00	\$ 3,443.61	-SQRT(SUMKINY	1		feres_y	rans		18	· (113-25	824962400/7	028.030279	G
8		5	2012 May	£ 33,000.00	£ 9,554.39								<ul> <li>1962166</li> </ul>	.821		
9		6	2012 Aute	€ 9,000.00	€ 9,663.16		Suns Pe	e 60.00'85	of the differen	nos in two cars	equanding ray	dee n. m.r.s	jiL.			
10		7	2012 July	6 30,000.00	6 9,771.93					Arrey_y bt				an be a numb	er er name,	8785.
11			2012 August	\$ 11,000.00	6 9,880.70					B7 14	ference that	conteine nur	Des.			
12		9	2012 Septemb	\$ 30,000.00	\$ 9,589.47											
13		10	2012 October	£ 3,000.00	£ 10,098.25		Parmie	- fuer	1400.773651							
34		11	2012 Novembr	£ 12,000.00	£ 30,207.02									-		-
15		12	2012 Decembe	£ 11,000.00	£ 10, 315, 79		260.00	the Local	22					OK.	Cam	-
16		13	2013 January	€ 30,000.00	€ 30,424.56											_
17		14	2013 February	\$ 11,000.00	6 10,533.33											
15		15	2013 March	\$ 12,000.00	\$ 10,642.11											
19		16	2013 April	\$ 30,000.00	\$ 10,750.88											
20		17	2013 May	£ 11,000.00	£ 10,859.65											
23		18	2013 3414	\$ 30,000.00	€ 30,968.42											
22		19	2013 Avly	£ 12,000.00	€ 11,077.19											
23		20	2013 August	€ 11,000.00	€ 11, 185.96											
24		21	2013 Septemb	6 30,000.00	6 11, 294, 74											
25		22	2013 October		6 11, 403, 51											
26		23	2013 Novembe		\$11,512.28											
27		24	2013 Decembe		€ 11,621.05											
10																



	<b>G7</b>	•		fx =SQR	T(SUMXMY2	(E4:E6,F4:F6)/	(3)	
1	А	В	С	D	E	F	G	н
1								
2								
3		Period	Year	Months	Sales	Forecast	Standar error	
4		1	2012	January	£ 8,000.00	£ 9,119.30		
5		2	2012	February	£10,000.00	£ 9,228.07		
6		3	2012	March	£ 9,000.00	£ 9,336.84		
7		4	2012	April	£ 8,000.00	£ 9,445.61	809	
8		5	2012	May	£10,000.00	£ 9,554.39	966	
9		6	2012	June	£ 9,000.00	£ 9,663.16	895	
10		7	2012	July	£10,000.00	£ 9,771.93	954	
11		8	2012	August	£11,000.00	£ 9,880.70	480	
12		9	2012	Septembe	£10,000.00	£ 9,989.47	763	
13		10	2012	October	£ 9,000.00	£10,098.25	660	
14		11	2012	Novembe	£12,000.00	£10,207.02	905	
15		12	2012	December	£11,000.00	£10,315.79	1214	
16		13	2013	January	£10,000.00	£10,424.56	1277	
17		14	2013	February	£11,000.00	£10,533.33	1135	
18		15	2013	March	£12,000.00	£10,642.11	537	
19		16	2013	April	£10,000.00	£10,750.88	864	
20		17	2013	May	£11,000.00	£10,859.65	935	
21		18	2013	June	£10,000.00	£10,968.42	900	
22		19	2013	July	£12,000.00	£11,077.19	712	
23		20	2013	August	£11,000.00	£11,185.96	777	
24		21	2013	Septembe	£10,000.00	£11,294.74	780	
25		22	2013	October		£11,403.51		
26		23	2013	Novembe	r	£11,512.28		
27		24	2013	December	-	£11,621.05		
28								

### **Procedures**

1. Select the cell where the result is to be displayed.

- Type =SQRT( SUMXMY2(select the range with the actual values. Type"," select the range with the forecast)/3)
- 3. Click OK.

### CALCULATE MAD OR MAE (MEAN ABSOLUTE DEVIATION OR MEAN ABSOLUTE ERROR)

#### Discussion

The MAD/MAE is a very important measurement to compare forecast methods. You need an overall result to compare methods. MAD/MAE is the average of the absolute deviation/error.

You can calculate MAD (Mean Absolute Deviation) or MAE (Mean Absolute Error) by using the average function.

- 1. Select the cell where the result is to be displayed.
- Type =average( select the range or enter the cell references for the range containing absolute error/deviation and type )

Λ

	E18	•	. (=	<i>f</i> <sub>x</sub> =A	VER	AGE(E5:E14)	T	he average func
- sil	A	В		С		D		C
1	Forecasting						N	
2								
3								
	Period	Month		Sales		Forecast function		Error/Deviation
4								
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	£	30,654.55
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	£	97,090.91
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	£	4,836.36
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	£	2,581.82
9	5	May-12	£	1,278,000.00	£	1,319,672.73	£	41,672.73
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	£	41,927.27
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	£	64,181.82
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	£	13,563.64
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	£	8,690.91
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	£	69,054.55
15	11	Nov-12			£	1,453,200.00		
16	12	Dec-12			£	1,475,454.55		
17								MAD
18								37425.45455

3. Press enter.

.

# CALCULATE MSQ (MEAN SQUARE ERROR)

### Discussion

MSQ (Mean Square Error) is a method to calculate forecast accuracy and to compare forecasting methods. MSQ is the average of the calculated Square Error.

### **Procedures**

- 1. Select the cell where the result is to be displayed.
- Type =average( select the range or enter the cell references for the range containing absolute error/deviation and type )

	E18		<b>-</b> (0	$f_{x}$	=AVERAGE(E5:E14)	The averag
	В		С		D	E
4	Month		Sales		Forecast function	Squared Error
5	Jan-12	£	1,200,000.00	£	1,230,654.55	93970115
6	Feb-12	£	1,350,000.00	£	1,252,909.09	942664462
7	Mar-12	£	1,280,000.00	£	1,275,163.64	23390413.2
8	Apr-12	£	1,300,000.00	£	1,297,418.18	6665785.12
9	May-12	£	1,278,000.00	£	1,319,672.73	173661619
10	Jun-12	£	1,300,000.00	£	1,341,927.27	175789619
11	Jul-12	£	1,300,000.00	£	1,364,181.82	411930578
12	Aug-12	£	1,400,000.00	£	1,386,436.36	183972231.
13	Sep-12	£	1,400,000.00	£	1,408,690.91	75531900.8
14	Oct-12	£	1,500,000.00	£	1,430,945.45	476853024
15	Nov-12			£	1,453,200.00	
16	Dec-12			£	1,475,454.55	
17						MSQ
18						230382545

3. Press enter.

# CALCULATE MPE (MEAN PERCENTAGE ERROR)

### Discussion

The MPE (Mean Percentage Error) is the average of the Percentage Error. Use the AVERAGE function to calculate MPE.

### **Procedures**

1. Select the cell where the result is to be displayed.

- Type =average( select the range or enter the cell references for the range containing absolute error/deviation and type)
- 3. Press enter.

	F18	•	0	f <sub>x</sub> =A	VER	AGE(F5:F14)	The aver	age function
	A	В		С		D		
1	Forecasting							
2								
3								
4	Period	Month		Sales		Forecast function (linear regression)	Error/Deviation	Percentage error
5	1	Jan-12	£	1,200,000.00	£	1,230,654.55	-£30,654.55	-2.55%
6	2	Feb-12	£	1,350,000.00	£	1,252,909.09	£97,090.91	7.19%
7	3	Mar-12	£	1,280,000.00	£	1,275,163.64	£4,836.36	0.38%
8	4	Apr-12	£	1,300,000.00	£	1,297,418.18	£2,581.82	0.20%
9	5	May-12	£	1,278,000.00	£	1,319,672.73	-£41,672.73	-3.26%
10	6	Jun-12	£	1,300,000.00	£	1,341,927.27	-£41,927.27	-3.23%
11	7	Jul-12	£	1,300,000.00	£	1,364,181.82	-£64,181.82	-4.94%
12	8	Aug-12	£	1,400,000.00	£	1,386,436.36	£13,563.64	0.97%
13	9	Sep-12	£	1,400,000.00	£	1,408,690.91	-£8,690.91	-0.62%
14	10	Oct-12	£	1,500,000.00	£	1,430,945.45	£69,054.55	4.60%
15	11	Nov-12			£	1,453,200.00		
16	12	Dec-12			£	1,475,454.55		
17								MPE
18								-0.13%

# CALCULATE MAPE (MEAN ABSOLUTE PERCENTAGE ERROR):

### Discussion

The MAPE (Mean Absolute Percentage Error) is the average of the Absolute Percentage Error. Use the AVERAGE function to calculate MAPE.

#### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type =average( select the range or enter the cell references for the range containing absolute error/deviation)
- 3. Press enter.

	E18		<b>▼</b> (°	$f_x$	=AVERAGE(E5:E14)	The average
	В		С		D	E.
1	g					N
2						
3						
	Month		Sales		Forecast function	Absolute Percentage error
4						
5	Jan-12	£	1,200,000.00	£	1,230,654.55	3%
6	Feb-12	£	1,350,000.00	£	1,252,909.09	7%
7	Mar-12	£	1,280,000.00	£	1,275,163.64	0%
8	Apr-12	£	1,300,000.00	£	1,297,418.18	0%
9	May-12	£	1,278,000.00	£	1,319,672.73	3%
10	Jun-12	£	1,300,000.00	£	1,341,927.27	3%
11	Jul-12	£	1,300,000.00	£	1,364,181.82	5%
12	Aug-12	£	1,400,000.00	£	1,386,436.36	1%
13	Sep-12	£	1,400,000.00	£	1,408,690.91	1%
14	Oct-12	£	1,500,000.00	£	1,430,945.45	5%
15	Nov-12			£	1,453,200.00	
16	Dec-12			£	1,475,454.55	
17						MAPE
18						3%

# CALCULATE TSE (TRACKING SIGNAL ERROR)

### Discussion

Once a forecast model is developed it should indicate if the actual values following the forecast, and indicate if any deviation in order to correct the model. TSE (Tracking Signal Error) is used to pinpoint forecasting models that need adjustment. As long as the tracking signal is between –4 and 4, assume the model is working correctly.

To calculate TSE you need to calculate MAD (Mean Absolute Deviation). Summarise the error/deviation and divide it by MAD and you will have TSE.

### **Procedures**

- 1. Select the cell where the result is to be displayed.
- 2. Type =sum( select the Error range and type ) type/select the cell with the MAD.
- 3. Press enter.

	E18	•		<i>f</i> <sub>x</sub> =	SUM(E	6:E14)/F18		
- 24	A	В		С		D	E	F
1	Forecasting							
2								
3								
4	Period	Month		Sales		Naïve Forecast	Error/Deviation	Absolute Error/Deviation
5	1	Jan-12	£	1,200,000.00				
6	2	Feb-12	£	1,350,000.00	£	1,200,000.00	£150,000.00	£150,000.00
7	3	Mar-12	£	1,280,000.00	£	1,350,000.00	-£70,000.00	£70,000.00
8	4	Apr-12	£	1,300,000.00	£	1,280,000.00	£20,000.00	£20,000.00
9	5	May-12	£	1,278,000.00	£	1,300,000.00	-£22,000.00	£22,000.00
10	6	Jun-12	£	1,300,000.00	£	1,278,000.00	£22,000.00	£22,000.00
11	7	Jul-12	£	1,300,000.00	£	1,300,000.00	£0.00	£0.00
12	8	Aug-12	£	1,400,000.00	£	1,300,000.00	£100,000.00	£100,000.00
13	9	Sep-12	£	1,400,000.00	£	1,400,000.00	£0.00	£0.00
14	10	Oct-12	£	1,500,000.00	£	1,400,000.00	£100,000.00	£100,000.00
15	11	Nov-12			£	1,500,000.00		
16	12	Dec-12						
17							Tracing Signal Error	
18							5.5785	£53,777.78

### Exercises

#### Exercise 1 Error/deviation

- 1. Open the file Forecasting and data analysis.
- 2. Open the Error-deviation exercises sheet.
- 3. Select G2 and calculate the error (=E2-F2).
- 4. Copy down the calculation to G25.
- 5. Select H2 and calculate the absolute error (=abs(E2-F2)) and copy down the calculation to H25.
- 6. Select I2 and calculate the percentage error (=G2/E2) and copy down the calculation to I25. Add percentage style and 2 decimals.
- 7. Select J2 and calculate the absolute percentage error (=H2/E2) and copy down the calculation to J25. Add percentage style and 2 decimals.
- 8. Select K2 and calculate the square error (=(E2-F2)^2) and copy down the calculation to K25.
- 9. Save the file.

#### Exercise 2 Mean errors/deviation

- 1. Open the file Forecasting and data analysis.
- 2. Open the Error-deviation exercises sheet.
- 3. Select H32 and calculate the mean absolute deviation (MAD) (=average(H2:H25)).
- 4. Select I32 and calculate mean percentage error (MPE) (=average(I2:I25)).
- 5. Select J32 and calculate mean absolute percentage error (MAPE) (=average(J2:J25)).
- 6. Select K32 and calculate mean square error (MSQ) (=average(K2:K25)).
- 7. Select J32 and calculate mean absolute percentage error (MAPE) (=average(J2:J25)).
- 8. Select G32 and calculate tracking signal error (TSE) (=sum(G2:G25)/H32)
- 9. Save the file.

## LESSON 3 – USING THE SOLVER TO OPTIMISE FORECASTS

In this lesson, you will learn how to:

- Install the Solver
- Use the **Solver** to optimise exponential smoothing forecasts
- Use the **Solver** to optimise weighted moving average forecasts
- Use the **Solver** to optimise seasonal forecasts

# **CONCEPT AND TERMS**

### Discussion

The **Solver** is an advanced Excel tool you can use in a lot of different situations. In this book the **Solver** will be used to optimise Weighted Moving Average forecasts, Seasonal forecasts, and Exponential Smoothing forecasts.

You can specify the following items in the **Solver** Parameters dialog box:

Parameter	Description
Set Target cell	The cell containing the formula you want <b>Solver</b> to use
To (equal to Excel 2007)	Whether to set the target cell to its maximum value, its minimum value, or a specified value
By Changing cells	The variable cells that <b>Solver</b> can change in order to reach the desired target cell value
Constraints	You can set constraints or limitations on the changing cells, the target cell, or other cells in the worksheet

Se <u>t</u> Objective:				<b></b>
To: <u> </u>	Mi <u>n</u>	O Value Of:	0	
By Changing Variable Cells:				
Subject to the Constraints:				
			^	Add
			[	Change
				<u>D</u> elete
				<u>R</u> eset All
			-	Load/Save
Make Unconstrained Varia	bles Non-N	egative		
Select a Solving Method:	GRO	S Nonlinear	•	Options
Solving Method				
Select the GRG Nonlinear en engine for linear Solver Prob non-smooth.				

(This is a screenshot of the Excel 2010 **Solver**. The Excel 2007 **Solver** looks a little different, but the parameters and how to use it for optimising forecasts will be the same).

### **INSTALLING THE SOLVER**

### Discussion

**Solver** is not part of the standard Excel application as normally installed, it is an Add-In (often referred to as a "plug-in."). Add-Ins are additional Excel components that are not commonly used and as a result, have to be installed on your computer. There are many third party (non-Microsoft) Add-Ins that help Excel do useful and clever things that it cannot normally do, or that enhance some of the things that it can do.

These can be found and downloaded from the Internet although it is wise to consult with your IT department first in case they have objections on grounds of security and computer software safety. It is unlikely that in the working environment you will be able to install these programs yourself anyway.

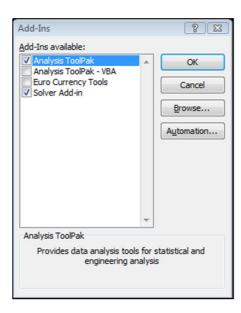
There are, however, selections of Add-Ins that come with Excel and that are perfectly safe and suitable for use; one of these is **Solver**.

#### Procedure

- 1. Click the Office Button (Excel 2007) or the File tab (Excel 2010).
- 2. Click Excel Options.
- 3. Click Add-Ins at the left.
- 4. Click Add-Ins at the left.

General	View and n	nanage Microsoft Offi	ce Add-ins		
Formulas	wew and n	lanage microsoft off	ce add-llis.		
rormulas					
Proofing	Add-ins				
Save	Name 🔺		Location	Туре	
Language	Active Application	Add-ins			
Language	Analysis ToolPak		C:\fice\Office14\Library\Analysis\ANALYS32.XLL	Excel Add-in	
Advanced	Solver Add-in		C:\fice\Office14\Library\SOLVER\SOLVER.XLAM	Excel Add-in	
Customize Ribbon	Inactive Applicatio	on Add-ins			
	Analysis ToolPak -	VBA	C:\\Office14\Library\Analysis\ATPVBAEN.XLAM	Excel Add-in	
uick Access Toolbar	Custom XML Data		C:\iles\Microsoft Office\Office14\OFFRHD.DLL	Document Inspecto	
	Date (Smart tag lis		C:\Files\microsoft shared\Smart Tag\MOFL.DLL	Action	
dd-Ins	Euro Currency Too		C:\ft Office\Office14\Library\EUROTOOL.XLAM	Excel Add-in	
rust Center	Financial Symbol (		C:\Files\microsoft shared\Smart Tag\MOFL.DLL	Action	
rust center	Headers and Foot		C:\iles\Microsoft Office\Office14\OFFRHD.DLL	Document Inspecto	
	Hidden Rows and		C:\iles\Microsoft Office\Office14\OFFRHD.DLL	Document Inspecto	
	Hidden Workshee Invisible Content	ts	C:\iles\Microsoft Office\Office14\OFFRHD.DLL C:\iles\Microsoft Office\Office14\OFFRHD.DLL	Document Inspecto Document Inspecto	
	Microsoft Actions	Pana 2	C:\lles\Wilcrosoft Office\Office14\OFFRHD.DLL	XML Expansion Pac	
	Iniciosoft Actions	and 5		And Expansion ruce	
	Document Related	Add-ins			
	No Document Rela	ted Add-ins			
	Disabled Applicati	on Add inc			
	No Disabled Appli				
	Add-in:	Analysis ToolPak			
	Publisher:	Microsoft Corporation			
	Compatibility:	No compatibility informa	tion available		
	Location:	C:\Program Files\Microso	ft Office\Office14\Library\Analysis\ANALYS32.XLL		
	Description:	Provides data analysis to	ols for statistical and engineering analysis		
	Manage: Excel A	dd-ins	<u>G</u> o		

- 5. Select Excel Add-ins from the Manage: list at the bottom of the dialog box.
- 6. Click Go....
- 7. Click in box next to Solver Add-in.



8. Click in box next to Solver Add-in.

# USE THE SOLVER TO OPTIMISE EXPONENTIAL SMOOTHING FORECASTS

### **Discussion**

The **Exponential Smoothing** forecasting model needs an **Alpha** value. A percentage of the previous known actual value and a percentage of the previous forecast. You can analyse the data and calculate the percentage but you can also ask the **Solver** to find the right percentage to get the most accurate forecast.

In the example below the **Exponential Smoothing** model uses an **Alpha** of 80%. The forecast is based on 80% of the previous actual known sales figure and 20% of the previous period's forecast. This percentage gives a **MAD** of 1146.08.

#### **Solver parameters:**

The **Set Objective:** \$G\$33 is the cell with **MAD. To: Min** is selected because you want the lowest possible **MAD** to get the most accurate forecast. **By Changing Variable Cells:** \$F\$2 is selected. It is **Alpha** the **Solver** must change to bring down **MAD**. **Subject to the Constraints:** 2 constrains are entered **Alpha** must be less than or equal to 1 (100%) or greater than or equal to 0 (0%).

A .	6	C 0	1		1	G	н	1	1	K .	L	54	N	0	9
Lepane	rial smoothing			13000											
					ach										
						1									
	Period N	inar Months	Sales	-	tial analyticat	Absolute deviation	Absolute percentage deviation/error	Solver Pasameters		_	-	_	-		
		2012 January	£ 8,000.00		3,080.80										-
	;	2012 Februar			6,290.80					_					-
		2012 Manth	£ 3,800.00		3,540.00		7.11%	Seg Objective:		100					
		2012 Auril	£ 8,000.00		8,128.00		34. 37%	10 0 000		1 140	-				
		2013 May	\$10,000.00		8,225.60			~ 0.90			O Selas CE				
		2012 2410	6 9,000,00		9,645.32			By Changing Haria	the Celler:						
	7	2012 July	\$10,000.00	4	9,129,82		0.71%	80							
		2012 August	£11,800.00	6	9,625.80	6 1.174.28	20.67%								-
	,	2012 Septemi	ter £10,000.00	1	33,785.36	£ 355.16	7.65%	Sylper Sife Ca	10.00						
	10	2012 October	£ 9,000.00	*	33,153.45	¢ 1.153.03	12.81%	#102-0=1 #102.2=0						815	
	13	2012 Novemb	ev (12,800.00		9,290.41	£ 2,398.39	23.08%								
	13	2013 Deceral	er £11,000.00	4	11,696.12	£ 606.13	4.06%							0 mill	
	13	2013 January	\$10,000.00	4	11,089.32	6 1,019.22	20.89%							<b>Drive</b>	
	14	2013 Februar	£11,800.00	4	30,217.84	6 702.16	7.11%							Press.	_
	15	2013 March	£12,800.00	1	33,643.57		9.64%						1	Smail A	
	16	2013 April	£10,000.00	£	11,798.71									- per a	_
	17	2013 May	£11,808.08	1	33,555.34		5.88%						-	Land, Taxa	
	18	2013 June	£10,000.00		23,870.75		8.12%	12 Note Unwald	tained limits	No. No. No.	aite .				
	19	2013 July	\$13,808.08	-	20,134.35										
	20	2013 August	\$11,800.00		11,634.83			Splect a Solving N	kthot:	045	whee		•	Ogene	
	21	2013 Septemi		6	11,126.57		11.17%	Solving Heltool							
	22	2013 October		1	33,225.39			Select the Grish	and the second second	the first late	a Buildens Bui		andress 1	where the 19 for	and and
	23	2013 Novemb						major for lower	Salver Prob	inter, and se	inti the Duslate	mary major	for Laluer y	riddens that a	
	24	2013 Decenia	e/					ron-encoth.							
						MAD	W/S								
								140					5×4	0	
						£ 1,346.08	Mean AbsolutePercentage Error 31.32%					_			

The **Solver** found the best percentage to be 28% and this changed the **MAD** from 1146.08 to 885.58.

onential smoothing				Alpha	28%				
Period	Year	Months			tial smoothing	Absolute o		Absolute percentage deviation/error	Square error
1	2012	January	€ 8,000.00		9,000.00	6	1,000.00	12.50%	
2	2012	February	€ 10,000.00	٤	8,715.32	£	1,254.68	12.85%	
3	2012	March	€ 9,000.00	£	9,081.04	6	\$1.04	0.90%	
4	2012	April	£ 8,000.00	٤	9,057.97	6	1,057.97	13.22%	
5	2012	May	€ 10,000.00	£	8,756.78	£	1,243.22	12.43%	
6	2012	June	£ 9,000.00	2	9,110.71	6	110.71	1.23%	
7	2012	July	€ 10,000.00	£	9,079.19	£	920.81	9.21%	
	2012	August	£11,000.00	2	9,341.33	6	1,658.67	15.06%	
9	2012	September	€ 10,000.00	٤	9,813.53	£	186.47	1.86%	
10	2012	October	€ 9,000.00	6	9,866.61	6	\$55.61	9.63%	
11	2012	November	€ 12,000.00	٤	9,619.90	٤	2,380.10	19.83%	
12	2012	December	€ 11,000.00	6	10,297.48	6	702.52	6.39%	
13	2013	January	€ 10,000.00	£	10,497,47	£	457,47	4.57%	
14	2013	February	€ 11,000.00	£	10,355.85	6	644.15	5.86N	
15	2013	March	€ 12,000.00	٤	10,539.23	6	1,460.77	12.17%	
16	2013	April	€ 10,000.00	£	10,955.09	£	955.09	9.55%	
17	2013	May	€ 11,000.00	6	10,683.19	6	316.61	2.88N	
18	2013	June	€ 10,000.00	٤	10,773.38	£	773.38	7.73%	
19	2013	July	£12,000.00	6	10,553.21	6	1,445.79	12.06%	
20	2013	August	€ 11,000.00	٤	10,965.09	£	34.91	0.32%	
21	2013	September	€ 10,000.00	6	10,975.03	6	975.03	9.75%	
22	2013	October		٤	10,697,45				
23	2013	November							
24	2013	December							
						MAD		MAPE	MSQ
						Mean Abs	olute Deviation	Mean AbsolutePercentage Error	Mean Square Er
						6	885.58	8.59N	

Now the model can be optimised every time you get new actual known data in this example, when you get the October figures. Just use the **Solver** each time new data is entered.

