LECTURE NOTES

ON

FINANCIAL MODELING

MBA IV semester (IARE-R16)

Ms. P.BINDU MADHAVI
Assistant Professor

DEPARTMENT OF MASTER OF BUSINESS ADMINISTRATION
INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
DUNDIGAL, HYDERABAD - 500 043

FINANCIAL MODELLING SYLLABUS

UNIT-I	UNDERSTANDING THE BASIC FEATURES OF EXCEL
Introduction to modeling, introduction to excel, understanding advanced features of excel database functions in excel, creating charts using forms and control toolbox, understanding finance functions present in excel, creating dynamic models.	
UNIT-II	**SENSITIVITY ANALYSIS USING EXCEL**
Scenario manager, other sensitivity analysis features, simulation using excel different statistical distributions used in simulation generating random numbers that follow a particular distribution, building models in finance using simulation.	
UNIT-III	**EXCEL IN ACCOUNTING**
Preparing common size statements directly from trial balance, forecasting financial statements using excel, analyzing financial statements by using spreadsheet model, excel in project appraisal, determining project viability. Risk analysis in project appraisal, simulation in project appraisal, excel in valuation, determination of value drivers, discontinued cash flow valuation, risk analysis in valuation.	
UNIT-IV	**EXCEL IN PORTFOLIO THEORY**
Determining efficient portfolio, creating dynamic portfolios, portfolio insurance, fixed income portfolio management using excel, excel in derivatives black and schools model in excel, Greeks in excel, real options valuation, building a mega model.	
UNIT-V	**UNDERSTANDING SUBROUTINES AND FUNCTIONS AND BUILDING SIMPLE FINANCIAL MODELS USING SUBROUTINES AND FUNCTION**
Recording and editing macros, subroutines and functions, decision rules, message box and input box, debugging, designing advanced financial models using visual basic application user forms, other advanced features, actual model building.	

UNIT-1

UNDERSTANDING THE BASIC FEATURES OF EXCEL

Introduction to modeling, introduction to excel, understanding advanced features of excel database functions in excel, creating charts using forms and control toolbox, understanding finance functions present in excel, creating dynamic models.

INTRODUCTION TO MODELING:

Financial modeling is the construction of spreadsheet models that illustrate a company's likely financial results in quantitative terms. Financial models can simulate the effect of specific variables so that the company can plan a course of action should they occur.

Financial modelling is the process by which a firm constructs a financial representation of some, or all, aspects of the firm or given security. The model is usually characterized by performing calculations and makes recommendations based on that information. The model may also summarize particular events for the end user such as investment management returns or the Sortino ratio, or it may help estimate market direction, such as the Fed model. A financial model is a mathematical representation of the financial operations and financial statements of a company. It is used to forecast future financial performance of the company by making relevant assumptions of how the company would fair in the coming financial years.

It is also a risk management tool for analyzing various financial and economic scenarios and also provided valuations of assets. These models involve calculations, analyzing them and then provide recommendations based on the information gathered. A financial model generally includes projecting the financial statements such as the income statement, balance sheet and cash flow statement with the help of building schedules such as the depreciation schedule, amortization schedule, working capital management, debt schedule etc. It encompasses the company's policies and restrictions imposed by lenders that would impact the financial position.

DEFINITION:

"The process by which a firm constructs a financial representation of some, or all, aspects of the firm or given security. The model is usually characterized by performing calculations, and makes recommendations based on that information. The model may also summarize particular events for the end user and provide direction regarding possible actions or alternatives."

TYPES OF FINANCIAL MODEL:

There are various kinds of financial models that are used according to the purpose and need of doing it. Different financial models solve different problems. While majority of the financial models concentrate on valuation, some are created to calculate and predict risk, performance of portfolio, or economic trends within an industry or a region. The following are the different types of financial models:

DISCOUNTED CASH FLOW MODEL:

Among different types of Financial model, DCF Model is the most important. It is based upon the theory that the value of a business is the sum of its expected future free cash flows, discounted at an appropriate rate. In simple words this is a valuation method uses projected free cash flow and discounts them to arrive at a present value which helps in evaluating the potential of an investment. Investors particularly use this method in order to estimate the absolute value of a company.

COMPARATIVE COMPANY ANALYSIS MODEL:

Also referred to as the “Comparable” or “Comps”, it is the one of the major company valuation analyses that is used in the investment banking industry. In this method we undertake a peer group analysis under which we compare the financial metrics of a company against similar firms in industry. It is based on an assumption that similar companies would have similar valuations multiples, such as EV/EBITDA. The process would involve selecting the peer group of companies, compiling statistics on the company under review, calculation of valuation multiples and then comparing them with the peer group.

SUM-OF-THE-PARTS MODEL:

It is also referred to as the break-up analysis. This modeling involves valuation of a company by determining the value of its divisions if they were broken down and spun off or they were acquired by another company.