#### Procedure

- 1. To use **Solver**, first click the Data tab.
- 2. In the Analysis group, click the **Solver** button.
- 3. Select the target cell.
- 4. Set the Equal To: option to the one you require.
- 5. In the By Changing Cells: box, select, or type, the range of cells the **Solver** must use to compare against the target cell value.
- 6. Click the Add button.
- 7. In the Add Constraint dialog box, specify the first cell constraint.

Add Constraint		X
Cell Reference:	Co <u>n</u> s	traint:
QK	Add	Cancel

- 8. If necessary, click on Add to specify more cell constraints.
- 9. Click the OK button.

10. In the **Solver** Parameters dialog box, click the Solve button. The **Solver** Results

The Solver Results dialog box opens with the results.

### USE THE SOLVER TO OPTIMISE WEIGHTED MOVING AVERAGE FORECASTS

### Discussion

The **Weighted Moving Average** forecasting model needs a weight/percentage value for previous periods. Instead analysing the data the **Solver** can find the right weights to get the most accurate forecast.

In the example below the **Weighted Moving Average** model uses a weight for the 1<sup>st</sup> period of 10%, 20% for the 2<sup>nd</sup> period, and 70% for the 3<sup>rd</sup> period. These percentages return a **MAD** 1061.11.

#### **Solver parameters:**

The **Set Objective**: \$G\$35 is the cell with **MAD**. **To**: **Min** is selected because you want the lowest possible **MAD** to get the most accurate forecast. **By Changing Variable Cells**: the range \$F\$2:\$F\$4 is selected. It is weights the **Solver** must change to bring down **MAD**. **Subject to the Constraints**: 1 constrain is entered the sum of the weights must be equal to 1 (100%).

A A		C D		1	6	н	1 J K L	MN
1. Provenantly	reighted moving a	wenge		Weight			(a	
			Lat period	119			Salver Parameters	
			2nd period	267				
1			and period	781	6		Sej Objectives DESE	18.
5	3 months		Total		1			
5	_						™ ⊖ges @Ht ⊖yelatofi I	
1	Period Te			Forecast moving average	Absolute deviation/error	Percentage deviation/error	By Otanging Hariable Calle:	
1	1	2012 January	4 8,000.00					100
	2	2012 Pelinuary	10,000.00				8'82.8'94	18
8	3	2012 March	\$ 9,000.00				subject to the Constantial	
3	4	3012 April	£ 8,000.00			145		644
3	5	2012 May	410,000.00			16%		Ow
3		2012 June	1 9,000.00			15		Querge
4	7	2012 July	£10,000.00			2%		
5		2012 August	411,000.00	-		11%		Dekte
16		2012 September				4%		
7	30	2012 October	1 9,000.00			13%		Based Ad
18	11	2012 November			-	22%		
19	12	2012 December	\$11,000.00			25		(ced)Seve
0	28	2013 January	410,080.08			33%		
2	34	2013 Pebruary	11,000.00	-		5%		A
2	15	2013 March	£12,000.00			32%		Ogtone
2	35	2013 April	\$10,080.08			16%		
4	37	2013 May	€11,080.08			5%		ct the LP Simples
3	38	2013 June	10,000.00			5%	engine for linear Solver Problems, and select the Evolutionary engine for Solver problems	
5	29	2013 July	£12,000.00	-	-	15%		
0	20	2013 August	411,000.00			5%		
8	21	2013 September	10,000.00			11%	jate plan	Ope
9	22	2013 October		£ 30,480.00				
0	23	2013 November						
6	24	2012 December						
0								
53					MAD	MAPE		
14					Mean Absolute Deviation	Mean Absolute Percentage Error		
5					6 1,061.11	12%		

The **Solver** found the best percentage to be 71%, 14%, and 14% and this changed the **MAD** from 1061.11 to 769.80.

4	A	В	С	D	E	F	G	Н
1	Forecast weig	hted movir	ng average			Weight		
2					1st period	71%		
3					2nd period	14%		
4					3rd period	14%		
5		3 months			Total	1		
6								
7		Period	Year	Months	Sales	Forecast moving average	Absolute deviation/error	Percentage deviation/error
8		1	2012	January	£ 8,000.00			
9		2	2012	February	£10,000.00			
10		3	2012	March	£ 9,000.00			
11		4	2012	April	£ 8,000.00	£ 8,431.03	£ 431.03	5%
12		5	2012	May	£10,000.00	£ 9,568.97	£ 431.03	4%
13		6	2012	June	£ 9,000.00	£ 9,000.00	£ 0.00	0%
14		7	2012	July	£10,000.00	£ 8,431.03	£ 1,568.97	16%
15		8	2012	August	£11,000.00	£ 9,856.32	£ 1,143.68	10%
16		9	2012	September	£10,000.00	£ 9,431.03	£ 568.97	6%
17		10	2012	October	£ 9,000.00	£ 10,143.68	£ 1,143.68	13%
18		11	2012	November	£12,000.00	£ 10,568.97	£ 1,431.03	12%
19		12	2012	December	£11,000.00	£ 10,143.68	£ 856.32	8%
20		13	2013	January	£10,000.00	£ 9,718.38	£ 281.62	3%
21		14	2013	February	£11,000.00	£ 11,568.97	£ 568.97	5%
22		15	2013	March	£12,000.00	£ 10,856.32	£ 1,143.68	10%
23		16	2013	April	£10,000.00	£ 10,431.03	£ 431.03	4%
24		17	2013	May	£11,000.00	£ 11,000.00	£ 0.00	0%
25		18	2013	June	£10,000.00	£ 11,568.97	£ 1,568.97	16%
26		19	2013	July	£12,000.00	£ 10,143.68	£ 1,856.32	15%
27		20	2013	August	£11,000.00	£ 11,000.00	£ 0.00	0%
28		21	2013	September	£10,000.00	£ 10,431.03	£ 431.03	4%
29		22	2013	October		£ 11,568.97		
30		23	2013	November				
31		24	2013	December				
32								
33							MAD	MAPE
34							Mean Absolute Deviation	Mean Absolute Percentage Error
35							£ 769.80	7%

#### Procedure

- 11. To use **Solver**, first click the Data tab.
- 12. In the Analysis group, click the **Solver** button.
- 13. Select the target cell.
- 14. Set the Equal To: option to the one you require.
- 15. In the By Changing Cells: box, select, or type, the range of cells the **Solver** must use to compare against the target cell value.
- 16. Click the Add button.
- 17. In the Add Constraint dialog box, specify the first cell constraint.

Cell Reference:	Co	nstraint:
\$F\$5	= 1	-

- 18. If necessary, click on Add to specify more cell constraints.
- 19. Click the OK button.

20. In the **Solver** Parameters dialog box, click the Solve button. The **Solver** Results

The **Solver** Results dialog box opens with the results.

### USE THE SOLVER TO OPTIMISE SEASONAL FORECASTS

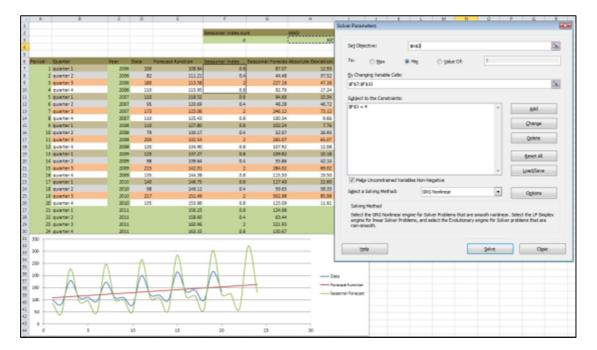
#### Discussion

The **Seasonal** forecasting model needs a weighted value for each period. The weights must equal the number of periods (if you are working with quarters the sum of the weights must equal 4, Months 12 etc.). Instead analysing the data the **Solver** can find the right weights to get the most accurate forecast.

In the example below the **Seasonal** forecast model uses a weight for the 1<sup>st</sup> period of 0.8, 0.4 for the 2<sup>nd</sup> period, 2 for the 3<sup>rd</sup> period, and 0.8 for the 4<sup>th</sup> period. These percentages return a **MAD** 34.

#### **Solver parameters:**

The **Set Objective:** \$H\$3 is the cell with **MAD. To: Min** is selected because you want the lowest possible **MAD** to get the most accurate forecast. **By Changing Variable Cells:** the range \$F\$7:\$F\$10 is selected. It is weights the **Solver** must change to bring down **MAD. Subject to the Constraints:** 1 constrains are entered the sum of the weights must be equal to 4 (the sum of the weights and number of periods).



The **Solver** found the best suitable weights for the Seasonal forecast model and the forecast is much more accurate now with a MAD of 5 and please look at the chart. It is very clear that the forecast is very accurate.

- al-	Α	В	C	D	E	F	G	Н	
1									
2						Seasonal index su	m	MAD	MSQ
3						4		5	46
4									
5									
_	Period	Quarter		Data	Forecast function	Seasonal Index	1	Absolute Deviation	and the second se
7		quarter 1	2006	100	108.84		99.23	0.77	
8		quarter 2	2006	82	111.21		77.68	4.32	
9		quarter 3	2006	180	113.58		171.40	8.60	
10		quarter 4	2006	110	115.95		102.13	7.87	
11		quarter 1	2007	110	118.32		107.87	2.13	
12		quarter 2	2007	95	120.69		84.30	10.70	
13		quarter 3	2007	173	123.06		185.70	12.70	
14 15		quarter 4	2007 2008	110 110	125.43		110.48	0.48	
15		quarter 1 quarter 2	2008	79	127.80		90.92	11.92	
17		quarter 3	2008	200	132.53		200.00	0.00	
18		quarter 4	2008	120	134.90		118.82	1.18	
19		quarter 1	2009	120	137.27		125.15	5.15	
20		quarter 2	2009	98	139.64		97.54	0.46	
21		quarter 3	2009	215	142.01		214.30	0.70	
22		quarter 4	2009	135	144.38		127.17	7.83	2
23		quarter 1	2010	140	146.75		133.79	6.21	
24	18	guarter 2	2010	98	149.12	0.70	104.15	6.15	37.88
25	19	quarter 3	2010	217	151.49	1.51	228.60	11.60	134.55
26	20	quarter 4	2010	135	153.86	0.88	135.52	0.52	0.27
27	21	quarter 1	2011		156.23	0.91	142.43		
28	22	quarter 2	2011		158.60	0.70	110.77		
29	23	quarter 3	2011		160.96	1.51	242.90		
30	24	quarter 4	2011		163.33	0.88	143.86		
31	300								
32	17202								
33	250						^		
34 35					A		$\langle \rangle$		
35 36	200		^	Λ	$\Lambda$	$\Lambda$	1		
30		$\wedge$	$\wedge$	1			-	_	Data
38	150				-16	161	1	_	Forecast function
38 39	100	-161	6		2/ 1			_	Seasonal Forecast
40	100	V A		1	0				
40	50	-	0						
41	50								
43	0								
44	0	5		10	15	20	25	30	
45	•	-			**				

### Procedure

- 1. To use **Solver**, first click the Data tab.
- 2. In the Analysis group, click the **Solver** button.
- 3. Select the target cell.
- 4. Set the Equal To: option to the one you require.
- 5. In the By Changing Cells: box, select, or type, the range of cells the **Solver** must use to compare against the target cell value.
- 6. Click the Add button.
- 7. In the Add Constraint dialog box, specify the first cell constraint.
- 8. If necessary, click on Add to specify more cell constraints.

- 9. Click the OK button.
- 10. In the **Solver** Parameters dialog box, click the Solve button. The **Solver** Results

The **Solver** Results dialog box opens with the results.

# **Exercises**

#### Exercise 1 Optimising exponential smoothing forecasts using the Solver

- 1. Open the file Forecasting and data analysis.
- 2. Open the **Optimise using Solver exercises** sheet.
- 3. Open the **Solver** parameters dialog box.
- The Solver will be used to bring down the MAD (Mean Absolute Deviation). Set Objective: \$G\$35 To: select Min. to get the lowest possible value.
- 5. **By Changing Variable Cells:** the cell with the **Alpha** (\$F\$2) value is the cell the **Solver** can change to bring down the error.
- 6. Add two constraints the **Alpha** value must be greater than or equal to 0 and less than or equal to 1 (between 0% and 100%).
- 7. Click **Solve** and examine the MAD and the chart.
- 8. Save the file.

#### Exercise 2 Optimising weighted 3 periods moving average using the Solver

- 1. Open the file Forecasting and data analysis.
- 2. Open the **Optimise using Solver exercises** sheet.
- 3. Open the **Solver** parameters dialog box.
- The Solver will be used to bring down the MAD (Mean Absolute Deviation). Set Objective: \$G\$71 To: select Min. to get the lowest possible value.
- 5. **By Changing Variable Cells:** the cells with **weights** \$F\$38:\$F\$40 values are the cells the **Solver** can change to bring down the error.
- 6. Add one constraint the **Sum of weights** (\$G\$38) must equals 100%.
- 7. Click **Solve** and examine the MAD and the chart.
- 8. Save the file.

#### Exercise 3 Optimising seasonal forecasts using the Solver

- 1. Open the file Forecasting and data analysis.
- 2. Open the **Optimise using Solver exercises** sheet.
- 3. Open the **Solver** parameters dialog box.
- The Solver will be used to bring down the MAD (Mean Absolute Deviation). Set Objective: \$J\$106 To: select Min. to get the lowest possible value.
- 5. **By Changing Variable Cells:** the cell with the seasonal weights or index values (\$G\$77:\$G\$80) are the cells the **Solver** can change to bring down the error.
- 6. Add one constraint the sum of the weights (\$G\$74) must equals 4.
- 7. Click **Solve** and examine the MAD and the chart.
- 8. Save the file.

# LESSON 4 - SHOWING TRENDS AND FORECASTS USING CHARTS

In this lesson, you will learn how to:

- Choose the right chart type
- Create trendlines
- Choose the best trendline for your data
- Visualise forecasts and forecast errors in a chart

# **CONCEPTS AND TERMS**

## Discussion

Excel provides us with a wide selection of charts. Charts are very powerful tools to visualise data and can make it much easier to understand data analysis. In this book the primary idea is to look at the best charts for visualising forecasts and data analysis. How trends easy can be spotted, how forecasts easily can be done in a chart, how you can visualise forecast errors.

# **C**HOOSE THE RIGHT CHART TYPE

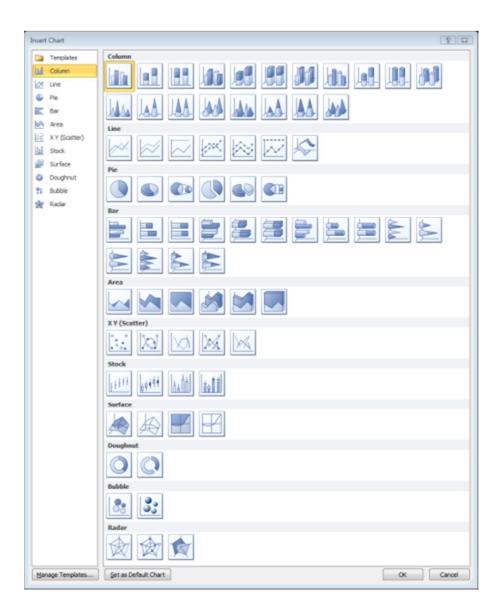
# Discussion

The most common charts used to visualise data analysis are **Column** charts, **Line** charts, **Scatter** charts, and **Pie** charts, but all the charts provided by Excel can be used.

Chart type	Description
Pie charts:	Pie charts are superb for displaying data points as a percentage of the whole, but as with all chart types if the value for the data points getting to small (the gap between the values to big) it is difficult to distinguish each data point in the chart. If a data point is less than 5% of the pie, it becomes hard to distinguish the slice. Pie charts can only display one data series, which means you can include only one column or row of values in your selection when you create a pie chart.
Column charts:	Data that is arranged in columns or rows on a worksheet can be plotted in a column chart. Column charts are useful for showing data changes over a period of time or for illustrating comparisons among items.
	In column charts, categories are typically organized along the horizontal axis and values along the vertical axis.
	Consider using a column chart when:
	<ul> <li>You have one or more data series that you want to plot.</li> </ul>
	<ul> <li>Your data contains positive, negative, and zero (0) values.</li> </ul>
	<ul> <li>You want to compare the data for numerous categories side by side.</li> </ul>

Line charts:	Line charts are great tools to track and trend data. Line charts can display continuous data over time, set against a common scale, and are therefore ideal for showing trends over time. As a general rule, you may want to use a Line chart if your data has non-numeric x-values. (For numeric x-values, it's usually better to use a Scatter chart).
Scatter charts:	Scatter charts are commonly used for displaying and comparing numeric values, such as scientific, statistical, and engineering data. You should use a Scatter chart if you want to change the scale of the x-axis, or make it a logarithmic scale. You can use this chart type to effectively:
	Display worksheet data that includes pairs or grouped sets of values. You can adjust the independent scales of a Scatter chart to reveal more information about the grouped values.
	Show similarities between large sets of data. Rather than showing the differences between data points, a Scatter chart can point out interesting similarities.
	Compare large numbers of data points without regard to time. The more data that you include in a Scatter chart, the better the comparisons that you can make.
	Scatter charts can be displayed with or without lines to connect the data points, and connecting lines can be displayed with or without data markers.

Below you can see the Excel chart dialog box where you can find the entire chart types in Excel.



# **CREATE TRENDLINES**

# Discussion

Before you start creating charts and trendlines make sure that:

You have enough data to show a meaningful chart and enough data for Excel to be able to calculate a reliable trend. Insufficient data might twist the results. For example, seasonal fluctuations might be mistaken for long-term trends if the data is from only one year. The chart must be a 2-D chart. Excel cannot create trendlines on 3-D charts.

- The data is ordered from earliest to most recent.
- No data is missing. If data is unavailable for a period, enter an estimate.

You can forecast with trendlines you will see how later in this book.

So what are trendlines, really?

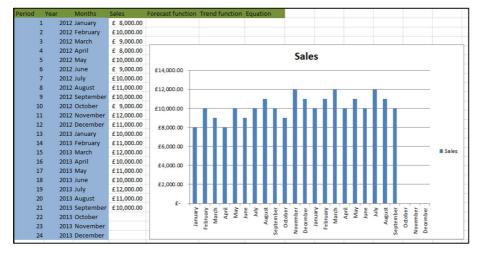
Trendlines are graphical representations of trends in data that you can use to analyse problems of prediction. Such analysis is also called regression analysis. By using regression analysis, you can extend a trendline in a chart beyond the actual data to predict future values. For example, the preceding chart uses a simple logarithmic trendline that is forecast ahead four quarters to clearly show a trend toward rising revenue.

R<sup>2</sup> (R-squared)

So you might be wondering: How reliable are these trendlines, anyway? The answer has to do with something called R-squared — or, more specifically, the R-squared value of the trendline (this is where math comes in). Think of the R-squared value as a magic number — in this case, a number between 0 and 1.

You don't have to understand all about R-squared values — just remember: A trendline is most reliable when its R-squared value is at or near 1. When you fit a trendline to your existing data, Excel automatically calculates its R-squared value based on a formula. The more closely a trendline match your existing data, the more accurate a forecast that uses this trendline is likely to be. If you want, you can display this value on your chart.

First you need to create a chart.



It can be difficult to see a trend just looking at the chart. To add a trendline you need to select the chart and select the contextual **Chart Tool** tab **layout**. Select **Linear Trendline** from the trendline list.

	ecesting and data analysis b west Formulas Out 9	vout tab	Layout Parmat	
Chart Area Fasual Selection Perset is Methy Style Current Selection	Chaff Aris Legred Data Data Tife - Tifes - Labeth - Table - Labeth	Ares Gridines at	Charl Oluri 3.D Well-Floer-Rotation Background	Click to get the trendline list

You just created a trendline!

Right click the trendline and click Format Trendline. Click **Display R-squared value** on chart to display R<sup>2</sup>.

Sales 1	forecast function. Trend function. Equilion	Format Transline	1
Sales         P           £         0,000,00         £         20,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         3,000,00         £         5,000,00         £         3,000,00         £         5,000,00         £         5,000,00         £         5,000,00         £         5,000,00         £         5,000,00         £         5,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,10,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00         £         5,100,000,00	Sales #14,000.00 #12,000.00 #16,000.00	Format Trendline           Pendies Option:           Une Colar           Use Solar           Dialization:           Gen and Soft Edges           Or Pager           Or Pager           Or Sprant:           Dialization:	
£ 10,000.00 £ 11,000.00	f 4,500.00	Gustani     Destani	
£ 10,000.00 £ 12,000.00 £ 11,000.00 £ 10,000.00	CTTORONO C C C C C C C C C C C C C C C C C C	Precuest Conventi 0.0 periods Gadinanti 0.0	
			Close

The R-squared value, which tells you how closely your trendline follows your data, appears on the chart. With a linear trendline in this example above, the value is 0.3692. As you can see the trendline doesn't follow the data very closely because the sales goes up and down. A linear trendline with an R-squared value of 0.3692 is not a very reliable trendline for a forecast. The linear trendline in this example will may be not be able to give us an accurate forecast but it is easy to see that the trend is going up so you have increasing sales trend and that is of course nice.

You can change the trendline to another trendline type and compare the R-square values. May be there is a trendline which is a better match to the data. In the next chapter you will see a description of all the different trendlines and when to use the different types.

### **Procedure**

- 1. Create a chart.
- 2. Make sure that the chart is selected. Click **Trendline** on the contextual **Chart Tools** tab.
- 3. Click on the trend line type you want to create.
- 4. Right click the trendline and choose Format Trendline.
- 5. Click Display R-squared value on chart to display R<sup>2</sup>.

Instead of right click the trendline to format the trendline you can click **More Trendline Options** in the trendline type dialog list.



You can create a trendline by right click the data series and click **Add Trendline**.

# **CHOOSING THE BEST TRENDLINE FOR YOUR DATA**

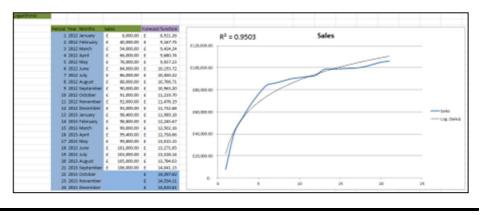
# Discussion

When you want to add a trendline to a chart in Excel, you can choose between six different trend/regression types. You should use the type which fit best to your data.

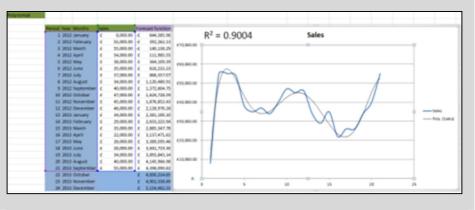
Choosing the right trendline for your data is very important. Checking the R-squared value can help you choose the best trendline for your data. It also helps to understand the types of trendlines that are likely to fit different scenarios.

Туре		D	escription		
Linear	linear data sets		ear if the pa	ttern in its	data points
	Proof Test March           1         2023 Televary           2         2033 Televary	fm         fmmask keeline           1.000.0         6         5,157.0         F,14,107.0         F           1.000.0         6         5,157.7         F,14,107.0         F         F           1.000.0         6         5,157.7         F         F,14,107.0         F         F           1.000.0         6         3,157.2         E         E         F	<sup>2</sup> = 0.9008	Sales	

# Logarithmic A logarithmic trendline is a best-fit curved line that is most useful when the rate of change in the data increases or decreases quickly and then levels out. A logarithmic trendline can use negative and/or positive values.

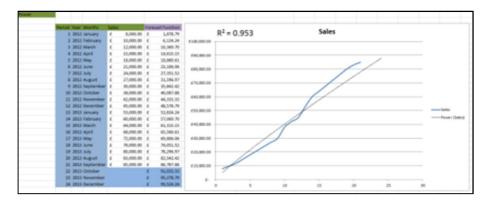


Polynomial A polynomial trendline is a curved line that is used when data fluctuates. It is useful, for example, for analysing gains and losses over a large data set. The order of the polynomial can be determined by the number of fluctuations in the data or by how many bends (hills and valleys) appear in the curve. An Order 2 polynomial trendline generally has only one hill or valley. Order 3 generally has one or two hills or valleys. Order 4 generally has up to three.





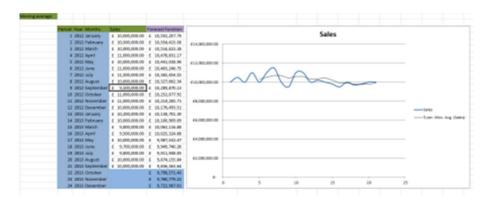
A power trendline is a curved line that is best used with data sets that compare measurements that increase at a specific rate — for example, the acceleration of a race car at one-second intervals. You cannot create a power trendline if your data contains zero or negative values.



Exponential An exponential trendline is a curved line that is most useful when data values rise or fall at increasingly higher rates. You cannot create an exponential trendline if your data contains zero or negative values.



Moving average A moving average trendline smooth out fluctuations in data to show a pattern or trend more clearly. A moving average trendline uses a specific number of data points (set by the Period option), averages them, and uses the average value as a point in the trendline. If Period is set to 2, for example, then the average of the first two data points is used as the first point in the moving average trendline. The average of the second and third data points is used as the second point in the trendline, and so on.

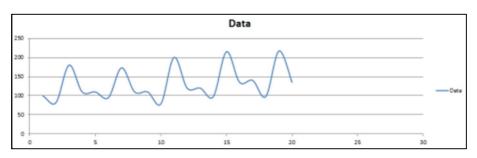


# VISUALISE FORECASTS AND FORECAST ERRORS IN A CHART

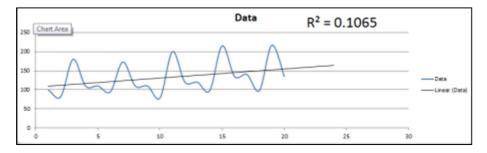
## **Discussion**

Forecast charts are exceptional to show the result in a very user friendly easy understandable manner. Line charts, scatter chart, columns charts, or a combination of column charts and line charts should be the charts used for forecasts.

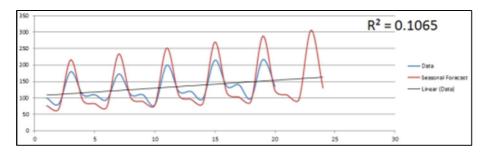
In the scatter chart below the blue line is data over 20 quarters. The vertical axis shows the data and the horizontal axis shows the quarters. It is easy to see that it is seasonal data.



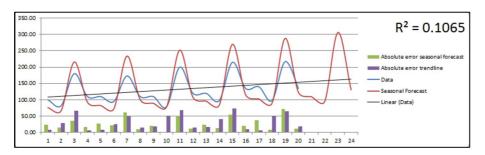
By adding a 4 periods forecast trendline it is obvious that the values increase over time but also that the data is not linear data (the  $R^2=0.1065$ ). It tells us that the trendline's prediction for period 21 to 24 is not reliable.



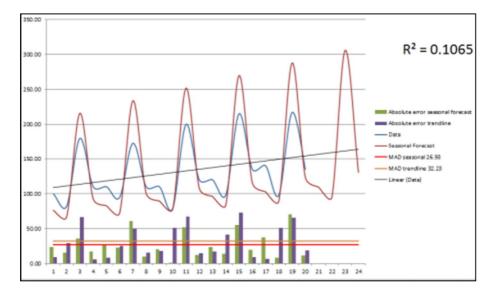
For seasonal data a seasonal forecast should be better to predict the future. In the chart below the result of a seasonal forecast is added and you can see that it is much better to "find" the ups and downs in the data.



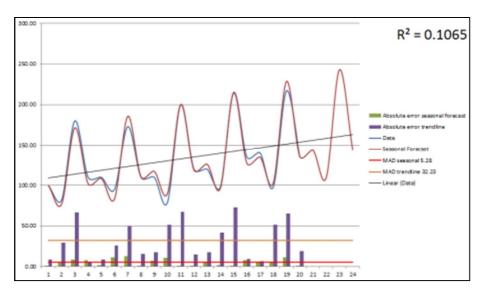
By adding the absolute error for the two forecast methods the forecast accuracy can be shown in the chart period by period, but it is not obvious which one is the most accurate.



By adding the MAD (Mean Absolute Deviation) to the chart you can now see that the seasonal forecast is the most accurate forecast, but it is not because it is much more accurate than the trendline forecast.



In the example below the **Solver** has been used to optimise the seasonal forecast and it is easy to see that now the seasonal forecast is much more accurate than the trendline forecast. The **Solver** decreased MAD from 26.93 to 5.28.



### **Procedures**

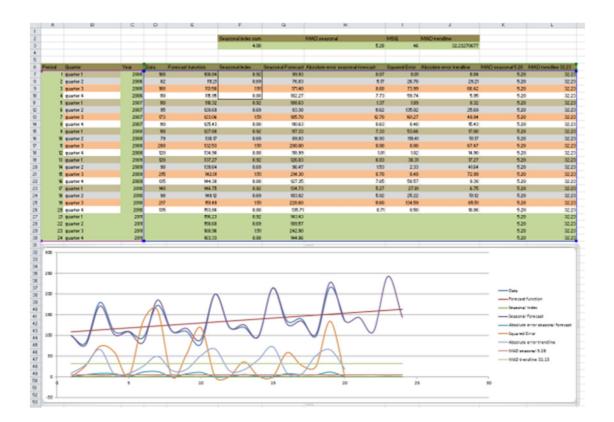
4	A	8	¢	D	1	F.	G	н	1	,	ĸ	L.
1						Seasonal Index su	-	MAD sessonal	MSQ	MAD trendline		
2						4.00		5.28				
4												
5												
6	Period	Quarter	Year	Data	Forecast function	Seasonal Index	Seasonal Forecas	Absolute error seasonal forecast	Squared Error	Absolute error trendline	MAD seasonal \$ 28	MAD trendline 32.23
7	3	evener 1	2006	330	108.84	0.92	99.53	0.07	0.00	8.84	5.28	82.25
8	2	querter 2	2006	82	113.21	0.69	76.83	5.17	26.70	29.23	5.28	52.25
9	3	quarter 3	2006	180	113.56	1.51	171.40	8.60	73.99	66.43	5.28	32.21
23	4	examer 4	2006	310	115.95	0.88	302.27	7.78	59.74	5.95	5.28	82.2
11	5	querter 1	2907	110	118.52	0.92	238.63	1.57	1.89	8.52	5.28	52.25
12	6	quarter 2	2907	95	120.69	0.69	45.34	11.62	135.02	25.69	5.28	52.25
23	7	quarter à	2907	171	123.06	1.51	185.33	12.78	161.27	49.94	5.28	82.2
24		eventor 4	2907				110.65	0.65	0.43		5.28	
25		quarter 1	2906						53.66		5.28	
25		quarter 2	2006					20.93	119.41		5.28	
22		Evener 8	2908					0.00			5.28	
28		querter 4	2008					1.03	1.02		5.28	
29		quarter 1	2006					6.03	36.35		5.28	
20		evener 5	2009					1.53	2.89		5.28	
21		querter 3	2909					0.79			5.28	
22		quarter 4	2905				127.35	7.65	58.57		5.28	
28		quarter 1	2010					\$.27	27.85			
24		querter 2	2010					5.02	25.22		5.28	
25		quarter 3	2010					11.60			5.28	
26		quarter 4	2010				135.71	0.73	0.50	18.86	5.28	
27		querter 1	2913		156.25		245.45				5.28	
25		querter 2	2013		158.60						5.28	
29		quarter 3	2011		163.96		342.90				5.28	
90	24	Evener 4	2013		163.33	0.88	344,06				5.28	82.2

1. Create the data you want to visualise in a chart.

2. Select the data, click **Insert** tab and on the charts group select the chart type you want to create.

Pro	ettable Table Picture C	te Svipei Sva	6441 Screet	uhot Column Sine	* *	ien saiter 🕹	Selec	et chart	type	Test Header Word Ecx & Faster	Line *	π tquation
_	Tables	Bushabani			Charts					Ter	( · · · · · · · · · · · · · · · · · · ·	5240
	A6 + (	· £ P	eriod									
1	A B	C	0	1	r r	6			1	1	1 E	
1												
2					Seasonal Index su		MAD seesonal		MSQ	MAD srendtine		
5					4.00			5.28	48	52.25279677		
4												
	Period Quarter	Tear	Cata	Forecast function	Seasonal Index	Tables of French	Manufacture and the	Andread Browned	Included Brand	Absolute evor treadline	MART CONTRACTOR NO.	ALC: NO.
-	1 cuertor 1	2006		108.54	0.52			0.07	0.03			
1	2 quarter 2	2006		111.21				5.17	26.70			
1	A suprov à	2006		113.58				8.60	72.99			
10	4 exerter 4	2006		115.99				7.75	59.74			
11	5 querter 1	2007			0.52	108.63		1.57	1.89			
12	6 quarter 2	2007			0.09			11.62	135.02			
13	7 quarter à	2087	173	122.06	1.51	185.70		12.70	161.27	49.54	5.28	
14	8 svener 4	2007	130	125.45	0.88	130.65		0.63	0.48			
15	9 querter 1	2008			0.92			7.55	53.66			
16	10 quarter 2	2008		130.17				10.93	139.43			
17	11 quarter 8	2008		192.53	1.51	290.00		6.00	0.00			
38.	12 evener 4	2008		154.90		138.99		1.01	1.02			
15	13 querter 1	2009			0.52			6.03	36.53			
20	14 quarter 2	2009		139.64	68.0	96.47		1.53	2.55			
23	15 quarter à	2009		142.01	1.51	254.30		6.70	0.49			
22	16 evener 4	2009		144.38	0.88	127.55		7.85	58.57			
끈	17 querter 1 18 querter 2	2000		148.75	0.52	154.75		5.27	27.83			
-	18 quarter 2 19 quarter 2	2000		151.49		228.60		11.60	134.58			
-	20 suener 4	2000		153.86	0.88	135.72		0.71	0.50			
22	21 querter 1	2000		156.25	0.52	145.45		171	0.34	18.80	5.26	
28	22 cuerter 2	2011		158.60		109.57					5.28	
29	23 suprov 3	2011		163.96		242.90					5.28	
10.	24 suener 4	2001		163.55							3.28	

3. Move and resize the chart.



# **Exercises**

#### Exercise 1 Adding trendlines

- 1. Open the file Forecasting and data analysis.
- 2. Open the Visualise forecasts exercise sheet.
- 3. Right click the data series **Sales** on the chart in **Exercise 1**.
- 4. Click Add Trendline.
- 5. Create a linear trendline and tick **Display Equation on chart** and **Display R-squared value on chart**.
- 6. Click Line Color top left in the Format Trendline dialog box.
- 7. Select **Solid line** and the colour red.
- 8. Examine the R<sup>2</sup> value. Do you think this is the right trendline for this chart?
- 9. Right click the trendline and click **Format Trendline**.
- 10. Type 4 in the Forward: box under Forecast.
- 11. Click Close.
- 12. Save the file.

#### Exercise 2 Trendline types

- 1. Open the file Forecasting and data analysis.
- 2. Open the Visualise forecasts exercise sheet.
- 3. Right click the data series **Sales** on the chart in **Exercise 2**.
- 4. Click Add Trendline.
- 5. Create a linear trendline and tick **Display Equation on chart** and **Display R-squared value on chart**.
- 6. Examine the R<sup>2</sup> value. Do you think this is the right trendline for this chart? The **R-squared** value is relatively high but the trendline does not reflect the data series very well.
- 7. Write down the **R-squared** value. Right click the trendline and click **Format Trendline**.
- 8. Try the other trendline types and compare the **R-squared** value.
- 9. Use the trendline with the highest **R-squared** value
- 10. Save the file.

#### Exercise 3 Visualising forecasts and errors

In the exercise 3 area (starting from row 40) two different methods have been used to forecast the sales the **Forecast** function and seasonal forecasting. Use the chart to compare the two methods and to decide which one you should use to get the most accurate forecast.

- 1. Open the file Forecasting and data analysis.
- 2. Open the Error-deviation exercises sheet.
- 3. Add the **Forecast** function data to the chart (copy the range F40:F68 click on the chart area and paste the data).
- 4. Do the same with the seasonal forecast data (copy the range O40:O68 click on the chart area and paste the data).
- 5. Add the forecast function's Absolute error (column H) and the seasonal forecast's Absolute error (column Q) to the second chart (the blank chart).
- 6. Right click the two error series and change chart type to column (If they are not in columns already).
- 7. Add the forecast function's MAD (range L40:L68) and the seasonal forecast's MAD (U40:U68) to the second chart.
- 8. Right click the two MAD series and change chart type to line.
- 9. Use the **Solver** to optimise the seasonal forecast. The right parameters are already added to the **Solver** parameter dialog box.
- 10. Compare the two methods which one is the best and most accurate?
- 11. Save the file.

# LESSON 5 – COMPARING FORECASTING METHODS AND MODELS

In this lesson, you will learn how to:

- Compare different forecasting models
- Understand which forecasting model to use

# **CONCEPT AND TERMS**

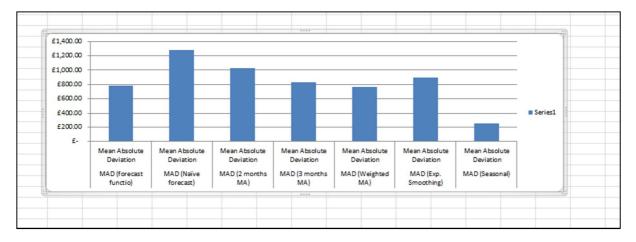
# Discussion

To keep your forecast on track it is important to continuously developing your forecast model. You have seen different forecasting models and how to calculate the errors. You should use more than one method and every time you add more data calculate the errors and optimise your model. It can change over time which forecast method generates the most accurate forecasts. If you by comparison of the different method can see a change in accuracy between the methods you can keep your forecasts on track by always knowing which forecast method generates the best result for your data.

A4	* (°	J.c.												
A U	C 0				н	1	4	К	k.	51	N	0	P	q
In the start at set [	_													
_						-								
-		2.64			and the second second second					Absolute designation (Party	of the local division in the local divisione		Works in Landson Bar	and the Real Property lies
1	282 January	4 8,895.00	£ 3,3%7.62	ALCOURT DATA AND	No. I Prove Apr Providence			Contrajo deviduante da	Property and a	PROVED IN CONTRACT OF IT	The spectry and the second second	and how your	ADDIDE OVALUATION PRO	and all a second
2	282 February 282 Match	6 N.00L00				4 8,009.30 4 10,009.30								
	DED April	6 5,000.00	\$ 3,298.48			1 8,000.00	800	the state of the s			195 A	3,895.00		
2	2012 May 2012 July	6 N,000.00				1 K 8,308.38		201			105 A	3,891.01		
7	DET JA	A NUMBER		A 200	47	Ti & 9,009.00	1 1000	80	9,509,39	A 500.00	05 A	3,895,88	\$ 1,000.00	
	2012 August	6 8,890.00				1 9,000.00		81	9,500.00		MS &	3,666.67		
10	2012 September 2012 Gotaber	6 N.891.81			.19 1	5 4 9,009.30 5 4 9,009.30	1000	RC /			15 k	N., HHL. HL N., 323, 33		
	282 Monette					5. 4 9,009.30		2011	9508.38		275 4	51,801.01		
2	282 December 282 January	6 N.895.85				5 6 E.308.38		80			05 k 105 k	9L333.33 9L666.67	L 058.87 L 058.87	
	2012 February	£ 2,000.00	4 9,523.32	4 40	67	5 6 9,309.39	800	81	0,509.39	A 500.00	01.4	1,001.00	£ -	
	2010 March 2012 April	6 51,800.00				TL & 10,000.00		80	0.500.00		1012 A. 1012 A.	1,000.07		
-	2012 May	6 5,000.00	1 9,279.09	4 12		T. & 10,000.00	800	81	1,000.00	4 .	05.4	8,000.00	£	
	200 Adv 200 Adv	6 NL89L90				5. 6 10,000,00		Mrs I			65 k	R,806.86 96,323.23		
20		5 2,000.00				1 4 9,0030 1 4 9,0030		the A			10% A 0% A	8,000.00		
21	2012 September	6 91,001.00	4 9,303.33			5. 6 9,000.00	1000	HC 1	1,500.30		105 A	1,000.00		
22	OTO NOVEREA		E 1047.62 E 10541.30			k 9,08.30			0,500.30			COLUMN		
28	282 December		1 10/10.00											
				MAD IN IN IN IN IN	MPE Int MeanPercettage Enc		MAD M Mean Abacker Deviat M			MAD MPE Mean Abookus-Deviaria Mean			MAD M91 Mean-Rooban Desiato Mer	
				4 741	All I		4 1277.74	124		4 00279	101		¥ 900.00	
			-											
A 8	C 0		_	R				× 1	V	×		Z.	M	AB
		-			ight .		A244				Swatchalledes car			
			temperiod		88%		20%				12300000EW			
Colo earl drast														
			Incessor Inconsist		28%									
Tanid Patien On to start dreet			Indpend Indpend Tara		201									
	Tear Montal 2912 January	5.000 1 0.000.00	Solperiod Taras Emonifica veign	nd moving server Ad	cshor deviationient Perce	nap belatow	6 6,800.00	action decisionless: Pr	nortage deviation for	featured Forecast (Forecast)	A2 0/86079879 6	#10014	ooko belafaning Perset	101 012 10
	280 February	£ 9,369,39	Tara Tara Tenanta veige	nd noving were Ad	28s	top bridenk	6 6,600,00 6 6,600,00	oothan derivation here. Pr	nornaja declarantem	6 5,040 6 9,54	A2 0-3604796673 6 30 9044273062 6	8,567,50	cours decisionance Parsent	aga dani ati
	Tear Montes 2012 - Ansany 2012 February 2012 March 2012 Anol	5 404 L 8,300,30 L 9,300,30 L 9,300,30 L 9,300,30	Disperior Tara Emonfra veign	net moving surray Ad	28s	nage Beliafonik	6 6,800.00	anten Beilatonker: Po 105.1;	nersy Schlader	6 5,00	A2 0/960/79873 6 38 9044279082 6 38 9/279082 6	#10014	ookas deviadionikas: Persent	nga deni di
	2812 Fidewary 2812 March 2812 April 2812 Mas	L 0,308,30 L 3,308,30 L 8,308,30 L 8,308,30	Encontravego	659647 K	Dis colore deviationiers: Perce 599.30 599.30	-	6 6.00.00 6 6.00.00 6 6.052.32 5 6 6.200.72 6 6 6 6.595.07 6	705.72 (#24.00	22	6 5,97 6 3,98 6 3,27 6 5,27 6 5,27 7	A2 0-060779875 6 38 9044273082 6 38 0:27308057 6 48 0-060878088 6 78 1.8F08508 6	6,980,94 9,597,50 6,495,01 0,590,90 0,590,90 0,000,97 0	NU.H 367.61	igi delat
	282 Fideuary 282 March 282 April 282 May 282 Jane	E 9,308,30 E 9,308,30 E 9,308,30 E 9,308,30 E 9,308,30	Encode vege	4,916-67 2,210(4-2 0,00000	285 colore devariations Prece 558.30 539.30 539		6 6.000.00 6 6.000.00 6 6.000.22 6 6.000.22 6 6.000.22 6 6.000.00 6 6.000.00 6 6.000.00 6 6.000.00 7 6.000.00 7 6.000.00 7 6.000.00 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	706.72 (#04.00 000	222	6 0.07 6 5.8 6 5.27 6 0.08 6 0.08 6 0.08	A2 0-060779875 6 38 9044273082 6 38 01273080507 6 48 0-060978088 6 78 1.8F00508 6 38 0-000904302 6	8,340,34 9,597,50 0,495,01 0,590,39 0,00,37 0,00,37 0,00,37 0,00,37 0,00,00 0,00,00 0,00,00 0,00,00 0,00,00	80.38	uga dirukan
	IEE February IEE March IEE Ant IEE Mag IEE Jane IEE Jane IEE Jane	L 0.303.30 L 3.309.30 L 3.309.30 L 0.309.30 L 0.309.30 L 0.309.30 L 0.309.30 L 0.309.30	E tronte vege	0,000-07 E 0,400-02 E 0,000-02 E 0,000-07 E 4,440-07 E	285 calue devacción C Perce 506.30 506.30 8.30 (4.86.30 (4.86.30	-	6 6.001.00 6 6.001.00 6 6.001.02 8 6 6.001.02 8 6 6.001.02 8 6 6.001.02 8 6 6.001.02 8 6 6.001.00 8 6 6.001.00 8 6 6.001.00 8 6 6.001.00 8 6 6.001.00 8 6.001.000 8 6.001.000000000000000000000000000000000	705.12 1414.00 000 90000 900000	29239	6 0.047 6 9.84 6 8.275 6 0.08 6 0.08 6 0.08 6 0.08 6 0.08 6 0.071 6 0.071	A2 0/95079879 ( 39 9/44277982 ( 39 9/44277982 ( 39 9/24287788 ( 30 0/0575388 ( 30 0/057588 ( 31 0/06064402 ( 31 0/06064402 ( 32 0/6607878 (	8,547,55 6,455,04 9,662,57 6,753,66 9,062,57 6,753,66 6,753,66 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,957,567,557,5757,567,5757,5757,5757,5757	88.38 367.81 367.07 UN2.06	igi divi di
	280 February 280 March 280 April 280 April 280 April 280 April 280 April 280 April 280 April 280 Septembe	L 9,301,30 L 3,301,30 L 8,301,30 L 8,301,30 L 9,301,30 L 9,301,30 L 9,301,30 L 9,301,30 L 9,301,30	Englement Type I monthiz weight	6,596-67 E 6,490-62 E 6,696-67 E 6,696-67 E 6,696-67 E	28% colors deviationient: Perce 559.30 539.30 539.30 (010.30 (030.30 (030.30 (0.00.30 (0.00.30		6 6.000.00 6 7.000.00 6 7.000.00 7 7.000.000 7 7.000.000 7 7.000.000 7 7.000.000 7 7.0000.000 7 7.0000.0000 7 7.0000.0000 7 7.0000.0000 7 7.000000 7 7.0000000 7 7.00000000000000000000000000000000000	785.12 1454.00 9000 900000 907004 97704	235239	6 5.047 6 9.54 6 8.27 6 8.27 6 8.38 6 8.58 6 8.58 6 8.78 6 8.78 6 8.78 6 8.78 6 8.78 6 8.78 6 8.78 78 8 8.78 8 7.78 8	A2 0.950779679 ( 30 9(34277967) ( 31 9(2796957) ( 40.040575308 ( 32 0.960575308 ( 33 0.00050402 ( 34 0.96057878 ( 34 0.96057878 ( 35 0.96057878 ( 36 0.96057878 (	8,340,34 8,547,50 6,455,04 6,062,57 6,0750,9 6,0757,9 6,0757,94 6,0757,95 7,0757,9577,9577,9577,9577,9577,9577,957	991,39 307,63 306,09 507,07 UN42,00 UN42,00	uga dirukan
	IEE February IEE March IEE Ant IEE Mag IEE Jane IEE Jane IEE Jane	E 9,300,30 E 9,300,300,30 E 9,300,300,300,300,300,300,300,300,300,30	Bridgeriod Tara E monfear weight E E E E E E E E E E E E E E E E E E E	0,000-07 E 0,400-02 E 0,000-02 E 0,000-07 E 4,440-07 E	285 calue devacción C Perce 506.30 506.30 8.30 (4.86.30 (4.86.30		6 6.001.00 6 6.001.00 6 6.001.02 8 6 6.001.02 8 6 6.001.02 8 6 6.001.02 8 6 6.001.02 8 6 6.001.00 8 6 6.001.00 8 6 6.001.00 8 6 6.001.00 8 6 6.001.00 8 6.001.000 8 6.001.000000000000000000000000000000000	705.12 1414.00 000 90000 900000	29239	6 5.00° 6 2.00° 6 3.00° 6 5.00° 6 5.00° 7 5	A2 0980779879 6 30 9044273082 0 40 0980575 4 40 0980575388 0 40 0980575388 0 40 09805788 0 40 0980588 0 40	8,547,55 6,455,04 9,662,57 6,753,66 9,062,57 6,753,66 6,753,66 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 6,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,757,56 7,957,567,557,5757,567,5757,5757,5757,5757	88.38 367.81 367.07 UN2.06	nge den i Af

								MACI Mean.Allo		1098 Mean Presentage Ex	-		MAD Marat Ab		NPE Musi Percentaje Ence Ku					MMD Minut		MPR. Moai Presentage Br
	28	2012	Oviender				-				-	_					1,01.0	1.00706.0011	A UARD			
			Second of			·					- 1					12.	1.541.80	LITTERSON?				
_	2		Espisando October		8,388.38		K/035.37		\$38.37		64	4 1,05.00 6 8,400.70		(JETERO	80.	14	8,333,33 8,467,40	CANAGE DEL GARAGE DE			26.48	
_	20		hqui		1,000.30	8	F)000-00		8.30		<u>-</u>		8	10.01	E.	14	11,213.05	0.980738779			2.86	
		283			0,888.88	8	14,786.88		7900-04		m-(		8	2455.04	Di-	4×.	1,04.75	YORONODER?			6.86	
		2853	300	1	10,000.00	8	F)400-03	8	1,438-30		Rb.	8 8,894.29	8	804.29	B-	11	\$1, \$196, 40	C-BCRRMASIC	A KOCUL	7 8	1.07	
	÷	2013	Mas		1,103.30	i -	F(000-00	i.	8.30		-		i.	290.45	2.	11	8.676.0	LATERANCE			6.62	
_		-	April		10,000,00	1	K.688.86	-	\$39.36		2		1	105.00		11-	8,763.86	OMOTION			786.27	
_		200	Palmara Marsh		0,000.00	-	F(400-62 N,806-61	-	430.32		2	8,3%L4 8,3%L4 8,8%L42	-	6CU55 1405.35		11-	H,K33.33 H,647.62	1044275082 UET560402	4 B,568.57		6.32	
_	0	280	January		8,368,38		0,000.00		8.05		5	1,00,0		64125	D.	11.	B,APLIE	0.968(75873	6 8,508.N		8.86	
	8	282	Occumber		8,000.00	4	K_300-00		508.36		76	6 8,381.46		606.60	Đ.	( C.	8,304.76	1.80%0001	4 10,000.90		6.96	
		2862 1	Noumba	1	0,108.38	4	N2400-62		1538.56		Ch.	E 8,690,77	ŧ	2,364.25	28%	ŪC.	0,751.48	1/1105062	4 0,005.5	7.8	4.63	
		2002	Center	1	1,103.30	à.	NL 100.00	1	1.00.50		CA.	< 8.50.0	î.	#2.41	80.	17-	8,575.00	0.0002486	6 5,004		1.0	
_		2002	Segnande		8,088,08	1	0.500.00	2	430.32		21	6 NJ72.N	1	00733		11-	8,962,96	0.004000008	1 440.6		LINE	
_		-	August	-	8,103.30	1	6,000.01	2	1.00.10		23	C RANN		9075-04	10-	12-	1,147,12	0.980738779	6 5,557.54		042.05	

Create a column chart displaying all MAD results from all the forecasting method can be a nice tool. Keep an eye on the chart when you are adding new data to you forecasting model and you will very easy visualise which model is the most reliable.