LEVERAGED BUY OUT (LBO) MODEL:

It involves acquiring another company using a significant amount of borrowed funds to meet the acquisition cost. This kind of model is being used majorly in leveraged finance at bulge-bracket investment banks and sponsors like the Private Equity firms who want to acquire companies with an objective of selling them in the future at a profit. Hence it helps in determining if the sponsor can afford to shell out the huge chunk of money and still get back an adequate return on its investment.

MERGER & ACQUISITION (M&A) MODEL:

Merger & Acquisitions type of financial Model includes the accretion and dilution analysis. The entire objective of merger modeling is to show clients the impact of an acquisition to the acquirer’s EPS and how the new EPS compares with the status quo. In simple words we could say that in the scenario of the new EPS being higher, the transaction will be called “accretive” while the opposite would be called “dilutive.”

OPTION PRICING MODEL:

On, to buy or sell the underlying instrument at a specified price on or before a specified future date”. Option traders tend to utilize different option price models to set a current theoretical value. Option Price Models use certain fixed knowns in the present (factors such as underlying price, strike and days till expiration) and also forecasts (or assumptions) for factors like implied volatility, to compute the theoretical value for a specific option at a certain point in time. Variables will fluctuate over the life of the option, and the option position’s theoretical value will adapt to reflect these changes.

INTRODUCTION TO EXCEL:

Excel is a spreadsheet program that is used to record and analyze numerical data. Think of a spreadsheet as a collection of columns and rows that form a table. Alphabetical letters are usually assigned to columns and numbers are usually assigned to rows. The point where a column and a row meet is called a cell. The address of a cell is given by the letter representing the column and the number representing a row. Let's illustrate this using the following image.

We all deal with numbers in one way or the other. We all have daily expenses which we pay for from the monthly income that we earn. For one to spend wisely, they will need to know their income vs. expenditure. Microsoft Excel comes in handy when we want to record, analyze and store such numeric data.

Running Excel is not different from running any other Windows program. If you are running Windows with a GUI like (Windows XP, Vista, and 7) follow the following steps.

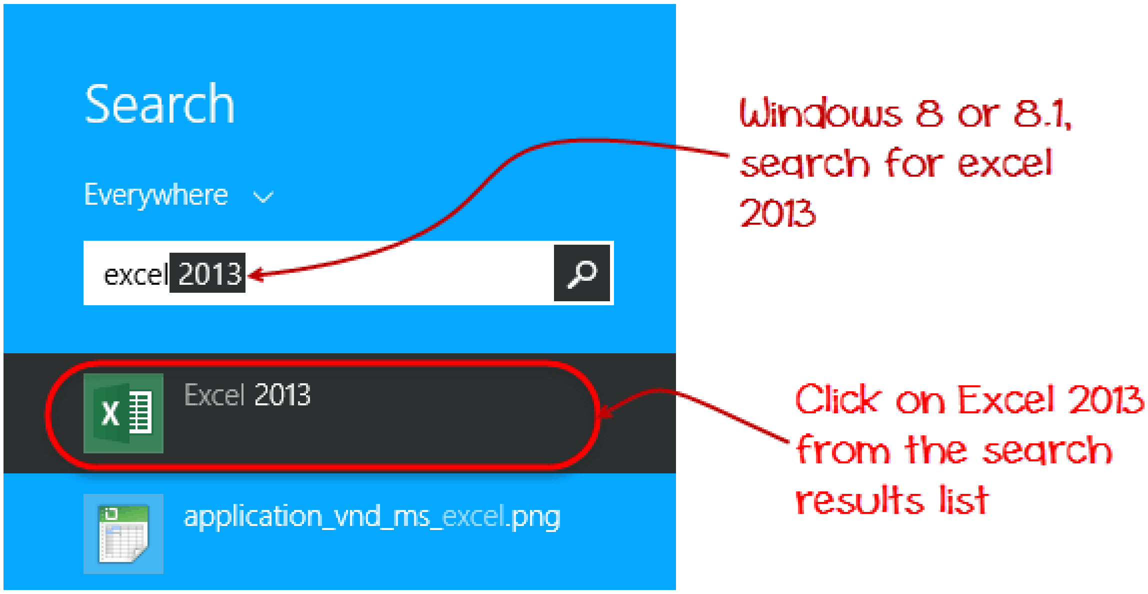
- Click on start menu
- Point to all programs
- Point to Microsoft Excel
- Click on Microsoft Excel

Alternatively, you can also open it from the start menu if it has been added there. You can also open it from the desktop shortcut if you have created one.