You can also after trying the different methods decide which one to use in the future and then use TSE (Tracking Signal Error) to make sure that the model is on track. The TSE value must be between -4 to 4.

# LESSON 6 – FORECASTING USING WHAT-IF ANALYSIS

In this lesson, you will learn how to:

- Use the Scenarios Manager
- Use the Goal Seek tool
- Use the Data Table tool

# **CONCEPTS AND TERMS**

## Discussion

The What-If analysis tools are very powerful tools when you need to forecast and you have some knowledge which Excel cannot calculate from the historical data. Your company will add 5 new products to the product line. The costs will be reduced because of an investment in new manufacturing equipment. You expect a marketing investment to pay off. You can manipulate your forecasts using What-If analysis.

# THE SCENARIOS MANAGER

## Discussion

The **Scenarios** tool can be a very nice supply to forecasting. You may need to forecast December. You have the data for each month from January 2011 to September 2012. You have the units you have sold, the unit price, the variable costs, the fixed costs, the sales, the profit, the total market units, and your company's market shares. The **Forecast** function has been used to calculate the forecast for Market shares and total market units for December. You know that the forecast will not be accurate.

First of all you know that the sales for December will be very good. You also know that your company will spend a lot of money getting a bigger market share. Your company is also working on reducing the fixed and variable costs and you also have plans changing the price policy for your products.

You want now to work with the forecast to see what will happen with all these changes. You do not know if all the changes will happen so you want to create different scenarios to be able to compare the different situations.

You can create a scenario summary report, which lists all the scenarios you have created in a side-by-side format so that you can compare them. When you create a scenario summary report, the Scenario Manager automatically inserts a Scenario Summary sheet in the workbook and places the report on it. This sheet allows you to easily view and print the scenario summary report. A scenario summary report appears in an outline format.

	A	В	С	D		E		F		G	Н		1	J		K	L	M
1	Period Y	fear	Months	Units	Uni	it Price	Variab	le Costs	Fixe	d costs	Sales	Profit		Total Market (un	its) T	otal Market (units) Forecast	Market Shares	Market Shares Forecast
2	1	2012	January	1000	£	8.00	£	2.00	£	500.00	£ 8,000.00	£	5,500.00	100	000	107273	1.00%	1.03%
3	2	2012	February	1250	£	8.00	£	2.00	£	500.00	£10,000.00	£	7,000.00	100	000	107545	1.25%	1.03%
4	3	2012	March	1125	£	8.00	£	2.00	£	500.00	£ 9,000.00	£	6,250.00	100	000	107818	1.13%	1.03%
5	4	2012	April	1000	£	8.00	£	2.00	£	500.00	£ 8,000.00	£	5,500.00	120	000	108091	0.83%	1.02%
6	5	2012	May	1250	£	8.00	£	2.00	£	500.00	£10,000.00	£	7,000.00	120	000	108364	1.04%	1.02%
7	6	2012	June	1125	£	8.00	£	2.00	£	500.00	£ 9,000.00	£	6,250.00	120	000	108636	0.94%	1.01%
8	7	2012	July	1000	£	10.00	£	2.00	£	500.00	£10,000.00	£	7,500.00	120	000	108909	0.83%	1.01%
9	8	2012	August	1100	£	10.00	£	2.00	£	500.00	£11,000.00	£	8,300.00	120	000	109182	0.92%	1.01%
10	9	2012	September	1000	£	10.00	£	2.00	£	500.00	£10,000.00	£	7,500.00	100	000	109455	1.00%	1.00%
11	10	2012	October	900	£	10.00	£	2.00	£	500.00	£ 9,000.00	£	6,700.00	100	000	109727	0.90%	1.00%
12	11	2012	November	1200	£	10.00	£	2.00	£	500.00	£12,000.00	£	9,100.00	100	000	110000	1.20%	0.99%
13	12	2012	December	1500	£	10.00	£	2.00	£	500.00	£15,000.00	£	11,500.00	130	000	110273	0.85%	0.99%
14	13	2013	January	1000	£	10.00	£	1.80	£	500.00	£10,000.00	£	7,700.00	90	000	110545	1.11%	0.99%
15	14	2013	February	1100	£	10.00	£	1.80	£	500.00	£11,000.00	£	8,520.00	100	000	110818	1.10%	0.98%
16	15	2013	March	1200	£	10.00	£	1.80	£	500.00	£12,000.00	£	9,340.00	100	000	111091	1.20%	0.98%
17	16	2013	April	1000	£	10.00	£	1.80	£	500.00	£10,000.00	£	7,700.00	100	000	111364	1.00%	0.97%
18	17	2013	May	1100	£	10.00	£	1.80	£	500.00	£11,000.00	£	8,520.00	120	000	111636	0.92%	0.97%
19	18	2013	June	1000	£	10.00	£	1.80	£	500.00	£10,000.00	£	7,700.00	120	000	111909	0.83%	0.97%
20	19	2013	July	1200	£	10.00	£	1.80	£	500.00	£12,000.00	£	9,340.00	120	000	112182	1.00%	0.96%
21	20	2013	August	1100	£	10.00	£	1.80	£	500.00	£11,000.00	£	8,520.00	120	000	112455	0.92%	0.96%
22	21	2013	September	1000	£	10.00	£	1.80	£	500.00	£10,000.00	£	7,700.00	110	000	112727	0.91%	0.95%
23	22	2013	October	1072	£	10.00	£	1.80	£	500.00	£10,720.00	£	8,290.40	113	000	113000	0.95%	0.95%
24	23	2013	November	1070	£	10.00	£	1.80	£	500.00	£10,700.00	£	8,274.00	113	273	113273	0.94%	0.94%
25	24	2013	December	1068	£	10.00	£	1.80	£	500.00	£10,680.00	£	8,257.60	113	545	113545	0.94%	0.94%
26																		
27																		
28	Period Y	fear	Months	Units	Uni	it Price	Variab	le Costs	Fixe	d costs	Total Market	Market	Shares Forecast	Sales	F	Profit		
29	24	2013	December	1068	£	10.00	£	1.80	£	500.00	113545		0.94%	£ 10,680	.00	£ 8,257.60		
30																		
31																		
32																		
33	Period Y	fear	Months	Units	Uni	it Price	Variab	le Costs	Fixe	d costs	Total Market	Market	Shares Forecast	Sales	F	Profit		
34	24	2013	December	1068	£	10.00	£	1.80	£	500.00	113545		0.94%	£ 10,680	.00	£ 8,257.60		
35																		
36																		
37																		
38	Period Y	fear	Months	Units	Uni	it Price	Variab	le Costs	Fixe	d costs	Total Market	Market	Shares Forecast	Sales	F	rofit		
39	24	2013	December	1068	£	10.00	£	1.80	£	500.00	113545		0.94%	£ 10,680	.00	£ 8,257.60		

Open up the scenarios tool by clicking the **Data** tab and click the **What-if Analysis** button in the **Data Tools** group. Click **Scenarios Manager** and the **Edit Scenario** dialog box will open. You first want to see how the forecast will change if the total market will increase because of Christmas and if your company's investment will pay off by giving you more shares of the market.

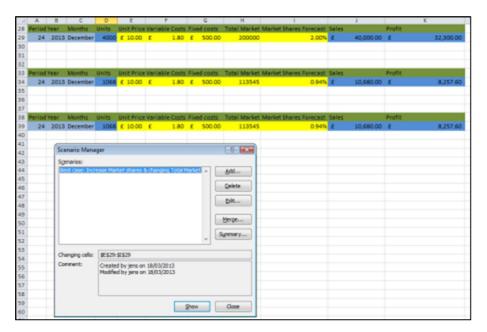
In the **Edit Scenario** dialog box first enter a name for the scenario. In the **Changing cells:** box you must select the changeable cells. Click **OK**.

X	1	- (H	(i) (ii)	w				Forecast	ng and data an	alysis blank.	alsi - M	icrosoft Excel			
U	20	Home	jens	Inset	Pa	pe Layout Formu	fas C	ata Review	View	Developer					
15	From Ac From W From Te	eb n	ten Other	Edition Connect		Correction	Z 4	AZ ZA Sort Pille	K Clear B Reapply D Advanced	Text to Columns	Remov	Data tes Validation	Consolidati	What-d Analysis -	en al
		Get E	demai Dat	3		Connections		Sort & I				Data To-	ofs		
	E	29	*	(°	f.	=ROUND(L2*J2,0)									
đ	A	8	С	D	ŧ	F	G	н	1			1		К	
28			Months December	Units		ce Variable Costs F			t Market Share	o 94%		10,680.00	Profit		7.60
50 81	-							~				10,000,000		6,20	
82 33	Period	Year	Months	Units	Unit Pri	Edit Scenario				Y	ales		Profit		
34	24	2013	December	1068	£ 10.0	Scenario game:					٤	10,680.00	£	8,25	7.60
55						Increase Market sho	ares & cha	nging Total Marks	٤						
36 37						Changing gells:					-				
38	Period	Vear	Months	Units	Unit Pri	\$E\$291\$1\$29				<b>1</b>	ales		Profit		
39		_	December			Ctrl+click cells to sele	ect non-ad	fjacent changing o	els.		£	10,680.00		8,25	7.60
40						Comment:									
41						Created by Jens on	18/03/20	13		*					
42											_				
43										w	-				
44 45						Protection									
45						Prevent change	es								
47						EHde									
48								-							
49									OK	Cancel					
50								1	1		-				
51															

Based on Christmas forecast from previous years your best guess for Total Market for December will be 200.000 units. Your hope that the investment will increase the Market share to 2%. Enter the values in the **Scenario Values** dialog box and click **OK**.

14	A	B	C		D	E	F			6	н	1		)		K
28	Period	Year	Month	s Ur	vits -	Unit Price	Variable	Costs	Fixe	d costs	<b>Total Market</b>	<b>Market Shares Forecast</b>	Sales		Profit	
29	24	2015	Decem	ber	1068	€ 10.00	£	1.80	٤	500.00	113545	0.94%	٤	10,680.00	£	8,257.60
80																
80 81 82																
32									-						and the	
20	Period	2013	Month	-						500.00	Total Market 113545	Market Shares Forecast 0.94%		10,680.00	Profit	8,257.60
54 55		2015	Decem	Ger	1008	1 10.00		1.80		300.00	113343	0.94%		10,080.00		8,437.99
56																
56 57																
58	Period	Year	Month	s Ur	vits .	Unit Price	Variable	Costs	Fixe	d costs	<b>Total Market</b>	<b>Market Shares Forecast</b>	Sales		Profit	
89	24	2013	Decem	ber	1068	€ 10.00	£	1.80	£	500.00	118545	0.94%	٤	10,680.00	£	8,257.60
40	Scen	ario Val	ues				-8-1	*								
41 42	Enter	values	for each	of the	changi	ng cels.										
43	1:		12 \$29													
	2		F129	1.8												
44 45 46	2		05529	500				-1								
46	\$		91629													
47	8			0.02				-1								
48 49	20		890	wod												
50				1	0	к	Cancel									
51		_	_		_		_	_								
52																

If you click **Show** you can see the result of your scenario in the worksheet. If the increase of market shares and total market units will be as predicted the sales increase from £ 10,680.00 to £ 40.000,00. To add more scenarios click add and just go through the steps again.



## **Procedures**

# **Creating scenarios**

- 1. Click the **Data** tab.
- 2. Click the **What-If Analysis** button in the **Data Tools** group.
- 3. Click the Scenario Manager command.

- 4. Click the **Add**... button.
- 5. In the **Scenario name:** box, type a name that identifies the scenario.
- 6. In the **Changing cells:** box, select or type the cells you want to modify in the scenario.
- 7. In the **Comments:** box, type an explanatory note regarding that particular scenario.
- 8. Click the **OK** button.
- 9. In the **Scenario Values** box, type values for each of the displayed changing cells.
- 10. Click the **OK** button.
- 11. The Scenario Manager box now displays the scenario.
- 12. . Click the Close button.

### Showing a scenario

- 1. To display a scenario, first click the Data tab.
- 2. Click the What-If Analysis button.
- 3. Click the Scenario Manager... button.
- 4. Select the scenario you want to display.
- 5. Click the **Show** button.
- 6. The chosen scenario data is now displayed.
- 7. Click the **Close** button.

#### **Deleting a scenario**

- 1. To delete a scenario, first click the **Data** tab.
- 2. Click the What-If Analysis button.
- 3. Click the Scenario Manager... button.
- 4. Select the scenario you want to delete.
- 5. Click the **Delete** button.

- 6. The chosen scenario data is deleted.
- 7. Click the Close button.

### Edit values in a scenario

- 1. To edit values in a scenario, first click the **Data** tab.
- 2. In the **Data Tools** group, click the **What-If analysis** arrow.
- 3. Click the Scenario Manager... button.
- 4. Select the name of the scenario you want to edit in the Scenarios list box.
- 5. Click the **Edit**... button.
- 6. In the Edit Scenario dialog box, reselect the Changing cells that you want to edit, if necessary.
- 7. Click the **OK** button.
- 8. In the **Scenario Values** dialog box, type a new value for the cell you want to change.
- 9. Click the **OK** button.
- 10. To display the effect, click the **Show** button.
- 11. Click the **Close** button.
- 12. The effect for that scenario is now displayed.

### Creating a scenario summary report

- 1. To create a scenario summary report, first click the **Data** tab.
- 2. Click the What-If Analysis button.
- 3. Click the Scenario Manager... button.
- 4. In the Scenario Manager dialog box, click the scenario you want to view.
- 5. Click the **Summary**... button.
- 6. In the Scenario Summary dialog box, click the OK button.

- 7. A Scenario Summary worksheet is displayed with the report.
- 8. The effect for that scenario is now displayed.

# THE GOAL SEEK TOOL

## Discussion

The **Goal Seek** tool can be very useful in a forecasting situation. Your forecast predicts that you in December will reach sales of £ 9,000.00 but you really need the sales to be £ 10,000.00.

The Goal Seek tool can now tell you what to do to get what you want. Open up the Goal Seek tool by clicking the Data tab and click the What-if Analysis button in the Data Tools group. Click Goal Seek and the Goal Seek dialog box will open. Click in the Set Cell: box and select the cell with the value you want to change. Click in the To Value: box and type the value you want the Set cell: cell to have. Click in By Changing Cell: box and click the cell you want Excel to change to get the result you want in the Set Cell: cell.

	A	5	С	D	E		G	н		1		1		K
81														
32														
33	Period	Year	Months	Units	Unit Price	Variable Costs	Flored costs	<b>Total Market</b>	Market Sh	vares Forecast	Sales		Profit	
54	24	2013	December	920	£ 9.80	£ 1.80	£ 500.00	100000		0.92%	٤	9,016.00	£	6,860.00
35											1			
56														
57														
58	Period	Year	Months	Units	Unit Price	Variable Costs	Pixed costs	Total Market	Market Sh	hares forecast	Sales		Profit	
59	24	2015	December	1068	£ 10.00	£ 1.80	£ 500.00	113545		0.94%	٤	10,680.00	£	8,257.60
40														
41														
42							Goal Seek	E.	7					
43								-						
44							Set celli	\$2\$34	18					
45							To yelue:	10000						
46							By changing or	4: \$1\$34	1					
47							01 2 3 dr y 0		100					
48								K C	ancel					
49														

Click **OK** and you will get the result.

## **Procedures**

- 1. To create a scenario summary report, first click the **Data** tab.
- 2. Click the What-If Analysis button.
- 3. Click the Scenario Manager... button.

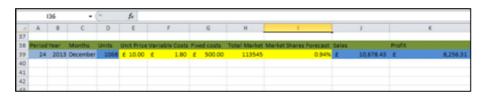
- 4. In the Scenario Manager dialog box, click the scenario you want to view.
- 5. Click the **Summary**... button.
- 6. In the Scenario Summary dialog box, click the OK button.
- 7. A Scenario Summary worksheet is displayed with the report.
- 8. The effect for that scenario is now displayed.

# THE DATA TABLE TOOL

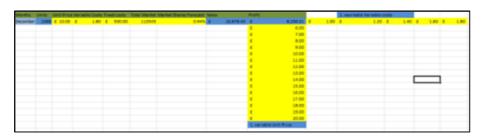
### **Discussion**

The **Data Table** tool is another **What-if Analysis** tool which is working very well with forecasts. A lot of forecasters must have asked themselves what if this or this happens. What will happen to my forecast? The **Data Table** tool can work with one or two variables. The **Data Table** tool can return a lot of results very fast.

You have a forecast for December but you want to see what will happen to the forecast if you change the price for the product and reduce the costs.



If you want to work with two variables you must have the variables in the same column and row as the formula.



Select the formula, the variable rows and columns and click **Data** tab, click **What-If Analysis** in the **Data Tools** group. Click **Data Table** and in the **Data Table** dialog box **Row input cell:** box enter the cell reference for the cell the formula use to calculate the variable in the row of the selection. In the **Column input cell:** box the **Data Table** tool need the same for the column input.

37				
2.8	Months Units Unit Price Variable Casts Fixed co	ors. Tutal Market Market Shares Farecast, Sales	Profit	2. severable variable costs
3.9	December 1068 € 10:00 € 1.80 € 10	0.00 113545 0.94% € 30,878.48	4 8,258.55	£ 100 £ 1.30 £ 1.40 £ 1.80 £ 1.80
40			£ £.00	
41			£ 7.00	
42			£ 8.00	
45			£ \$.00	
-64			£ 18.00	
45			£ 11.00	
			£ 12.00	
47		Desites C. S. S.	£ 15.00	
		Contraction of the second seco	£ 14.00	
49		Benefacture and a second secon	£ 15.00	
50		Chamingstrolt grant (%)	£ 16.00	
91			£ 17.00	
82		OK Canol	£ 18.00	
55			£ 18.00	
54			K 25.00	
55			& variable unit Price	
3.6				

#### Click OK.

1	Martha I	Grund L	UNIT PERM	Viscable I	COATE !	tred costs	TOTAL STRATES	Market Shares Porecast Sales		Profe.				2.1911	able variable c	100			
ij	December	1048	£ 12.00	4	1.80	# NO0.0	1135-45	0.00% E	10,478.43	4	8,256.31	4	1.00	4	1.20		1.40	£ 1.80	4 1.8
1										t.	6.80	ť.	4,899,21	1	4,625.84	ť.	4,412.08	€ 4,198.51	€ 5,9643
Į.										4	7.80	£	5,907.06	8	5,685.49	٤	5,479.82	€ 5,196.35	\$ 5,852.
										4	8.00	4	8,874.80	4	8,781.83		8,347.76	6 8,304.10	6 0,132/
										e	9.00	6	8,042.74	4	7,829.17		7,605.80	€ 7,482.04	€ 7,388.
										e	30.80	£	\$130.58	1	8,697.01	£	8,685.45	€ 8,469.86	€ 0.256.
										4	11.80	8	10.178.43	4	8,964.86		8,751.29	6 8,527.72	6 9,324
										4	13.80	4	11,248.37	4	11,083.70		10,819.13	612,403.56	\$ 20,895
										£	15.80	1	12,514,11	4	12,100.54	1	11,686.97	£11,678.41	€11,458
										£	\$4.80	£	13,581.95	£	13,160.39	£	12,954.82	\$12,741.25	€ 12,527
										4	35.00	4	14,449.80	4	14,229,22		14,023.80	613,809.09	\$ 13,595
										4	36.00	6	15,517.84	4	18,804.07		18,080.50	614,876.83	\$24,863
										£	17.80	£.	16,585,48	1	15,571,91	e.	16,158.34	£15,944.76	€15,750
										4	18.80	£	13,653.32	4	17,439.76		17,226.19	6 17,012.62	\$ 26,799
										4	29.00	4	18,721.37	4	18, NOT AD		18,294.03	618,080.46	617,808
										e	20.80	1	18,789.01	4	18,575.44		15,541.87	€18,148.30	€38,854
										1. variable Onici	<b>Brice</b>								

## **Procedures**

## **One-variable**

- 1. To create a one-variable (column) data table, first select the cell immediately above the output column.
- 2. Enter the formula you want to use.
- 3. Press the [Enter] key to confirm the entry.
- 4. Select the range containing the formula, the input column, and the output column.
- 5. Click the Data tab.
- 6. In the Data Tools group, click the What-If Analysis button.
- 7. Click the Data Table... button.
- 8. In the Data Table dialog box, click in the Column input cell: text box.
- 9. Enter, or select, the input cell.
- 10. Click the OK button.
- 11. The results are displayed in your one column data table.

## **Two-variable**

- 1. To create a two-variable data table, first select the cell above the column input values and to the left of the row input values.
- 2. Enter the formula you want to use.
- 3. Select the complete data table.
- 4. Click the Data tab.
- 5. In the Data Tools group, click the What-If Analysis button.
- 6. Click the Data Table... button.
- 7. In the Data Table dialog box, click in the Row input cell: text box.
- 8. Enter, or select, the input cell.
- 9. In the Data Table dialog box, click in the Column input cell: text box.
- 10. Enter, or select, the input cell.
- 11. Enter, or select, the input cell.
- 12. The results are displayed in your two-variable data table.

# Exercises

#### Exercise 1 Forecasting using scenarios

You have the data for each quarter from 2007 to 2011. You have the units you have sold, the unit price, the variable costs, the fixed costs, the sales, the profit, the total market units, and your company's market shares. The **Forecast** function has been used to calculate the forecast for Market shares and a seasonal forecast has been used to forecast Total Market (units) for 2012.

What will happen with the forecast for quarter 4 2012 if you can increase your market shares with 2%, decrease fixed and variable costs and if the total market units will increase?

- 1. Open the file Forecasting and data analysis.
- 2. Open the What-If analysis sheet.
- 3. Open up the Scenarios tool's parameters dialog (Data tab, Data Tools group, What-If Analysis).
- 4. Click Add and call the scenario "Best case forecast".
- 5. In **Changing cells:** type **F32:I32** or click in the box and select the range **F32:I32**.
- 6. In **Comment:** type "Decrease variable and fixed costs. Increase market shares and total market".
- 7. Click **OK** button.
- Change \$F\$32 (variable costs) to 1.6, change \$G\$32 (fixed costs) to 16000, change \$H\$32 (total market units forecast) to 180000, and \$I\$32 (market shares forecast) to 0.22.
- 9. Click OK button.
- 10. Click **Add** and call the scenario "Worst case forecast" do not change **Changing cells:**.
- 11. In **Comment:** type "Decrease market shares and total market units".
- 12. Click **OK** button.
- 13. Change **\$H\$32** (total market units forecast) to 140000, and **\$I\$32** (market shares forecast) to 0.18.
- 14. Click **OK** button.
- 15. Select **Best case forecast** and click **Show** button. Examine the result.
- 16. Select Worst case forecast and click Show button. Examine the result.

#### Exercise 2 Forecasting using goal seek

You have the data for each quarter from 2007 to 2011. You have the units you have sold, the unit price, the variable costs, the fixed costs, the sales, the profit, the total market units, and your company's market shares. The **Forecast** function has been used to calculate the forecast for Market shares and a seasonal forecast has been used to forecast Total Market (units) for 2012.

In the best case scenario from the previous exercise you reached a profit of £ 376,040.00, but you will like to find out how you can get a profit of £ 400,000.00.

- 1. Open the file Forecasting and data analysis.
- 2. Open the What-If analysis sheet.
- 3. Open up the **Goal Seek** tool's parameters dialog (**Data tab**, **Data Tools** group, **What-If Analysis**).
- 4. In Set cell: type **\$K\$37** or click in the box and select **K37**.
- 5. In **To value:** type 400000.
- 6. In **By changing cell:** type **\$I\$37** or click in the box and select **I37**.
- 7. Click **OK** button and examine the result (you need market shares of 26.67% to get £400,000.00 in profit).
- 8. Click **Cancel** button to reset the values and to close down the **Goal Seek** dialog box.
- 9. Go through step 3 to 8 again but this time please find out how much you need to increase the unit price to get £ 400,000.00 in profit.
- 10. Go through step 3 to 8 again but this time please find out how much you need to decrease the variable costs to get £ 400,000.00 in profit. You will find out that it is not possible to get a profit of £ 400,000.00 by only reducing the variable costs.
- 11. Save the file.

#### Exercise 3 Forecasting using data tables

You have the data for each quarter from 2007 to 2011. You have the units you have sold, the unit price, the variable costs, the fixed costs, the sales, the profit, the total market units, and your company's market shares. The **Forecast** function has been used to calculate the forecast for Market shares and a seasonal forecast has been used to forecast Total Market (units) for 2012.

You want to find out what will happen to the forecast if you can bring down the variable and fixed cost.

- 1. Open the file Forecasting and data analysis.
- 2. Open the What-If analysis sheet.
- 3. For the first variable **fixed costs** use column **K**. Select **K43** and type 10000. Type 12000 in **K44**, 14000 in **K45**, 16000 in **K46**, 18000 in **K47**, 20000 in **K48**, and 22000 in **K49**.
- 4. For the second variable **Variable costs** use row **42**. Select **L42** and type 1. Type 1.2 in **M42**, 1.4 in **N42**, 1.6 in **O42**, 1.8 in **P42**, 2 in **Q42**, and 2,2 in **R42**.
- 5. Select the range **K42:R49**.
- 6. Open up the **Data Table** tool's parameters dialog (**Data tab**, **Data Tools** group, **What-If Analysis**).
- 7. In **Row input cell:** type **F42** or click in the box and select the range **F42**. The row variable is **Variable Costs**.
- 8. In **Column input cell:** type **G42** or click in the box and select the range **G42**. The column variable is **Fixed Costs.**
- 9. Click **OK** button.
- Please do step 3 to 9 again. This time use the profit formula in K55 and Unit Price (use the range 8 to 20 pounds increased by 2 each time) in column K and Market Shares Forecast (use the range 16% to 30% increased by 2 each time) in row 55 as the two variables.
- 11. Compare the two tables. To increase the profit is it best to increase the costs or to try to get a bigger part of the market shares?
- 12. Save the file

# **LESSON 7 - CORRELATION COEFFICIENT**

In this lesson, you will learn how to:

- Use the **Correl** function
- Use the Data Analysis Tool Correlation
- Create a scatter chart to visualise Correlation Coefficient

### **CONCEPTS AND TERMS**

### Discussion

The **Correl** function determines the relationship (the correlation coefficient) between two arrays of data.

You may need to find out if your company's increased advertising costs also increase your company's sales figures or if higher temperatures in summer increase sales of ice cream. Or if you increase the price for your products will it affect the quantity you are selling.

The **Correl** function will return a result between -1 and 1.

Between 1 and 0:

If the result is close to 1 then it is because there is a close positive relationship between the two arrays (If the temperature rises the ice cream sales increase). Close to 0 then there is not a close relationship between the two arrays (the sales do not increase because of increased advertising costs).

Between 0 and -1:

If the result is close to -1 then there is a close negative relationship between the two arrays (if the price goes up the sales goes down). Close to 0 but a negative value then there is not a close relationship between the two arrays (the sales does not decrease if the price goes up).

### THE CORREL FUNCTION

### Discussion

The **Correl** function consists of two required arguments, in the following order: **Array1**, **Array2**. **Array1** and **Array2** are the arrays of data you want to examine to see if there is any relationship. In the **Array1** box enter the first range of data. In the **Array2** box enter the second range of data.

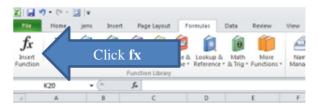
Array1 and array2 must have the same number of data points. If not the **Correl** function returns the #N/A error value.

If either array1 or array2 is empty the **Correl** function returns the #DIV/0! Error.

Month	Advertising costs	Sales
January	20000	100000
February	30000	80000
March	20000	100000
April	10000	150000
May	20000	150000
June	20000	300000
July	30000	200000
August	20000	100000
September	10000	100000
October	20000	100000
November	10000	200000
December	30000	300000

#### **Procedures**

- 1. To use a **Correl** function, first create a data range with two columns of values.
- 2. Click in the cell where you want to place the function.
- 3. Click on the **Formulas** tab.
- 4. In the Function Library group, click on the Insert Function button.

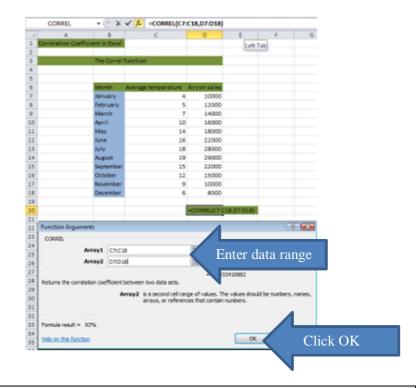


- 5. In the Insert function dialog box, locate **Statistical** category in the **Or select a category:** box.
- 6. Click on Correl.
- 7. Click on the **OK** button.

nsert Function			? 🔀	
Search for a function:				
Type a brief descripti Go	on of what you want	to do and then dick	Go	
Or select a category:	Statistical		Select statistical	1
Select a function:				
CHISQ.INV.RT CHISQ.TEST CONFIDENCE.NORM CONFIDENCE.T		1		
CORREL		Select C	Correl	
COUNT				
CORREL(array1,arr Returns the correlation		two data sets.		
telp on this function		ОК	Click OK	

- 8. In the Function Arguments dialog box, click in the Array1 box.
- 9. Select the cells containing the value from the first column in the data range.

- 10. In the **Array2** box, select the cells containing the value from the second column in the data range.
- 11. Click on the OK button.



The **COVARIANCE.P** function is another useful function to compare data from two different arrays. The **COVARIANCE.P** function has two arguments **Array1** and **Array2**. Enter the ranges for the two data sets and the function will return a positive or negative number. If it is positive close to zero there is a close positive relationship between the 2 arrays. Negative and close to zero there is a close negative relationship. If the value increases the two arrays are less related.

# THE DATA ANALYSIS TOOL CORRELATION

### Discussion

The Data Analysis Tool Correlation is working the same way as the Correl function.

The difference between the two tools is with the **Correl** function you can find the relationship between two arrays of data, with the Data Analysis Tool **Correlation** you can find the relationship between any numbers of arrays.

As the **Correl** function the Data Analysis Tool **Correlation** will return a result between -1 and 1.

Between 1 and 0:

If the result is close to 1 then it is because there is a close positive relationship between the two arrays (If the temperature rise the ice cream sales increase). Close to 0 then there is not a close relationship between the two arrays (the sales do not raise because of increased advertising costs).

Between 0 and -1:

If the result is close to -1 then there is a close negative relationship between the two arrays (if the price goes up the sales goes down). Close to 0 but a negative value then there is not a close relationship between the two arrays (the sales does not decrease if the price goes up).

### **Using the Correlation tool**

You can use **Correlation** tool by selecting the Data Analysis command from the Analysis group at the far right end of the data ribbon. Select **Correlation** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

After you have entered all necessary information into the **Correlation** dialog box, you can get the result in the output range.

Parameter	Description
Input	The array where you have the data you want to examine
Grouped By	input data grouped by columns or rows
Labels	If labels are selected in the input range the box must be ticked
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook

You can specify the following items in the **Correlation** parameters dialog box:

When you have finished entering the information click OK and you will get the output.

### **Procedures**

- 1. To use the **Correlation** tool, first click the Data tab.
- 2. In the **Analysis** group, click the **Data Analysis** button.

Data Analysis ? 🔀 Analysis Tools OK Click OK Anova: Single Factor . Anova: Two-Factor With Replication Cancel Anova: Two-Factor Without Replication Ξ Select Correlation Help Covariance Descriptive Statistics Exponential Smoothing F-Test Two-Sample for Variances Fourier Analysis . Histogram

#### 3. Select Correlation from the list and click OK.

#### 4. Select the Input Range.

Month	Average temperature	Aircon sales	Advertising costs	Price per unit
lanuary	2	10000	1200	500
February		5 12000	1000	450
March	1	7 14000	800	420
April	10	16000	1200	410
May	14	18000	600	400
une	16	5 22000	1200	390
uly	18	3 28000	800	380
August	19	29000	1200	370
September	15	5 22000	1000	390
October	12	15000	1200	410
November	9	9 10000	1000	460
December	(	5 8000	1200	490

- 5. Select the desired options for **Grouped By**, **Labels**, and **Output**.
- 6. Click OK

#### The output

Month	Average temperature	Aircon sales	Advertising costs	Price per unit
January	4	10000	1200	500
February	5	12000	1000	450
March	7	14000	800	420
April	10	16000	1200	410
May	14	18000	600	400
June	16	22000	1200	390
July	18	28000	800	380
August	19	29000	1200	370
September	15	22000	1000	390
October	12	15000	1200	410
November	9	10000	1000	460
December	6	8000	1200	490
	Average temperature	Aircon sales	Advertising costs	Price per unit
Average temperature	1		,	
Aircon sales	0.933410882	1		
Advertising costs	-0.145073235	-0.1520328	1	
Price per unit	-0.896696678	-0.8976502	0.257331145	1

Let us have a look at the output. You got a table with the column labels from the input array, because you selected the column labels when you selected the Input Range. In the output table you have the labels both as row and columns labels.

You can see that the relationship between Aircon sales and Average temperature is close, because the result is close to 1. It means that if the average temperature rises you are selling more air-condition units.

If you look at the relationship between Aircon sales and Advertising costs you got a negative result close to 0. It means that it is not a good idea spending money on advertising. The sales of air-condition units do not increase if you spend more money on advertising. In this example the sales actually decrease a little bit if you increase the advertising budget.

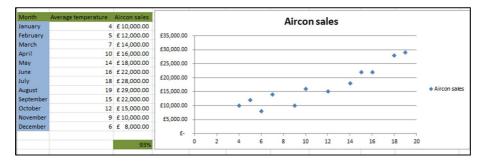
You got a result close to minus 1 for the relationship between Aircon sales and Price per unit. It means that you have a close negative relationship between the two columns. If the price goes up the sales go down. If the price goes down the sales go up.

### CREATE A SCATTER CHART TO DISPLAY CORRELATION COEFFICIENT

### Discussion

Charts are very useful to visualise data analysis. The **Scatter** chart is the most beneficial when working with data analysis.

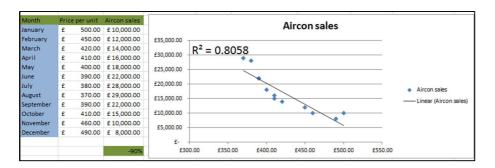
In the example below it is easy to spot the trend in the chart. There is a close relationship between average temperature and aircon sales. Of course you can also see that the **Correl** function returns 93% wich also emphasise that there is a close relationship between the two arrays.



To make it even easier to spot the trend you can add a linear **Trendline** to the chart and if you add the R<sup>2</sup> (R square error) to the **Trendline** you can see how accurate your **Trendline** is. A value close to 1 shows that the **Trendline** is very accurate. Close to 0 there is not really any trend.

Month	Average temperature	Aircon sales			••			
January	4	£ 10,000.00			Aircon	sales		
February	5	£ 12,000.00	£35,000.00 T					
March	7	£14,000.00		$R^2 = 0.8713$				
April	10	£ 16,000.00	£30,000.00 -	11 = 0.0713				
May	14	£ 18,000.00	£25,000.00				~	
June	16	£ 22,000.00				**		
July	18	£ 28,000.00	£20,000.00 -			-		<ul> <li>Aircon sales</li> </ul>
August	19	£ 29,000.00	£15,000.00 -		-	· ·		
September	15	£ 22,000.00	213,000.00					
October	12	£ 15,000.00	£10,000.00 -	+	+			
November	9	£ 10,000.00	£5,000.00	•				
December	6	£ 8,000.00	25,000.00					
			£- +	1	1	1		
		93%	0	5	10	15	20	
		10			9899			4

In the example below there is a close negative relationship between the Price per unit and Aircon sales. Again it is easy to see in a scatter chart.



In the example below there is no close relationship between Advertising costs and Sales. The **Correl** function returns 21% and the  $R^2$  value is 0.0421 which tells you that there is not really a trend in the data.

Month	Advertisin	g costs	Sales	;	Sales	
January	£	20,000.00	£	100,000.00	Sales	
February	£	30,000.00	£	80,000.00	£350,000.00	
March	£	20,000.00	£	100,000.00	$R^2 = 0.0421$	
April	£	10,000.00	£	150,000.00	£300,000.00	
May	£	20,000.00	£	150,000.00	£250,000.00	
June	£	20,000.00	£	300,000.00		
July	£	30,000.00	£	200,000.00	£200,000.00 •	<ul> <li>Sales</li> </ul>
August	£	20,000.00	£	100,000.00	£150.000.00	
September	£	10,000.00	£	100,000.00	2130,000.00	Linear (Sales)
October	£	20,000.00	£	100,000.00	£100,000.00	
November	£	10,000.00	£	200,000.00	•	
December	£	30,000.00	£	300,000.00	£50,000.00	
					£-	
				21%	£- £5,000.00 £10,000.00£15,000.00£20,000.00£25,000.00£30,000.00£35,000.00	

In the example below the **Data Analysis** tool **Correlation** has returned the correlation for three arrays and again a chart is very useful to examine the outcome.

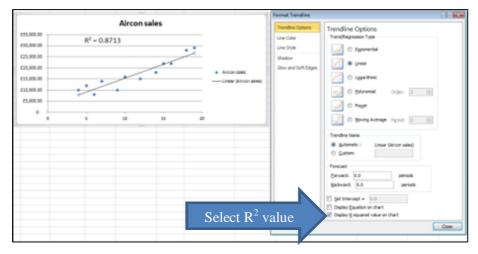
Month	Average temperature	Aircon sales	Advertising costs	Pric	e per unit	£35,000.00			£1,400.00	
January	4	£ 10,000.00	£ 1,200.00	£	500.00	£30,000.00 -			£1,200.00	
February	5	£ 12,000.00	£ 1,000.00	£	450.00			**	ž	
March	7	£14,000.00	£ 800.00	£	420.00	£25,000.00	$R^2 = 0.021$		- £1,000.00	<ul> <li>Aircon sales</li> </ul>
April	10	£ 16,000.00	£ 1,200.00	£	410.00	£20,000.00	$K^2 = 0.021$	**	£800.00	Advertising costs
May	14	£ 18,000.00	£ 600.00	£	400.00	S F	$R^2 = 0.8041$	•	5	-
June	16	£ 22,000.00	£ 1,200.00	£	390.00	£15,000.00	•	* + -	£600.00 8	Price per unit
July	18	£ 28,000.00	£ 800.00	£	380.00	£10,000.00			£400.00 . 🖉 👘	<ul> <li>Linear (Advertising costs)</li> </ul>
August	19	£ 29,000.00	£ 1,200.00	£	370.00		· · · ·		: 문 _	- Linear (Aircon sales)
September	15	£ 22,000.00	£ 1,000.00	£	390.00	£5,000.00	2 0.0740		£200.00 g	- Linear (Price per unit)
October	12	£ 15,000.00	£ 1,200.00	£	410.00	£- 1	$R^2 = 0.8713$		- £-	
November	9	£ 10,000.00	£ 1,000.00	£	460.00	0	5	10 15	20	
December	6	£ 8,000.00	£ 1,200.00	£	490.00	_	Average te	emperature		
							Average temperature	Aircon sales	Advertising costs	Price per unit
						Average temperature	e 1			
						Aircon sales	0.933410882	1		
						Advertising costs	-0.145073235	-0.152032775		1
						Price per unit	-0.896696678	-0.89765018	0.257331	145

#### **Procedures**

- 1. To create a chart to visualise correlation select the arrays with the data you want to examine.
- 2. Click Insert tab.
- 3. Click the scatter chart option you want to use.

🗶 🛃 🎝 • (* -						Forecastin	g and
elect insert tab	Inser	t Page Layout	Formulas	Data R	eview View	Developer	
3	ا 🚼 🔝	1 🔁 🖥	94 🔒	<u>///</u>	• 불	🍋 🗠 🕻	Salast south an antion
PivotTable Table	Picture Clip S Art	hapes SmartArt Scree	enshot Column	Line	Pie Bar /	rea Scatter Oth	
Tables		llustrations			Charts		
O33	<b>v</b> (n	f <sub>×</sub>					
1							

- 4. Click **Layout** tab (the chart most be selected to have access to the **Layout** tab).
- 5. In the **Analysis** group click **Trendline** and **Linear Trendline**.
- 6. Right click the **Trendline** and click **Format Trendline**.



7. Select the option Display R Squared Value on Chart

8. Click Close.

# EXERCISE

#### Using Correl function and the data analysis tool Correlation

- 1. Open the file Forecasting and data analysis.
- 2. Open the **Correlation Coefficient** sheet.
- 3. Use the **Correl** function in D60 to get the correlation coefficient for the two arrays C47:C58 and D47:D58 (Average temperature and Ice sales).
- 4. The result should be 0.9566537. What does this tell us about the relationship between the two arrays?
- 5. Create a scatter chart showing the Correlation Coefficient between the average temperature and the ice sales.
- 6. Click the **Data** tab. Click **Data analysis** in the Analysis group. Open the **Correlation** tool.
- 7. Use the Data Analysis Tool **Correlation** to find the Correlation Coefficient between the average temperature, the ice sales, and advertising costs (the input should be O46:Q58).
- 8. The result should be:

	Average temperature	Ice sales	Advertising costs
Average temperature	1		
Ice sales	0.956653704	1	
Advertising costs	-0.204621004	-0.196872578	1

- 9. What does this tell us about the relationships between the two arrays?
- 10. Create a scatter chart showing the Correlation Coefficient between the average temperatures, the ice sales, and advertising costs.
- 11. Save and close the file

# **LESSON 8 – BREAK-EVEN ANALYSIS**

In this lesson, you will learn how to:

- Calculate Break-even
- Visualise break-even using scatter chart
- Use the goal seek tool to calculate break-even
- Use the Solver tool to calculate break-even
- Exercise

### **CONCEPTS AND TERMS**

### Discussion

When you are considering an investment or launching a new product you want to know at what point you will break-even. When will you start earning money? How many units do I need to sell to Break-even if you invest £ 100.000 on television commercials? How should the products be prised to break-even this year?

For forecasting break-even analysis is very important to forecast new product's financial success.

In this workbook you will see the math behind break-even and the break-even will be manually calculated. The Goal Seek tool in Excel can do these calculations and is a very valuable tool for break-even analysis.

### **CALCULATE BREAK-EVEN**

The formula for break-even looks like this:

0 (profit) = Units \*(Sales Price – Variable Costs) – Fixed Costs

Example:

- 100 Units
- Sales Price = £10
- Variable Costs = £4
- Fixed Costs = £600

With above values the formula will be true a profit of 0. You need to sell 100 units for a price of £10 if the variable costs are £4 and fixed costs are £600

If you want to find out how many units you need to sell to break-even you must change the formula using the math rules for equations.

0 (profit) = Units \*(Sales Price – Variable Costs) – Fixed Costs

First add Fixed Costs on both sides of the equal sign:

Fixed Costs=Units \*(Sales Price – Variable Costs)

This equation can now be used to calculate the Fixed Costs to break-even.

By using the values from the example:  $600=100^{*}(10-4)$ 

Divide with (Sales Price – Variable Costs) on both sides of the equal sign:

Units = Fixed Costs/(Sales Price – Variable Costs)

This equation can calculate how many units you need to break-even.

By using the values from the example: 100=600/(10-4)

The equation to find the sales price is:

Sales Price = Fixed Costs/Units + Variable Costs

To get this equation start from the break-even equation again:

0 (profit) = Units \*(Sales Price – Variable Costs) – Fixed Costs

First add Fixed Costs and both sides of the equal sign:

Fixed Costs=Units \*(Sales Price – Variable Costs)

Then divide Units on both sides of the equal sign:

Fixed Costs/Units=Sales Price – Variable Costs

Then add Variable Costs on both sides of the equal sign:

Sales Price = Fixed Costs/Units + Variable Costs

This equation can calculate sales price you need to break-even.

By using the values from the example: 10=600/100 + 4

### Procedures (calculate units to break-even)

Units = Fixed Costs/(Sales Price – Variable Costs)

- 100 Units
- Sales Price = £10
- Variable Costs = £4
- Fixed Costs = £600
  - 1. Type =600/(10-4).

2. Press enter.

### **Procedures (calculate sales price to break-even)**

Sales Price = Fixed Costs/Units + Variable Costs

- 100 Units
- Sales Price = £10
- Variable Costs = £4
- Fixed Costs = £600
  - 1. Type =600/100+4
  - 2. Press enter.

### **Procedures (calculate fixed costs to break-even)**

Fixed Costs=Units \*(Sales Price – Variable Costs)

- 100 Units
- Sales Price = £10
- Variable Costs = £4
- Fixed Costs = £600
  - 1. Type =100\*(10-4)
  - 2. Press enter.

### **VISUALISE BREAK-EVEN USING SCATTER CHART**

#### Discussion

Charts can be very useful to understand and visualise data analysis. Scatter charts is the chart type, which should be used to visualise break-even analysis.

In the example below in column A there are units going from 0 to 4000 with an increment of 400. In column B the sales (units times unit price), in column C variable cost (units times unit variable cost), in column D the fixed cost, in

column E total costs (variable cost + fixed cost), and in column F the net income (sales – total costs).

If you look at the table it is not easy to see the break-even. It is somewhere between 1200 and 1600 units.

	А	В	С	D	E	F
1			Assumptions			
2	Time	Units Start	Units increment	Unit Price	Unit Variable Cost	Total Fixed Costs
3	Month	0	400	£ 40.00	£ 32.00	£ 10,000.00
4					<u> </u>	
5	Units	Sales	Variable Cost	Fixed	Total Costs	Net Income
6	0	£ -	£ -	£ 10,000.00	£ 10,000.00	-£10,000.00
7	400	£ 16,000.00	£ 12,800.00	£ 10,000.00	£ 22,800.00	-£6,800.00
8	800	£ 32,000.00	£ 25,600.00	£ 10,000.00	£ 35,600.00	-£3,600.00
9	1200	£ 48,000.00	£ 38,400.00	£ 10,000.00	£ 48,400.00	-£400.00
10	1600	£ 64,000.00	£ 51,200.00	£ 10,000.00	£ 61,200.00	£2,800.00
11	2000	£ 80,000.00	£ 64,000.00	£ 10,000.00	£ 74,000.00	£6,000.00
12	2400	£ 96,000.00	£ 76,800.00	£ 10,000.00	£ 86,800.00	£9,200.00
13	2800	£ 112,000.00	£ 89,600.00	£ 10,000.00	£ 99,600.00	£12,400.00
14	3200	£ 128,000.00	£ 102,400.00	£ 10,000.00	£ 112,400.00	£15,600.00
15	3600	£ 144,000.00	£ 115,200.00	£ 10,000.00	£ 125,200.00	£18,800.00
16	4000	£ 160,000.00	£ 128,000.00	£ 10,000.00	£ 138,000.00	£22,000.00
17						
18	=f3/(d3-e3)	Break Even x	Break Even y	Label		
19		1250	£ 50,000.00	Approx BEU 1250	0	
20						

To visualise break-even in a scatter chart select the units (A5:A16), the sales (B5:B16), and total costs (E5:E16), and create the straight line scatter chart.



The break-even point is where the sales line cross the total costs line.

To make it easier to see the break-even in the scatter chart you can calculate the break-even using the break-even equation you have seen earlier in this chapter;

In this example the calculation is; =f3/(d3-e3) and the result is 1250. You will also need to calculate the Y value to plot it on the chart. The Y value is breakeven units multiplied by unit price. In this example; =B19\*D3 (the break-even equation is calculated in B19). The result is calculated in C19 and is 50000. To make the exact break-even point very clear in the chart you can add the exact value to the legend label in the chart. In cell D19; ="BEU" & B19 has been entered. This will return "BEU 1250" on the legend label.

To add the break-even point and the legend label you need to select the chart and click the contextual Design tab. Click Select Data in the Data group. Click Add in Series Name click D19 in Series X values click B19 and in Series Y values click C19.

0	A	8	ç	0	5	۴.	0	PI		1	K
				UKKEK							
ī	Time	Linits Start	Units increment	Leit Price	Unit Variable Cost	<b>Total Fixed Conts</b>					
3	Month	0		400 g 40.00	£ 12.00	£ 13,090-90					
L											
Ŀ	units	Sales		Fixed	Yotal Corts		K100.000.00				
		£ .	٤	Edit Series	11.00	-00.000.00	640,800,80				
	-	€ 34,800.00		Series permit		-66,800.00					
		£ 22,800.00		"Treat-ener Analysis (*\$553)	-	-61,600.00	E140,300,30		11		
	129	C 45,000.00		Series 3 values		-6400.00	£130,000,00		1/		
	3100	€ 84,800.00		-Trail-ever Anima Callett		(2,808.08			//		
	330	£ 80,800.00		Garies 1 values:		\$6,000.00	£300,800.80				Sales
	3400	£ 96,800.00		"Beak-ware Andreas Discard	1 ml	£9,308.08	£98,000.20			_ `	- Total Case
	350	€ 132,800.00			_	€12,408.08	698,000,00				- BC # 1250
	1206	£ 128,800.00			K Cancel	\$15,808.08					
	198	£ 144,800.00		ILCINE W L DOMENT			£48,000.00				
l	400	K 180,800.00	1	328,000-00 f 30,000.00	€ 136,800.00	£22,808.08	638.000.00	1			
	14a-Co(4,0*	Greak Even a	Break Cven y	Label				1000 2000	3000 4000	9000	
		1290	\$	NL096-30, 28CV 1254	1					_	
ĺ.										_	_

The break-even point is still not visible on the chart. Well the label is visible in the legend. To make it visible you must change the data series' formatting. Select the data series and right click. Choose **Format Data** Series click **Marker Options** select **Build-in** and select a type and a size. Click Close.

Now it is very easy to see the break-even point.

103	A		8	ç	0	E.	F	9	H			K.
1.												
2	71.16.0				LIVE MISCH							
2	Month			400	6 40.00	4 92.08	6 18,000.00					
4		_										
ъ	LNIEL			Variable Card	Fixed		Nettracere	£180,800.80				
6			4 -	4 -	6 13,000.00	£ 30,000,00	-£30,808.08	£160,000,00				
7		400	f 18,000-30	£ 12,800.00	£ 13,090-90	£ 22,808.08	-05,800.00	Excusione		/		
ж		800	4 \$2,080.80		4 18,080-30		-61,800.00	\$340,300,30		11		
2		1308	£ 48,000.30	4 28,400.00	6 13,000.00	40,400.00	-6408.08	£130,800,80				
1.9		1608	£ 64,000-30	£ 51,200.00	£ 13,080-30	f 61,300.00	\$2,808.08					
1.1		2000	4 X3,080-30				#8,008.08	£300,800,80		11		Selco
12		2408	4 96,000.00				69,308.08	EH0.000.00				-Tetal Costa
13		2800	1 112,000-80	£ 81,800.00	£ 13,000-00	5 95,608.08	£12,408.08	640.000.00				
1.0		1308	£ 128,000-30		£ 13,080-30		\$13,805.00	610,000-00				
1.5		2000	4 \$44,000.00		6 13,000.00		639,908.08	648,000.00				
1.5		4000	f 398,000-30	£ 128,900.00	£ 18,000-80	£ 135,000.00	\$22,008.08	638,000.00	1			
1.7		_							/			
1.8	43/(\$2-03)			Break Sect y	Label			£.	0 1000 30	00 1000 4000	9088	
1.5		_	1256	£ 56,800.00	KKU 3250				0 100 20	au mus) 6000	-	
28												

If you have created the table as the one in this example you can change the variables in row three and everything will be updated immediately.



### **Procedures**

- 1. To create a scatter chart to visualise Break-Even for units sold select the arrays with the data you want to visualise.
- 2. Click Insert tab.
- 3. Click the scatter chart option you want to use and create the chart.



- Calculate Break-Even using the break-even equation. Units = Fixed Costs/(Sales Price – Variable Costs)
- 5. Calculate the Y value for break-even (break-even multiplied by unit price).
- 6. Select the chart and click the contextual **Design** tab and click **Select Data** in the **Data** group.
- 7. Click **Add** and in the **Edit Series** parameters dialog box in the **Series Name** box type a name for the data series.
- 8. In the **Series X values** box enter the cell reference for the cell with the break-even equation/calculation.
- 9. In the **Series Y values** box enter the cell reference for the cell with Y value calculation.



10. Click the **OK** button.

11. To make the break-even data series visible in the chart right click the series and choose **Format Data Series** or click **Layout** tab and select the data series from the chart object list in the **Current Selection** group and then in the same group click **Format Selection**.



12. Click **Marker Options** to the left, click **Build-in**, select a marker type and size. Click the **Close** button.

Fermat Data Series		V (8)
Series Options	Marker Options	
Marker Options	- Plaster Type	
Narker M	Agtonatic	
Line Color Line Style Marker Line Color Marker Line Style	© Ngre ∰ Bult-n Type: ♥ ♥ Son : 13 ©	
Shadav Gon and Soft Edges		
3-0 Format		
		Ocea

# USE SCENARIOS AND THE GOAL SEEK TOOL TO CALCULATE BREAK-EVEN

### **Discussion**

The **What-if** analysis tools in Excel are very useful also when you are working with Break-Even analysis. How can I change the break-even point? Which parameters will affect my break-even analysis most if I change them?

# EXERCISE

#### Calculating break-even

1. Open the file Forecasting and data analysis.

2. Open the Break-even Analysis 1 sheet.

3. Select C68 and calculate break-even. How many units must be sold to get 0 in profit (use the equation "Units=FixedCosts/(SalesPrice-VariableCosts)").

4. Select F68 and calculate the selling price to break-even selling 10000 units (use the equation "SalesPrice = FixedCosts/Units + VariableCosts").

5. Select H68 and calculate the Fixed Costs to break-even selling 10000 units (use the equation "FixedCosts= Units\*(SalesPrice - VariableCosts)").

6. Select K68 and calculate the Variable Costs to break-even selling 10000 units (use the equation "VariableCosts=SalesPrice-FixedCosts/Units").

8. Use the Goal Seek tool to Break-even Units, Sales Price, Fixed Costs, and Variable Cost in the same 4 tables.

7. Save and close the file.

### LESSON 9 – DATA ANALYSIS TOOLS

In this lesson, you will learn how to:

- Use Descriptive Statistics
- Use Histogram
- Use Regression
- Use Sampling

### **CONCEPTS AND TERMS**

### **Discussion**

You have already seen some of the tools from the **Data Analysis TOOLPAK** add-in. In this chapter some of the other tools will be briefly demonstrated. All the statically terms will not be explained.

### **DESCRIPTIVE STATISTICS**

### **Discussion**

The **Descriptive Statistics** tool can return statistical information from data in Excel.

Usually when you analyse data it is important examine the distribution and to discover information such as the minimum and maximum values and to determine if there are outliers. This is an important step in any analysis since it helps you understand if your data meet rules required by other analyses such as t-tests and regression and if the data are needed for forecasting.

The **Descriptive Statistics** tool can provide you with these information and much more.

Sales	
Mean	2708.180556
Standard Error	39.70767757
Median	2679
Mode	2600
Standard Deviation	336.9308169
Sample Variance	113522.3754
Kurtosis	0.873835822
Skewness	0.642971537
Range	1551
Minimum	2147
Maximum	3698
Sum	194989
Count	72
Largest(3)	3600
Smallest(3)	2155
Confidence Level(95.0%)	79.17486035

Information you should notice includes:

1. Search for outliers: Look at the Minimum and Maximum values to see if these values fall within your expected range for these data. If a value is unexpectedly small or large, you should examine your data to see if they were wrong. If there are corrections that need to be made, make them before continuing. If you have values that are unexpectedly large or small, but are actual values, it may indicate that your data are not normally distributed. This knowledge will help you to decide forecasting method. It may also indicate that the average is not the best value to report to describe the trend of this data set.

2. Symmetry: Another measure that helps you decide normality is Skewness and Kurtosis. The Skewness measure indicates the level of non-symmetry. If the distribution of the data is symmetric then skewness will be close to 0 (zero). The further from 0, the more skewed the data are.

How do you tell if the skewness is large enough to cause concern? Excel doesn't give you this value, but a measure of the standard error of skewness can be calculated as =SQRT(6/N) where N is the sample size. If the skewness is more than twice this amount, then it indicates that the distribution of the data is non-symmetric.

3. Kurtosis characterizes the relative peakedness or flatness of a distribution compared with the normal distribution. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution. Again, for normally distributed data the kurtosis is 0 (zero). As with skewness, if the value of kurtosis is too big or too small, there is concern about the normality of the distribution. In this case, a rough formula for the standard error for kurtosis is =SQRT(24/N) where N is the sample size. If the kurtosis is more than twice this amount the data may be considered not to meet the criteria for normality by this measure.

4. Evaluation of central trend: For normally distributed data the average is the typical value to measure. However, the average is not interesting without some evaluation of the inconsistency of the data. Therefore you should at least report three values – the average, the standard error of the average, and the sample size.

The median is another measure of central tendency and is usually reported when the data are not normally distributed. The mode, or the most frequent value, is a third measure of central tendency.

5. Measures of inconsistency: The measures of inconsistency reported in Excel's descriptive statistics include the standard error, the standard deviation, the variance and the range.

Standard Deviation = SQRT(Variance)

Standard Error = Standard Deviation / SQRT(N)

You can find The **Descriptive Statistics** tool by selecting the Data Analysis command from the Analysis group at the far right end of the data ribbon. Select **Descriptive Statistics** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

After you have entered all necessary information into the **Descriptive Statistics** dialog box, you can get the result in the output range.

You can specify the following items in the **Descriptive Statistics** parameters dialog box:

Parameter	Description
Input Range	The range where you have the data you want to examine
Grouped By	Do you have the data grouped by columns or rows
Labels	If labels are selected in the input range the box must be ticked
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook
Summary statistics	Tick the box if you want the output statistics summarised
Confidence Level for Mean	Tick the box if you want the confidence calculated for the average
Kth Largest	Tick the box if you want not only the largest value in the data range shown in the output. By typing 3 in the box the third largest value will be shown in the output
Kth Smallest	Tick the box if you want not only the smallest value in the data range shown in the output. By typing 3 in the box the third smallest value will be shown in the output

When you have finished entering the information click OK and you will get the output.

	А	B	С	D	E	F	G		Н	- I	J
1											
2											
3		Period Y	/ear	Months	Sales						
4		1	2012	January	£ 8,000.00						
5		2	2012	February	£10,000.00						
6		3	2012	March	£ 9,000.00						
7		4	2012	April	£ 8,000.00						
8		5	2012	May	£10,000.00	Descriptive S	tatistics			? 🔀	
9		6	2012	June	£ 9,000.00	Input			_	ОК	
10		7	2012	July	£10,000.00	Input Range		\$E\$3:\$E\$24	<b></b>		
11		8	2012	August	£11,000.00	Grouped By		Columns		Cancel	
12		9	2012	September	£10,000.00			Rows		Help	
13		10	2012	October	£ 9,000.00	Labels in	first row				
14		11	2012	November	£12,000.00						
15		12	2012	December	£11,000.00	Output optic			<b>1</b>		
16		13		January	£10,000.00	<u>O</u> utput F	-	\$G\$4			
17		14		February	£11,000.00	O New Wo					
18		15	2013	March	£12,000.00	O New Wo	rkbook				
19		16	2013	April	£10,000.00	Summar	statistics				
20		17	2013	May	£11,000.00	Confider	ce Level for Mean:	95	%		
21		18	2013	June	£10,000.00	Kth Larg	est:	3			
22		19	2013	July	£12,000.00	Kth Sma	lest:	3			
23		20	2013	August	£11,000.00						
24		21	2013	September	£10,000.00						
25		22	2013	October							
26		23	2013	November							
27		24	2013	December							

#### The output:

	А	В	С	D	E	F	G	Н
1								
2								
3		Period	Year	Months	Sales			
4		1	2012	January	£ 8,000.00		Sales	
5		2	2012	February	£10,000.00			
6		3	2012	March	£ 9,000.00		Mean	10190.4762
7		4	2012	April	£ 8,000.00		Standard Error	254.661752
8		5	2012	May	£10,000.00		Median	10000
9		6	2012	June	£ 9,000.00		Mode	10000
10		7	2012	July	£10,000.00		Standard Deviation	1167.00675
11		8	2012	August	£11,000.00		Sample Variance	1361904.76
12		9	2012	September	£10,000.00		Kurtosis	-0.36267376
13		10	2012	October	£ 9,000.00		Skewness	-0.19853301
14		11	2012	November	£12,000.00		Range	4000
15		12	2012	December	£11,000.00		Minimum	8000
16		13	2013	January	£10,000.00		Maximum	12000
17		14	2013	February	£11,000.00		Sum	214000
18		15	2013	March	£12,000.00		Count	21
19		16	2013	April	£10,000.00		Largest(3)	12000
20		17	2013	May	£11,000.00		Smallest(3)	9000
21		18	2013	June	£10,000.00		Confidence Level (95.0%)	531.215105
22		19	2013	July	£12,000.00			
23		20	2013	August	£11,000.00			
24		21	2013	September	£10,000.00			
25		22	2013	October				
26		23	2013	November				
27		24	2013	December				
28								

#### **Procedures**

- 1. To use a **Forecast** function, first create a data range with data values you know
- 2. Click in the cell where you want to place the function.
- 3. Click on the Formulas tab.

4. In the **Function Library** group, click on the **Insert Function** button.

### HISTOGRAM

### **Discussion**

The **Histogram** tool can return statistical information from data in Excel and group the output data. You must first create a **bin** to tell the **Histogram** tool how you want the output data grouped.

	А	В	С	D	E	F	G	Н
1								
2								
3		Period	Year	Months	Sales		Bind	
4		1	2008	January	£ 3,000.00		2000	
5		2	2008	February	£ 2,000.00		4000	
6		3	2008	March	£ 1,000.00		6000	
7		4	2008	April	£ 500.00		8000	
8		5	2008	May	£ 3,000.00		10000	
9		6	2008	June	£ 1,000.00		12000	
10		7	2008	July	£ 2,000.00		14000	
11		8	2008	August	£ 1,000.00		16000	
12		9	2008	September	£ 2,000.00		18000	
13		10	2008	October	£ 1,000.00			
14		11	2008	November	£ 5,000.00			
15		12	2008	December	£10,000.00			
16		13	2009	January	£ 1,000.00			
17		14	2009	February	£ 5,000.00			
18		15	2009	March	£ 2,000.00			
19		16	2009	April	£ 3,000.00			
20		17	2009	May	£ 500.00			
21		18	2009	June	£ 1,000.00			
22		19	2009	July	£ 2,000.00			
23		20	2009	August	£ 5,000.00			
24		21	2009	September	£ 6,000.00			

In the example above the bind starts with 2000 and goes to 18000 with an increment of 2000.

You can find the **Histogram** tool by selecting the Data Analysis command from the Analysis group at the far right end of the data ribbon. Select **Histogram** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

After you have entered all necessary information into the **Histogram** dialog box, you can get the result in the output range.

You can specify the following items in the **Histogram** parameters dialog box:

Parameter	Description
Input Range	The range where you have the data you want to examine
Bin Range	Select the range where the bin range has been defined
Labels	If labels are selected in the input range the box must be ticked
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook
Pareto (sorted histogram)	Tick the box if you want the output statistics sorted
Cumulative Percentage	Tick the box if you want cumulative percentage to be a part of the output
Chart output	Tick the box if you want to create a chart to visualise the output

	А	В	С	D	E	F		G	Н	1	J	
3		Period	Year	Months	Sales			Bind				
4		1	2008	January	£ 3,000.00			2000				
5		2	2008	February	£ 2,000.00			4000				
6		3	2008	March	£ 1,000.00			6000				
7		4	2008	April	£ 500.00			8000				
8		5	2008	May	£ 3,000.00			10000				
9		6	2008	June	£ 1,000.00			12000				
10		7	2008	July	£ 2,000.00			14000				
11		8	2008	August	£ 1,000.00			16000				
12		9	2008	September	£ 2,000.00	_		18000				
13		10	2008	October	£ 1,000.00	Histo	gram				? 🔀	
14		11	2008	November	£ 5,000.00	Inpu	ut				ОК	
15		12	2008	December	£10,000.00	Inp	ut Rang	je:	\$E\$3:\$E\$75	<b></b>		
16		13	2009	January	£ 1,000.00	Bin	Range:		\$G\$3:\$G\$12	<b>1</b>	Cancel	
17		14	2009	February	£ 5,000.00		Labels				Help	
18		15	2009	March	£ 2,000.00		Labels					
19		16	2009	April	£ 3,000.00	Out	put opt	ions				
20		17	2009	May	£ 500.00	۲	Output	Range:	\$G\$14	<b>1</b>		
21		18	2009	June	£ 1,000.00	0	New W	orksheet <u>P</u> ly:				
22		19	2009	July	£ 2,000.00	0	New W	orkbook				
23		20	2009	August	£ 5,000.00		Pareto	(sorted histogram)				
24		21	2009	September	£ 6,000.00		_	tive Percentage				
25		22	2009	October	£ 3,000.00		Chart C	Output				
26		23	2009	November	£ 4,000.00							
27		24	2009	December	£ 3,000.00							
28		25	2010	January	£ 1,000.00							
29		26	2010	February	£ 2,000.00							
30		27	2010	March	£ 500.00							
31		28	2010	April	£ 1,000.00							
32		29	2010	May	£ 2,000.00							
33		30	2010	June	£ 3,000.00							
34		31	2010	July	£ 5,000.00							
35		32	2010	August	£ 3,000.00							
36		33	2010	September	£ 2,000.00							
37		34	2010	October	£ 5,000.00							
38		35	2010	November	£ 6,000.00							
39		36	2010	December	£ 3,000.00							
40		37	2011	January	£ 6,000.00							
41		38	2011	February	£10,000.00							
42		39	2011	March	£ 7,000.00							
												-

2	A	В	С	D	E	F	G	Н	1	1	К	L
3		Period Ye	ar	Months	Sales		Bind					
4		1		January	£ 3,000.00		2000					
5		2		February	£ 2,000.00		4000					
6		3	2008	March	£ 1,000.00		6000					
7		4	2008	April	£ 500.00		8000					
8		5	2008	May	£ 3,000.00		10000					
9		6	2008	June	£ 1,000.00		12000					
10		7	2008	July	£ 2,000.00		14000					
11		8	2008	August	£ 1,000.00		16000					
12		9	2008	September	£ 2,000.00		18000					
13		10	2008	October	£ 1,000.00							
14		11	2008	November	£ 5,000.00		Bind	Frequency	Cumulative %	Bind	Frequency	Cumulative %
15		12	2008	December	£ 10,000.00		2000	19	26.39%	2000	19	26.39%
16		13	2009	January	£ 1,000.00		4000	10	40.28%	10000	14	45.83%
17		14	2009	February	£ 5,000.00		6000	10	54.17%	4000	10	59.72%
18		15	2009	March	£ 2,000.00		8000	8	65.28%	6000	10	73.61%
19		16	2009	April	£ 3,000.00		10000	14	84.72%	12000	9	86.11%
20		17	2009	May	£ 500.00		12000	9	97.22%	8000	8	97.22%
21		18	2009	June	£ 1,000.00		14000	1	98.61%	14000	1	98.61%
22		19	2009	July	£ 2,000.00		16000	1	100.00%	16000	1	100.00%
23		20	2009	August	£ 5,000.00		18000	0	100.00%	18000	0	100.00%
24		21	2009	September	£ 6,000.00		More	0	100.00%	More	0	100.00%
25		22	2009	October	£ 3,000.00							
26		23	2009	November	£ 4,000.00							
27		24	2009	December	£ 3,000.00	-						1
28		25	2010	January	£ 1,000.00				Histogra	m		
29		26	2010	February	£ 2,000.00	20			-		120.00%	
30		27	2010	March	£ 500.00	20 18				Γ	120.00%	
31		28	2010	April	£ 1,000.00	16 -					100.00%	
32		29	2010	May	£ 2,000.00	14 -						
33		30	2010	June	£ 3,000.00					ľ	80.00%	
34		31	2010	July	£ 5,000.00	12 - 10 - 8 -				Ļ	60.00%	
35		32	2010	August	£ 3,000.00	8 -						Frequency
36		33		September	£ 2,000.00	6 -				F	40.00%	Cumulative %
37		34	2010	October	£ 5,000.00	4 -				L	20.00%	Controlative /o
38		35		November	£ 6,000.00	2 -						
39		36		December	£ 3,000.00	0 +			-		0.00%	
40		37		January	£ 6,000.00	20	00 1000 400	6000 2000	8000 14000 16000	18000 Nore		
41		38		February	£ 10,000.00	v	10- A.			10. 44		
42		39		March	£ 7,000.00			Bi	nd			
43		40		April	£ 5,000.00	-			3333			4.
44		41	2011		£ 4,000.00							
45		42	2011		£ 7,000.00							
46		43	2011	luly	£ 8,000,00							

#### The output.

### REGRESSION

### **Discussion**

The **Regression** tool can return statistical information from data in Excel. The tool can make a linear regression forecast returning the slope and Y-interceptor. It can also return the error or deviation and much more statistical informations.

Simple linear regression analysis can be easily completed using Excel.

You can find the **Regression** tool by selecting the Data Analysis command from the Analysis group at the far right end of the data ribbon. Select **Regression** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

After you have entered all necessary information into the **Regression** dialog box, you can get the result in the output range.

You can specify the following items in the Regression parameters dialog box:

Parameter	Description
Input Y Range	The range where you have the Y data you want to examine (values)
Input X Range	The range where you have the X data you want to examine (periods)
Labels	If labels are selected in the input range the box must be ticked
Constant is Zero	Tick the box if you want to work with a constant of zero.
Confidence Level	Enter a percentage from 0 to 100 per cent if you want to work with confidence level
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook
Residuals	Tick the box if you want the residuals (errors, deviation) as a part of the output
Standardized Residuals	Tick the box if you want the standardized residuals (standard errors, standard deviation) as a part of the output
Residuals Plots	Tick the box if you want the residuals (errors, deviation) visualised in a chart as a part of the output
Line Fit Plots	Tick the box if you want a chart showing the trends as a part of the output
Normal Probability	Tick the box if you want a chart showing the probability as a part of the output

	В	С	D		E	F	G	Н		J	K
1							_				
2	Period	Year	Months	Sales		forecast	Regre	ssion			? 🔀
3	1	2012	January	£	8,000.00	8064.85	Inpu	+			
4	2	2012	February	£	8,200.00	8105.6		ut <u>Y</u> Range:	\$E\$2:\$E\$23	<b>1</b>	OK
5	3	2012	March	£	8,150.00	8146.35	Tub	ut I Kange.	\$52:\$523	E	Cancel
6	4	2012	April	£	8,250.00	8187.11	Inp	ut <u>X</u> Range:	\$8\$2:\$8\$23	<b>1</b>	Concer
7	5	2012	May	£	8,300.00	8227.86					Help
8	6	2012	June	£	8,300.00	8268.61		Labels	Constant is Zer	0	Geib
9	7	2012	July	£	8,350.00	8309.37		Confidence Level:	95 %		
10	8	2012	August	£	8,300.00	8350.12					
11	9	2012	September	£	8,400.00	8390.87	Outp	out options			
12	10	2012	October	£	8,400.00	8431.63	0	Output Range:	\$H\$2	1	
13	11		November	£	8,410.00	8472.38		New Worksheet Ply:			
14	12	2012	December	£	8,500.00	8513.13	_				
15	13	2013	January	£	8,400.00	8553.89	_	New Workbook			
16	14		February	£	8,450.00	8594.64	Res	siduals			
17	15	2013	March	£	8,600.00	8635.39		Residuals	🔽 Resi <u>d</u> ua	al Plots	
18	16	2013	April	£	8,650.00	8676.15		Standardized Residual	s 🛛 🔽 Line Fit	Plots	
19	17	2013	May	£	8,800.00	8716.9		mal Probability			
20	18	2013	June	£	8,750.00	8757.65		Normal Probability	-		
21	19	2013	July	£	8,810.00	8798.41			5		
22	20	2013	August	£	8,900.00	8839.16	· · · · ·				
23	21	2013	September	£	9,000.00	8879.91					
24	22	2013	October								
25	23	2013	November								
26	24	2013	December								
27											

#### The output:

	A	В	С	D		E	F	G	Н		J	K	L	M	N	0	P
1	_	-			-												
2		Period	Year	Months	Sales		forecast		SUMMARY OUT	PUT							
3		1	2012	January	٤	8,000.00	8064.85										
4		2	2012	February	٤	8,200.00	8105.6			n Statistics							
5		3	2012	March	٤	8,150.00	8146.35		Multiple R	0.961541597							
6		4	2012	April	٤	8,250.00	8187.11		R Square	0.924562243							
7		5	2012	Mag	٤	8,300.00	8227.86		Adjusted R Squar	e 0.920591834							
8		6		June	٤	8,300.00	8268.61		Standard Error	74.10663344							
9		7	2012	July	٤	8.350.00	8309.37		Observations	21							
10		8		August	٤	8,300.00	8350.12										
11		9		September		8,400.00	8390.87		ANOVA								
12		10		October	٤	8,400.00	8431.63			ď	55	MS	F	Significance F			
13		11		November	ε	8,410.00	8472.38		Regression	1	1278836.883						
14		12		December	£	8,500.00	8513.13		Residual	19	104344.0693		232.003200	4.007202-12			
15		13		January	£	8,400.00	8553.89		Total	20	1383180.952						
							8594.64		TOCAL	20	1303100.332						
16		14		February	٤	8,450.00											
17		15		March	٤	8,600.00	8635.39				Standard Error	t Stat	P-value	Lower 95%		Lower 95.0%	
18		16		April	٤	8,650.00	8676.15		Intercept	8024.095238	33.53371467		1.6008E-34		8094.28211		
19		17		May	٤	8,800.00	8716.9		Period	40.75324675	2.670617692	15.259858	4.0673E-12	35.16357968	46.3429138	35.1635797	46.3429138
20		18		June	٤	8,750.00	8757.65										
21		19	2013		٤	8,810.00	8798.41										
22		20		August	٤	8,900.00	8839.16										
23		21	2013	September	٤	9,000.00	8879.91		RESIDUAL OUTP	UT				PROBABILITY OUTPI	UT		
24		22		October													
25		23	2013	November					Observation	Predicted Sales	Residuals	Standard Residuals		Percentile	Sales		
26		24		December						1 8064.848485	-64.84848485			2.380952381	8000		
27					-					2 8105.601732	94.3982684			7.142857143	8150		
28	- r									3 8146.354978	3.645021645			11.9047619	8200		
29	_			Norm	ial Pr	obability	Plot			4 8187,108225	62.89177489			16.666666667	8250		
30		9500								5 8227.861472	72.13852814			21.42857143	8300		
31			1							6 8268.614719	31.38528139			26.19047619	8300		
32	_	9000	1				'	• •		7 8309.367965	40.63203463			30.95238095	8300		
33	_	8500			. • •	*****				8 8350.121212	-50.12121212			35.71428571	8350		
34		<sup>0</sup> 8000	• • •							9 8390.874459	9.125541126			40.47619048	8400		
35		7500	+		-		-	-		0 8431.627706	-31.62770563			45.23809524	8400		
35			0	20	40	60	80	100		IU 8431.627706 11 8472.380952	-31.62770563			45.23803524	8400		
					Se	emple Percentile											
37										12 8513.134199	-13.13419913			54.76190476	8410		
38				Dent	- 1 0	Residual Pl	-			13 8553.887446	-153.8874459			59.52380952	8450		
39				rerie	oa n	esidual Pi	IOT			14 8594.640693	-144.6406926			64.28571429	8500		
40		200 -								15 8635.393939	-35.39393939			69.04761905	8600		
41										16 8676.147186	-26.14718615			73.80952381	8650		
42		100 - 100 - 100 -	+				+	+		8716.900433	83.0995671			78.57142857	8750		
43		-0 F	+	• •		•		-		8757.65368	-7.653679654			83.33333333	8800		
44		a .100	•	5	• 1	0 • 15		20		19 8798.406926	11.59307359			88.0952381	8810		
45										8839.160173	60.83982684			92.85714286	8900		
46		-200 -				Period				21 8879.91342	120.0865801	1.662553348		97.61904762	9000		
47						Penod											
48	12	-			_		_			3333					-		
49	- 11								Period	Line Fit Plo	+						
50									. enou								
51		£9,20	0.00														
52	- 11	£9.00	0.00 -										•				
53		£8.80										· · · ·					
54										1 A A							
55		18,60														8	
	- 8	A £8,40	0.00 -				A 10			· · ·				Pr	edicted Sales	1	
56		£8,20	0.00 -			1 1 1		*						Sai	es		
57		£8.00			-	-								•			
58				•													
		£7,80															
	-		0			5			10	1	5	20		25			
59 60			0			-											
60 61						-				Period							
60										Period							

### SAMPLING

### **Discussion**

The Sampling analysis tool creates a sample from a population by treating the input range as a population. When the population is too large to process or visualise in a chart, you can use a representative sample. You can also create a sample that contains only values from a particular part of a cycle if you believe that the input data is periodic.

You can find the **Sampling** tool by selecting the Data Analysis command from the Analysis group at the far right end of the data ribbon. Select **Sampling** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

After you have entered all necessary information into the **Sampling** dialog box, you can get the result in the output range.

You can specify the following items in the **Sampling** parameters dialog box:

Parameter	Description
Input Range	The array where you have the data you want to examine
Labels	If labels are selected in the input range the box must be ticked
Sampling Method	If there is a periodic trend in the data select this option. Enter a period number.
Period	
Sampling Method	If you want the tool to select randomly select this option. Enter a number of samples you need.
Random	
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook

	А	В	С	D	E	F	G	Н		J	K	L
2		Period	Year	Months	Sales							
3		1	1910	January	£ 8,000.00	Sampl	ing				?	<b>G</b>
4		2	1910	February	£ 8,200.00	Input	-					
5		3	1910	March	£ 8,150.00	Input	Range:		\$E\$2:\$E\$12	14 💽	ОК	
6		4	1910	April	£ 8,266.67	V La	abels				Cancel	
7		5	1910	May	£ 8,341.67		ling Method				Help	
8		6	1910	June	£ 8,416.67		-				Teb	
9		7	1910	July	£ 8,491.67		eriodic		12			
10		8	1910	August	£ 8,566.67	P	eriod:		12			
11		9	1910	September	£ 8,641.67	OB	andom					
12		10	1910	October	£ 8,716.67	N	umber of San	nples:	10			
13		11	1910	November	£ 8,791.67	Outo	ut options					
14		12	1910	December	£ 8,866.67		utput Range:		\$H\$2	<b>1</b>		
15		13	1911	January	£ 8,941.67							
16		14	1911	February	£ 9,016.67		ew Workshee					
17		15	1911	March	£ 9,091.67	ON	ew <u>W</u> orkbook					
18		16	1911	April	£ 9,166.67				1			
19		17	1911	May	£ 9,241.67							
20		18	1911	June	£ 9,316.67							
21		19	1911	July	£ 9,391.67							
22		20	1911	August	£ 9,466.67							
23		21	1911	September	£ 9,541.67							
24		22	1911	Octobor	6 9 616 67							

#### The output:

	А	В	С	D		E	F	G	H	1	J	K
1												-
2		Period	Year	Months	Sal	es			8866.667			
3		1	1910	January	£	8,000.00			9766.667			
4		2	1910	February	£	8,200.00			10666.67			
5		3	1910	March	£	8,150.00			11566.67			
6		4	1910	April	£	8,266.67			12466.67			
7		5	1910	May	£	8,341.67			13366.67			
8		6	1910	June	£	8,416.67			14266.67			
9		7	1910	July	£	8,491.67			15166.67			
10		8	1910	August	£	8,566.67			16066.67			
11		9	1910	September	£	8,641.67			16966.67			
12		10	1910	October	£	8,716.67			17866.67			
13		11	1910	November	£	8,791.67			18766.67			
14		12	1910	December	£	8,866.67			19666.67			
15		13	1911	January	£	8,941.67			20566.67			
16		14	1911	February	£	9,016.67			21466.67			
17		15	1911	March	£	9,091.67			22366.67			
18		16	1911	April	£	9,166.67			23266.67			
19		17	1911	May	£	9,241.67			24166.67			
20		18	1911	June	£	9,316.67			25066.67			
21		19	1911	July	£	9,391.67			25966.67			
22		20	1911	August	£	9,466.67			26866.67			
23		21	1911	September	£	9,541.67			27766.67			
24		22	1911	October	£	9,616.67			28666.67			
25		23	1911	November	£	9,691.67			29566.67			
26		24	1911	December	£	9,766.67			30466.67			
27		25	1912	January	£	9,841.67			31366.67			
28		26	1912	February	£	9,916.67			32266.67			
29		27	1912	March	£	9,991.67			33166.67			
20		20	1012	April	C	10.055.67			24055 57			

# **RANK & PERCENTILE**

### **Discussion**

The **Rank and Percentile** tool ranks data. For each rank the tool return a percentage for data below the specific ranking.

Finding and displaying the percentile of specific results can be valuable to your audience. Sometimes stand alone numbers do not tell the story, but, if I know that 80% of the other results are lower than me, that tells a more complete story.

The percentile is defined as the value of a variable below which a certain percent of observations fall. For example, if you score in the 80th percentile on a test, 80% of the other test takers did worse than you.

You can find the **Rank and Percentile** tool by selecting the Data Analysis command from the Analysis group at the far right end of the data ribbon. Select **Rank and Percentile** from the list and click OK.

If there is no Analysis group or **Data Analysis** command on the Ribbon, you must install **Data Analysis TOOLPAK** (please go to **Appendix A** in this workbook to see how to install **Data Analysis TOOLPAK**).

After you have entered all necessary information into the **Rank and Percentile** dialog box, you can get the result in the output range.

You can specify the following items in the **Rank and Percentile** parameters dialog box:

Parameter	Description
Input Range	The array where you have the data you want to examine
Grouped By	Do you have the data grouped by columns or rows
Labels	If labels are selected in the input range the box must be ticked
Output Range	Enter a cell reference for the output or New Worksheet Ply to get the output in a new worksheet in the workbook with the input data or New Workbook to get the output in a new workbook

	Α	В	С	D	E		F	G	Н	- I
1	Sales reps	Sales	Rar	nk and Percer	ntile				? 🔀	1
2	Michael	£ 285,120.00	In	put						
3	John	£ 341,250.00		put Range:		\$8\$1	:\$8\$11	<b></b>	OK	
4	Maria	£ 545,230.00		rouped By:		O Co			Cancel	
5	Anna	£ 258,250.00	6	rouped by:		© Ro				
6	Linda	£ 368,750.00		Labels in firs	trow	0 20			Help	
7	George	£ 255,250.00								
8	Lucas	£ 368,214.00	0	utput options						
9	Maggie	£ 475,230.00	۲	Output Rang	je:	\$D\$1				
10	Annette	£ 285,450.00	0	New Worksh	eet <u>P</u> ly:					
11	Gary	£ 368,750.00	0	New Workbo	ook					
12										

The output:

1	А	В	С	D		E	F	G
1	Sales reps	Sales		Point		Sales	Rank	Percent
2	Michael	£ 285,120.00		3	£	545,230.00	1	100.00%
3	John	£ 341,250.00		8	£	475,230.00	2	88.80%
4	Maria	£ 545,230.00		5	£	368,750.00	3	66.60%
5	Anna	£ 258,250.00		10	£	368,750.00	3	66.60%
6	Linda	£ 368,750.00		7	£	368,214.00	5	55.50%
7	George	£ 255,250.00		2	£	341,250.00	6	44.40%
8	Lucas	£ 368,214.00		9	£	285,450.00	7	33.30%
9	Maggie	£ 475,230.00		1	£	285,120.00	8	22.20%
10	Annette	£ 285,450.00		4	£	258,250.00	9	11.10%
11	Gary	£ 368,750.00		6	£	255,250.00	10	0.00%
12								

# APPENDIX A – INSTALLING DATA ANALYSIS TOOLPAK TO EXCEL

### **INSTALLING DATA ANALYSIS TOOLPAK**

### **Discussion**

The Data Analysis Toolpak is not part of the standard Excel application as normally installed, it is an Add-In (often referred to as a "plug-in."). Add-Ins are additional Excel components that are not commonly used and as a result, have to be installed on your computer. There are many third party (non-Microsoft) Add-Ins that help Excel do useful and clever things that it cannot normally do, or that enhance some of the things that it can do.

These can be found and downloaded from the Internet although it is wise to consult with your IT department first in case they have objections on grounds of security and computer software safety. It is unlikely that in the working environment you will be able to install these programs yourself anyway.

There are, however, selections of Add-Ins that come with Excel and that are perfectly safe and suitable for use; one of these is **ANALYSIS TOOLPAK**. This Add-in will add 19 analysis tools to Excel. After installation you will be able to find the **ANALYSIS TOOLPAK** tools in the data ribbon.

### **Procedure**

- 1. Click the Office Button (Excel 2007) or the File tab (Excel 2010).
- 2. Click Excel Options.

General	View and manage Microsoft	Office 444 inc	
tormular.	See New and manage Mecrosoft	UTICE ADD-INL	
OF MULLION			
hoeting	Addres		
lave	Name -	Location	Type
analasi i	Active Application Add-Ins		
	Analysis ToolPak	C1_Stal Office341.brany Analysis ANALYS32.8LL	Excel Add-in
dianced	Solver Add-in	C1_Scriptics4LbraySOLVERSOLVERSLAM	Excel Add-in
automice Ribbon	tractive optication Add-ins		
welloof many Adver	AAU DOPAK - VEA	C1_30F5cH4/GBrBh/AKMyGr/ATPVEADUXLAM	Excel Add in
AND ALLEN TOODAT		Insoft Office/OfficeS4/OFFFHD.011 consoft shared Smart Tag MORLD11	Document Inspects
idd-bro	Click Ad	d-Inc constant and a second	Excel Add.in
	Click Au	U-1115 encodi shared Smart Tag MOPLOLI	Action
wast Centrer		resoft Office/Dffeed4-DFFEHD.DLL	Document Inspects
	Hido ows and Columns	C1_Act/Merosoft Office/Office(4)/077EHD.DLL	Document Inspects
	Hidden (erkaheeta	C1Res/Microsoft Office/Office041:DPTRHD.DLL	Document Inspects
	Invisible Content Microsoft Actions Pane 3	C18er/Microsoft Office/Dffice64/DffFPHD.DLL	Document Inspects IIM, Expansion Pad
	MICENEL ACCOUNTS AND A		Int. Liperson Pao
	Document Related Add-ins		
	No Document Related Add-Inc		
	Disabled Application Add-ins		
	No Doubled Application Add-Ins		
	Add-inc Analysis TealPak		
	Publishes Microsoft Corporatio		
	Compatibility No compatibility info		
	Compatibility No compatibility info	remation available crosoft Office/Office/Alibrary/Analysis/ANALIS32.X11	
	Compatibility No compatibility inf Location: C:Program FileEMG	eroselt Office/OfficeE4Gibrary/Analysis/ANAL/S32.311	
	Compatibility No compatibility inf Location: C:Program FileEMG		
	Compatibility No compatibility inf Location: C:Program FileEMG	eroselt Office/OfficeE4Gibrary/Analysis/ANAL/S32.311	
	Compatibility No compatibility inf Location: C:Program FileEMG	eroselt Office/OfficeE4Gibrary/Analysis/ANAL/S32.311	20

- 3. Click Add-Ins at the left.
- 4. Select Excel Add-ins from the Manage: list at the bottom of the dialog box.
- 5. Click Go....
- 6. Click in box next to ANALYSIS TOOLPAK Add-in.

Click in the box	Add-Ins Add-Ins available: Analysis ToolPak Analysis ToolPak - VBA Euro Currency Tools Solver Add-in	Cancel Browse Automation	Click OK
	Analysis ToolPak Provides data analysis tool engineering ar	s for statistical and nalysis	

7. Click OK.

# **APPENDIX B – TEXT FUNCTIONS**

In this appendix, you will learn how to:

- Use the **Right**, **Left**, and **Mid** functions
- Use the Concatenate function
- Use the Len function
- Use the **Find** function
- Use nested text functions

## **CONCEPT AND TERMS**

### **Discussion**

Text functions are very useful if you need to clean up text strings, concatenate text, or split a text string to many cells. Specially if you import data from a database for analysing in Excel it is a advantage to know the text functions in Excel.

# USE THE RIGHT, LEFT, AND MID FUNCTIONS

### **Discussion**

If you want to extract characters from a text string you can use the **Left**, **Right**, and **Mid** function. The **Left** function can extract characters from the left of the text string, the **Right** function can extract characters from the right of a text string, and the **Mid** function can extract characters from the midle of a text string.

The first five characters of the text string "A37A221regionnorth" are the imployment number for a staff member, the next two characters are department number and the last five characters are region information. To extract the employment number you need the **Left** function.

The **Left** function consists of one required argument and one optional, in the following order: **Text**, **Num\_chars**. **Text** is the box in which the cell reference for the cell with the text string must be entered. In the **Num\_chars** box enter the number of characters you want to extract from left.

			0	D		5	0	
	Α	В	С	D	E	F	G	
1								
2		Import data	Employment number	Department number	Region			
3		A37A221north	=LEFT(B3,5)					
4		C25C541south						
5		H45B785westh						
6		D45C654north						
7	1							
8		Function Arguments				? 🛃		
9		LEFT						
10		Text	B3	= "A37A221nor	th"			
11		Num_chars	5	= 5				
12				= "A37A2"				
13		Returns the specified num	ber of characters from the sta					
14			Num_chars specifies how		EET to ovtra	ct. 1 if omitte		
15			num_cnars specifies now	many characters you want	LLI I WEXUA	ct, in omitted		
16								
17								
18		Formula result = A37A2						
19		Help on this function			OK	Cancel		
20							_	
21								

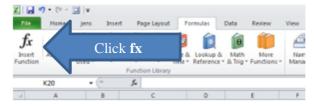
The **Mid** function consists of three required arguments, in the following order: **Text**, **Start\_num**, and **Num\_chars**. **Text** is the box in which the cell reference for the cell with the text string must be entered. In the **Start\_num** box enter the start number of the first character you want to extract from the middle of the text string. **Num\_chars** is the number of characters you want to extract.

	А	В	С	D	E	F	G	
1								
2		Import data	Employment number	Department number	Region			
3		A37A221north	A37A2	=MID(B3,6,2)				
4		C25C541south			•			
5		H45B785westh						
6		D45C654north						
7								
8	3 Function Arguments							
9	N	1ID						
10		Tex	t B3	📧 = "A37A22	21north"			
11		Start_nur	m 6	<b>E</b> = 6				
12		Num_char	<b>s</b> 2	= 2				
13				= "21"				
14	Re	turns the characters from th	ne middle of a text string, giv		nath.			
15				from which you want to ext	-			
16			lext is the text string	g from which you want to exi	ract the char	acters.		
17								
18								
19	Fo	rmula result = 21						
20	He	elp on this function			ОК	Can	cel	
21								
22								

The **Right** function consists of one required argument and one optional, in the following order: **Text**, **Num\_chars. Text** is the box in which the cell reference for the cell with the text string must be entered. In the **Num\_chars** box enter the number of characters you want to extract from right.

	А	В		С	D	E	F	
1								
2		Import data		Employment number	Department number	Region		
3		A37A221north		A37A2	21	=RIGHT(B3	,5)	
4		C25C541south						
5		H45B785westh						
6		D45C654north						
7	(-							
8	Fu	nction Arguments				E	? 💌	
9	R	IGHT						
10		Text	B3		📧 = "A37A221north"			
11		Num_chars	5	[	<b>S</b> = 5			
12					= "north"			
13	Re	turns the specified r	umber	of characters from the end o				
14				lum chars specifies how m		avtract 1 if a	mitted	
15				un_chars specifies now in	any characters you want to	exuact, 1110	mitteu.	
16								
17								
18	Fo	rmula result = nort	h					
19	He	lp on this function			OK	Ca	ancel	
20								
21								
22								

- 1. To use a **Left** function, select a cell where you want the function to extract characters from the left of a text string.
- 2. Click on the **Formulas** tab.
- 3. In the Function Library group, click on the Insert Function button.



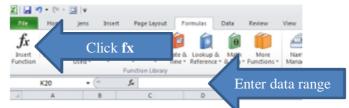
- 4. In the Insert function dialog box, locate **Text** category in the **Or select a category:** box.
- 5. Click on Left.
- 6. Click on the **OK** button.

Type a brief descript Go	ion of what you want	to do and then dick	<u>G</u> o		
Or select a <u>c</u> ategory:	Text		Select t	ext	
lect a function:					
EXACT FIND FIXED LEFT		Select	t Left		
LEN LOWER MID				-	
LEFT(text,num_ch Returns the specified	ars) number of characters	from the start of a	text string.		

- 7. In the Function Arguments dialog box, click in the Text box.
- 8. Click the cell containing the text string from which you want to extract the characters.
- 9. In the **Num\_chars** box, type the number of characters you want to extract.
- 10. Click on the OK button.

### **Procedures**

- 1. To use a **Mid** function, select a cell where you want the function to extract characters from the middle of a text string.
- 2. Click on the Formulas tab.
- 3. In the **Function Library** group, click on the **Insert Function** button.



4. In the Insert function dialog box, locate **Text** category in the **Or select a** category: box.

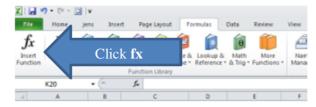
Click OK

- 5. Click on **Mid**.
- 6. Click on the **OK** button.

Type a brief descripti Go	on of what you want t	to do and then click	Go	
Or select a category:	Text	Select te	ext	
elect a function:				
FIXED LEFT LEN LOWER MID PROPER		Select Mid		
REPLACE MID(text,start_nu Returns the character		text string, given a startin	g position	
and length.				
lelp on this function		ОК	Click	OV

- 7. In the **Function Arguments** dialog box, click in the **Text** box.
- 8. Click the cell containing the text string from which you want to extract the characters.
- 9. In the **Start\_num** box, type the number of the first character you want to extract from the middle of you text string.
- 10. In the **Num\_chars** box, type the number of characters you want to extract.
- 11. Click on the OK button.

- 1. To use a **Right** function, select a cell where you want the function to extract characters from the right of a text string.
- 2. Click on the Formulas tab.
- 3. In the Function Library group, click on the Insert Function button.



- 4. In the Insert function dialog box, locate **Text** category in the **Or select a category:** box.
- 5. Click on **Right**.
- 6. Click on the **OK** button.

nsert Function		? 🛛	
earch for a function:			
Type a brief description of what y Go	you want to do and then the	k <u>G</u> o	
Or select a category: Text		Select text	
elect a functio <u>n</u> :			
PROPER	_		
REPLACE			
RIGHT	Select <b>Ri</b>	ght 📃 🚽	
SEARCH			
T		-	
RIGHT(text,num_chars) Returns the specified number of d	haracters from the end of a	text string.	
lelp on this function	ОК		ck OK

- 7. In the Function Arguments dialog box, click in the Text box.
- 8. Click the cell containing the text string from which you want to extract the characters.
- 9. In the **Num\_chars** box, type the number of characters you want to extract.
- 10. Click on the OK button.

# **USE THE CONCATENATE FUNCTION**

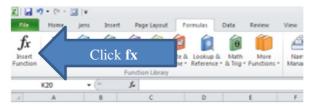
### **Discussion**

The **Concatenate** function joins up to 255 text strings into one text string. The joined items can be text, numbers, cell references, or a combination of those items. For example, if your worksheet contains a person's first name in cell A1 and the person's previous name in cell B1, you can combine the two values in another cell by using the following formula:

=concatenate(A1," ",B1)

The **Concatenate** function consists of one required argument and as many optional arguments you need up to 254, in the following order: **Text1**, **Text2**, **Text3**, **Text4** ....to **Text255. Text1** is the box in which the cell reference for the first cell with the text string must be entered. In the **Text2** box enter the cell reference of the cell containing the second text string you want to join. In the **Text3** box enter the cell reference of the cell containing the third text string you want to join etc... If you want to have a space between the text strings you can enter " " ("space") in every second argument.

- 1. To use a **Concatenate** function, select a cell where you want the function to join text strings.
- 2. Click on the Formulas tab.
- 3. In the Function Library group, click on the Insert Function button.



- 4. In the Insert function dialog box, locate **Text** category in the **Or select a category:** box.
- 5. Click on Concatenate.
- 6. Click on the **OK** button.

Insert Function	8 3
Search for a function:	
Type a brief description of what you want to do and then click Go	Go
Or select a category: Text Select to	ext
Select a function:	
CLEAN	
CODE	
CONCATENATE Select Concat	enate
DOLLAR	chute
EXACT	
FIND FIXED	-
CONCATENATE(text1,text2,) Joins several text strings into one text string.	
Help on this function OK	Click OV
	Click OK

- 7. In the **Function Arguments** dialog box, click in the **Text1** box.
- 8. Click the cell containing the first text string you want to join.
- 9. In the **Text2** box type " " to get a space between the first and second text string.
- 10. In the **Text2** box click the cell containing the second text string you want to join.
- 11. Click on the OK button.

10	Concatenate function		
11			
12	First Name	Last Name	First and Last name
13	James	Brown	ATE(B13," ",C13)
14	Andy	Night	
15	Susan	Berry	
16	Adam	Whitehouse	
17	Function Arguments		
18			
19	CONCATENATE		
20	Text1	B13	= "James"
21	Text2	••	<b>I</b> = **
22	Text3	C13	📧 = "Brown"
23	Text4		🐹 = text
24			(200)
25			
26			= "James Brown"
27	Joins several text strings i		
28			. are 1 to 255 text strings to be joined into a single text string kt strings, numbers, or single-cell references.
29		and can be tex	ct surings, numbers, or single-cell references.
30			
31	Formula result = James B	Brown	
32	Help on this function		OK Cancel
33	neip on this function		OK Caricei
34			
25			

# **USE THE** LEN FUNCTION

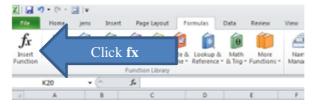
### **Discussion**

The **Len** function returns the number of characters in a text string. A space will also be counted as a character.

The **Len** function consists of one required argument: **Text1**. In **Text1** enter the cell reference for the cell with the text string and the function will return how many characters there is in text string.

### **Procedures**

- 1. To use a **Len** function, select a cell where you want the function to display the result.
- 2. Click on the **Formulas** tab.
- 3. In the Function Library group, click on the Insert Function button.



- 4. In the Insert function dialog box, locate **Text** category in the **Or select a category:** box.
- 5. Click on Len.
- 6. Click on the **OK** button.

Insert Function	8 23	
Search for a function:		
Type a brief description of what you want to do and ther Go	n dick <u>G</u> o	
Or select a category: Text	Select text	
Select a function:		
FIXED		1
LEFT LEN Sele	ect Len	
MID PROPER REPLACE	-	
LEN(text) Returns the number of characters in a text string.		
Help on this function	K Cli	ck OK

7. In the **Function Arguments** dialog box, click in the **Text** box.

- 8. Click the cell containing the text string you want to examine.
- 9. Click on the OK button.

19	Len functi	on			
20					
21		Import data	The length		
22		A37A221north	=LEN(B22)		
23		C25C541south			
24		H45B785westh			
25		D45C654north			
26	Function /	Arguments			? 🔀
27					
28	LEN				
29		Text B22	<b></b>	= "A37A221north"	
30				= 12	
31	Returns th	e number of characters in a	text string.		
32		Те	ext is the text whose length	you want to find. Spaces co	unt as characters.
33					
34	Formula re	sult = 12			
35	Help on thi	s function		ОК	Cancel
36	ricip off di	<u>o runcuori</u>		UN	
37					
20					

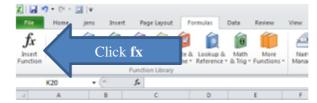
# **USE THE FIND FUNCTION**

### Discussion

The **Find** function can find a character or a text string within a text string and return the position of the character or text string. The **Find** function is very often used together with other text function such as the **Mid** function.

The **Find** function consists of two required arguments and one optional argument, in following order: **Find\_text**, **Within\_text**, **Start\_num**. In **Find\_text** you must enter the text string or character you want the function to find (the argument is case sensitive). In **Within\_text** enter the cell reference for the cell with the text string where you want to find the character or text string. In **Start\_num** you can enter the character number you want the function to start the search from. If you in a text string want to find the character "A" and there is two characters "A" then the function will return the position number for the first "A".

- 1. To use a **Find** function, select a cell where you want the function to display the result.
- 2. Click on the Formulas tab.
- 3. In the **Function Library** group, click on the **Insert Function** button.



- 4. In the Insert function dialog box, locate **Text** category in the **Or select a** category: box.
- 5. Click on **Find**.
- 6. Click on the **OK** button.

Insert Function	8 23	
Search for a function:		
Type a brief description of what you want to do a Go	d then click <u>G</u> o	
Or select a category: Text	Select text	
Select a function:		
CONCATENATE DOLLAR	<u>^</u>	
EXACT FIND	Select Find	
FIXED		
LEN	-	
FIND(find_text,within_text,start_num) Returns the starting position of one text string with case-sensitive.	hin another text string. FIND is	
Help on this function	ок Click OK	

- 7. In the **Function Arguments** dialog box, click in the **Find\_text** box.
- 8. Type the character or text string you want the function to find.
- 9. Enter the cell reference for the cell you want to examine in the **Within\_text** box.
- 10. In the **Start\_num** box enter a number you want the function to start the search from.
- 11. Click on the OK button.

Find function		Function Arguments			
Import data A37A22 Inerth C25A541south A45A785westh C45A654north	Find #FIND(*A2*,831,2)	Find_text Within_text Start_run Raturns the starting position	531 2 Find, text string within	another text string	
		Formula result = 4 thelp on this function			OK Canod

# **USE NESTED TEXT FUNCTIONS**

### **Discussion**

You can nest the text functions to get more dynamic options to extract text strings. May be you have imported text strings from a database and you want to extract different part of the text string to different cells in Excel but you do not know how many characters you want in each cell. You can use a combination of the **Right**, **Left**, **Mid**, **Len**, and **Find** functions to solve the problem. There is many solutions in Excel to deal with this but you will see some examples here.

#### Example 1

You have imported a number of text strings "A4337A221north", "C2A541south", "A445A785westh", and "C5A654north". You know that the first part of the text string is the employment number but you do not know how many characters. You know that the second part of the text string is department number and the department number is 2 characters. The last 5 characters of the text string is the region.

	Α	В	С	D	E	
39						
40	Nested te	xt functions		Employment number	? characters	
41				Department number	2 characters	
42				Region	5 characters	
43						
44						
45		Import data	Employment number	Department number	Region	
46		A4337A221north				
47		C2A541south				
48		A445A785westh				
49		C5A654north				
50						

You need the employment number in column C, department number in column D, and region in column E. The employment number is a mix of letters and digits but always there is the letter "A" and one digit at the end of the employment number. With this knowledge you can extract the employment number from the text string by using the **Left** and **Find** function.

Select the cell where you want the characters extracted. Start with the **Left** function. In the **Text** box enter the cell reference for the cell with the text string.

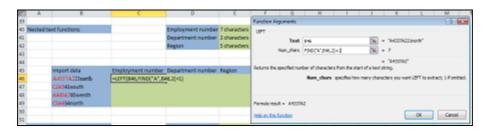
4	A		C	D	6	F	G	н	1	1		ĸ	L	M	
35						Function A	rguments .							-	
40	Nested to	at functions		Employment number	? characters	LIPT									
41				Department number	2 characters		Test	and		100	- 34		-		
42				Region	5 characters			141							
43							Nan_chas			1		nder -			
44											- X				
45		import data	Employment number	Department number	Region	Refume the	specfed nur	ther of charact	ters from the	start of a b	of sting.				
46		A4333A22Inorth	=LEFT(946)					140	d in the last	etting card	any the	than the	s you want	to extract	
47		CIA54Isouth		·											
48		A445A785eventh													_
49		CSA854north				Permission	A = Su								
50												_	OK	Cerv	
51						tisk on the	1.41.51(2)						UM.	Care	

Click in the **Num\_char** box and nest the **Find** function. The **Find** function must find the letter "A" the second last character in the employment number. In the

**Find\_text** box enter the character you want to find. In the **Within\_text** box enter the cell reference for the cell with the text string. In the **Start\_num** box enter the start number for the search. You don't want to find "A" if it is the first character in the text string as it is in this example that is why 2 is entered in the box. You want to start the search from character 2.



This will find the character number for "A" in the text string but the digit after "A" is also a part of the employment number. What you need to do is to click after the **Find** function in the **Left** function dialog box and type "+1". Click **OK** button and you have extracted the employment number.



To extract the department number you need the **Mid** function. In the **Text** box enter the cell reference for the cell with the text string. In **Start\_num** you need to nest the **Find** function. Again the **Find** function must find the character "A". This time you need to type "+2" after the **Find** function in the **Mid** function dialog box because the department number starts 2 characters from "A". In **Number\_char** box type 2 and click **OK**.

14	A	8	c	0	6	1 0	H I	1	K L	M N
29						Pariation Arguments				- 0 <b>- 10 - 10</b>
40	Nexted to	ext functions		Employment number	Pcharacters	MD				
41				Department number	2 characters	Test	22	14	- "MIDMIDIATION"	
42				Region	5 characters		F20(X'346.0-		- 1	
43										
44						Ben_chers	2	EN.		
45		Import data	Employment number	Department number	Region				* "25"	
46		A4997A22toeth	A4337A2	("A",848.2)+2.2)		Netures the characters from the	middle of a lead site	off' facility is a parallel be	Agreet here mailing	
47		CASAIsouth	CDAS				Test is the less	d string from which you	a want to exit all the d	haraders.
48		A46A785westh	A445A7							
49		CSA854north	CSA6							
50						Formula result = 21				
51									C CK	Canad
52						telo an this function				Lana
53										

To extract the region you do not need any nested function just use the **Right** function.

	A	8	c	D	t		0	н	1	J	K	1	M
39						Function.	Log,ments						- P - BOD
40	Nested te	at functions		Employment number	7 characters	132-17							
41				Department number	2 characters					1000	- 'A401182		
42				Region	5 characters		Test			A.400.4		same.	
43						1 1	Nat_das	1			- 5		
44											· 'tertt'		
45		Import data	Employment number	Department number	Region	Return #	te specified:	uniter of chara	these from the en	id of a te	d atting.		
46		A4037A221neth	A4337A2	21	-RIGHT[845,5			Barn, che	rs specifies ho	e maro d	waters you	want is exite	et, 14 anited.
47		C2A541south	C2A5	41		1							
-42		A4CA7IOwerth	A465A7	15									
40		CASHnorth	CSAS	54		Familare	nuit - fun						
50													
51						(top.m.th	is function					CK.	Canol
52													_
52													

#### Example 2

You have imported a number of text strings "A4337A221northwest", "C2A545east","A445A785southwesth", and "C5A654north". You know that the first part of the text string is the employment number but you do not know how many characters. You know that the second part of the text string is department number and the department number is 2 characters. The last part of the text string is the region but you do not know how many characters.

	А	В	С	D	E	F
63						
64	Nested te	ext functions		Employment number	? characters	
65				Department number	2 characters	
66				Region	? characters	
67						
68						
69		Import data	Employment number	Department number	Region	
70		A4337A221 northwest	A4337A2	21	northwest	
71		C2A545 east	C2A5	45	east	
72		A445A735 southwesth	A445A7	85	southwesth	
73		C5A654north	C5A6	54	north	
74						
75						

You need the employment number in column C, department number in column D, and region in column E. The employment number is a mix of letters and digits but always there is the letter "A" and one digit at the end of the employment number. With this knowledge you can extract the employment number from the text string by using the **Left** and **Find** function.

Select the cell where you want the characters extracted. Start with the **Left** function. In the **Text** box enter the cell reference for the cell with the text string.

Click in the **Num\_char** box and nest the **Find** function. The **Find** function must find the letter "A" the second last character in the employment number. In the **Find\_text** box enter the character you want to find. In the **Within\_text** box enter the cell reference for the cell with the text string. In the **Start\_num** box enter the start number for the search. You don't want to find "A" if it is the first character in the text string as it is in this example that is why 2 is entered in the box.

0	A	8	c	D	E		0		н	1	3	K	L	M
39						function	Arguments							9 83
40 B	iested te	at functions		Employment number	7 characters	FIND								
41				Department number	2 characters		Find_test	100				- 30		
42				Region	5 characters						Contra I			
43							Within_text	5-6				<ul> <li>"A4117A31</li> </ul>	SHOTH'	
44							Start, nun 2							
45		Import data	Employment number	Department number	Region	Fastures	the starting posit	tion of a	me text atri	ng within and	her heat a	ting. FPID is i	an orally.	
46		A4337A221sorth	LEFT(846,FIND("A",8	46.20				No		peales the d	ander at	which to star	The search, T	e fint
67		C14541south								haracter in Vi	Da Jeda	s derader n	riber 1. If out	ted, Start_run
48		A445A7E5weath												
45		C34654north				Formula	wait - A4333	A .						
50													_	
51						teda an J	tes function						X	Carcal

This will find the character number for "A" in the text string but the digit after "A" is also a part of the employment number. What you need to do is to click after the **Find** function in the **Left** function dialog box and type "+1". Click **OK** button and you have extracted the employment number.

4	A	8	¢	D	E .	F	G	н	1	1	ĸ	L	M
63						Function L	ep,ments						-9-80
64	Nested to	ent functions		Employment number	? characters	LEFT							
65				Department number	2 characters	-	Test	120		201	- 14033	Allingthe	~
66				Region	7 characters								n
67							Non, chan	FIND("X",870,3	Q+1		= 7		
65											- '44223	43°	
-		Emport data	Employment number	Department number	Region	Relats the	specified nur	iter af character	rs Fran the sta	wi of a test	t shing.		
20		A4337A2 sorthwest	ND("A",870,2[+1]	ba	northwest			Run_chers	specifies here	meny che	uny embar	nant UCPT to	exhect; 1if enites
71		CIAS east	CANS	45	east								
72		AMSAT southwesth	A445A7	65	ritered to c								
75		C346 month	CSA6	54	north	Formula rea	ut - A4223	6.A					
74												- ox	- danad
75						tek m fra	Madan					OK.	Canol
76													1
-													

To extract the department number you need the **Mid** function. In the **Text** box enter the cell reference for the cell with the text string. In **Start\_num** you need to nest the **Find** function. The **Find** function must find the character "A". This time you need to type "+2" after the **Find** function in the **Mid** function dialog box because the department number starts 2 characters from "A". In **Number\_char** box type 2 and click **OK**.

To extract the region without knowing the number of characters you can not use the **Right** function. you must use a combination of the **Mid**, **Find** and **Len** functions. Start with the **Mid** function. You need to nest the **Find** function in **Start\_num** again to find the character "A". This time you need to type "+4" after the **Find** function in the **Mid** function dialog box to find the position of the first character in the region information. Nest the **Len** function in **Num\_char** this will reurn the number of characters for the whole text string. Click **OK** and the **Mid** function will return the region information.

0	A		¢.	0		Function Legaments				12.000
63 64 65 66 67	Nested te	at functions		Engloyment rumber Department rumber Region		ND Test	1000(9383030+4	1	- "#403042251##tweet" - 10 - 18	
編 65 72 72 72		Import deta A4337A2 aprilevest C2A0 east A665A7 southwesth	Employment number A4223x2 C2A3 A445A7	Department number 25 45 45	Flegton LiN(#70[] exst southweath	Patans the characters from the s			<ul> <li>'surfacest'</li> <li>outon and length.</li> <li>alter you ward to excitual. To</li> </ul>	e first diaracter in
73 74 75 76		C46 in orth	CSA4	м	north	Formula result + rorthwart Hele on this function			OK.	Canol

# INDEX

#### A

Absolute Error · 48, 55 Analysis Toolpak · 142

#### В

Break-even · 121, 122, 129 Visualise break-even · 124, 125

#### С

 $\begin{array}{l} \mbox{Column charts} \cdot \mbox{79} \\ \mbox{Concatenate function} \cdot \mbox{144, 150, 151} \\ \mbox{Correl function} \cdot \mbox{98, 110, 111, 112, 113, 116, 117, 120} \\ \mbox{Correlation} \cdot \mbox{110, 113, 114, 116, 117, 120} \\ \mbox{Correlation Coefficient} \cdot \mbox{110, 116, 120} \end{array}$ 

#### D

Data Analysis Tool Exponential Smoothing · 7, 28 Data analysis tools Descriptive statistics · 131 Exponential smooth · 7, 28 Histogram · 130, 133, 134 Regression · 136 Sampling · 130, 138, 139

#### Ε

Excel Add-ins  $\cdot$  67, 142, 143 Exponential smoothing  $\cdot$  7, 26

#### F

Find function  $\cdot$  144, 154, 155, 156, 157, 158, 159 Forecast accuracy Absolute error/deviation  $\cdot$  48, 55 Error/deviation  $\cdot$  61 MAD (Mean Absolute Deviation)  $\cdot$  46, 55, 59, 62, 68, 70, 72, 73, 75, 76, 77, 88, 94 MAPE (Mean Absolute Percentage Error)  $\cdot$  46, 58, 62 MPE (Mean Percentage Error)  $\cdot$  46, 57, 62 MSQ (Mean Square error)  $\cdot$  46, 56, 62 Percentage error/deviation  $\cdot$  46, 50, 51 R-Square  $\cdot$  87, 92, 93, 117 Standard error  $\cdot$  53 TSE (Tracking Signal Error)  $\cdot$  46, 59, 62 Forecast function  $\cdot$  7, 9, 10, 13, 21, 25, 38, 39, 41, 42, 45, 94, 95, 98, 107, 108, 109 Forecasting tools Exponential smoothing  $\cdot$  7, 26 Forecast function  $\cdot$  7, 9, 10, 13, 21, 25, 38, 39, 41, 42, 45, 94, 95, 98, 107, 108, 109 Growth function  $\cdot$  7, 22, 24, 25, 42 Intercept function  $\cdot$  19, 41 Moving average  $\cdot$  86 Naïve forecasting  $\cdot$  30, 44 Seasonal forecasting  $\cdot$  45, 72 Slope function  $\cdot$  18, 41 Trend function  $\cdot$  7, 9, 14, 16, 17, 21, 41

#### G

goal seek · 108, 121, 128 Growth function · 7, 22, 24, 25, 42

#### Η

Histogram · 130, 133, 134

#### I

Intercept function · 19, 41

#### L

Left function · 145, 147, 156, 158 Len function · 144, 152, 159 Line charts · 79, 80, 87 linear trendline · 83, 84, 92, 93 logarithmic trendline · 82, 85

#### М

 $\begin{array}{l} \mathsf{MAD} \cdot \ 46, \ 55, \ 59, \ 62, \ 68, \ 70, \ 72, \ 73, \ 75, \ 76, \ 77, \ 88, \\ \mathsf{94} \\ \\ \mathsf{MAPE} \cdot \ 46, \ 58, \ 62 \\ \\ \mathsf{Mid} \ \mathsf{function} \cdot \ 144, \ 145, \ 146, \ 148, \ 154, \ 157, \ 158, \\ \ 159 \\ \\ \mathsf{Moving} \ average \cdot \ 86 \\ \\ \mathsf{MPE} \cdot \ 46, \ 57, \ 62 \\ \\ \mathsf{MSQ} \cdot \ 46, \ 56, \ 62 \end{array}$ 

#### Ν

Naïve forecasting · 30, 44

#### Р

Pie charts  $\cdot$  79 polynomial trendline  $\cdot$  85

#### R

Regression · 9 Right function · 145, 146, 149, 157, 159

#### S

$$\begin{split} & \text{Sampling} \cdot 130, 138, 139 \\ & \text{Scenarios} \cdot 97, 98, 99, 102, 107, 128 \\ & \text{Creating a scenario summary report} \cdot 102 \\ & \text{Creating scenarios} \cdot 100 \\ & \text{Deleting a scenario} \cdot 101 \\ & \text{Edit values in a scenario} \cdot 102 \\ & \text{Showing a scenario} \cdot 101 \\ & \text{Seasonal forecasting} \cdot 45, 72 \\ & \text{Slope function} \cdot 18, 41 \\ & \text{Solver} \cdot 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, \\ & 76, 77, 88, 94, 121, 128 \\ & \text{SQRT function} \cdot 53, 54, 55 \\ & \text{Standard error} \cdot 53 \\ & \text{Sumxmy2 function} \cdot 53 \end{split}$$

#### T

Table tool  $\cdot$  97, 104, 105, 109 Text functions Concatenate function  $\cdot$  144, 150, 151 Find function  $\cdot$  144, 154, 155, 156, 157, 158, 159 Left function  $\cdot$  145, 147, 156, 158 Len function  $\cdot$  144, 152, 159 Mid function  $\cdot$  144, 145, 146, 148, 154, 157, 158, 159 Right function  $\cdot$  145, 146, 149, 157, 159 Tracking Signal  $\cdot$  46, 59 Trend function  $\cdot$  7, 9, 14, 16, 17, 21, 41 Trendline  $\cdot$  9, 82, 83, 84, 92, 93, 117, 118 TSE  $\cdot$  46, 59, 62

#### V

Visualise forecasts Column charts · 79 Line charts · 79, 80, 87 Linear trendline · 83, 84, 92, 93 Logarithmic trendline · 82, 85 Pie charts · 79 Polynomial trendline · 85 Trend lines · 9, 82, 83, 84, 92, 93, 117, 118

#### W

What-if analysis Goal seek tool · 97, 103, 108, 122, 129 Scenarios tool · 97, 98, 99, 102, 107, 128 Table tool · 97, 104, 105, 109