For this tutorial, we will be working with Windows 8.1 and Microsoft Excel 2013. Follow the following steps to run Excel on Windows versions

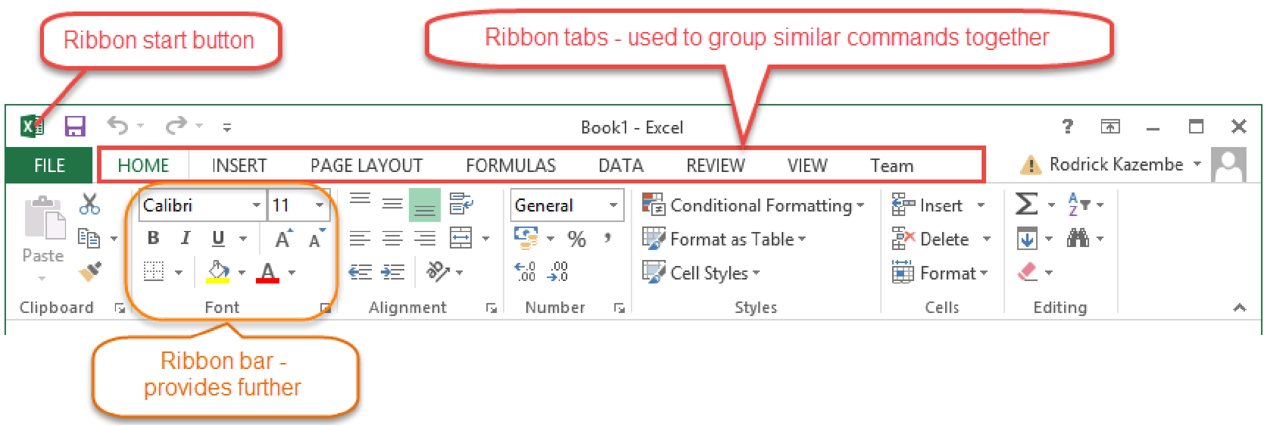
- Click on start menu
- Search for Excel N.B. even before you even typing, all programs starting with what you have typed will be listed.
- Click on Microsoft Excel

The following image shows you how to do this:



UNDERSTANDING THE RIBBON:

The ribbon provides shortcuts to commands in Excel. A command is an action that the user performs. An example of a command is creating a new document, printing a documenting, etc. The image below shows the ribbon used in Excel .



RIBBON COMPONENTS EXPLAINED:

Ribbon start button - it is used to access commands i.e. creating new documents, saving existing work, printing, accessing the options for customizing Excel, etc.

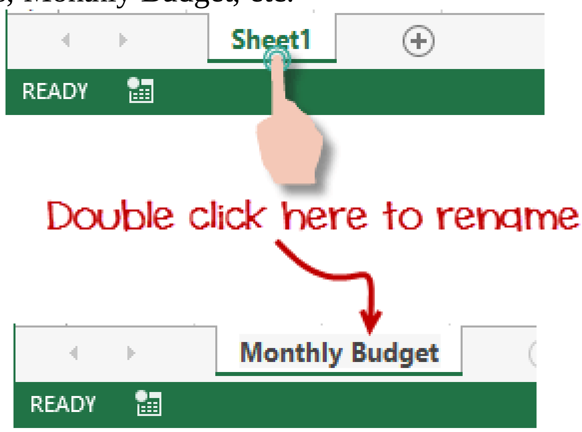
Ribbon tabs – the tabs are used to group similar commands together. The home tab is used for basic commands such as formatting the data to make it more presentable, sorting and finding specific data within the spreadsheet.

Ribbon bar – the bars are used to group similar commands together. As an example, the Alignment ribbon bar is used to group all the commands that are used to align data together.

UNDERSTANDING THE WORKSHEET (ROWS AND COLUMNS, SHEETS, WORKBOOKS):

A worksheet is a collection of rows and columns. When a row and a column meet, they form a cell. Cells are used to record data. Each cell is uniquely identified using a cell address. Columns are usually labelled with letters while rows are usually numbers.

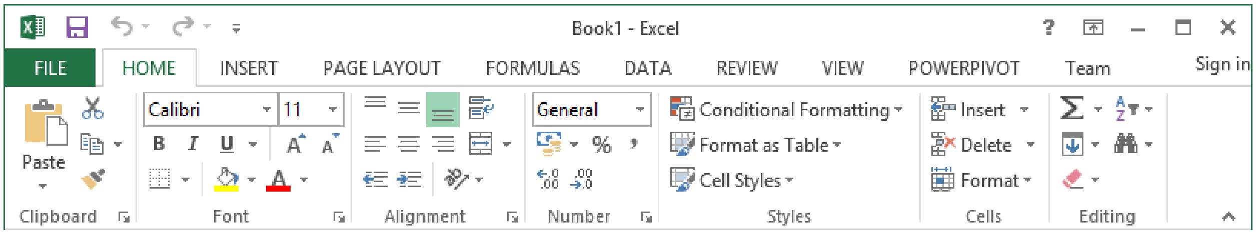
A workbook is a collection of worksheets. By default, a workbook has three cells in Excel. You can delete or add more sheets to suit your requirements. By default, the sheets are named Sheet1, Sheet2 and so on and so forth. You can rename the sheet names to more meaningful names i.e. Daily Expenses, Monthly Budget, etc.



CUSTOMIZATION MICROSOFT EXCEL ENVIRONMENT:

Personally I like the black colour, so my excel theme looks blackish. Your favourite colour could be blue, and you too can make your theme coulor look blue-like. If you are not a programmer, you may not want to include ribbon tabs i.e., developer. All this is made possible via customizations. In this sub-section, we are going to look at

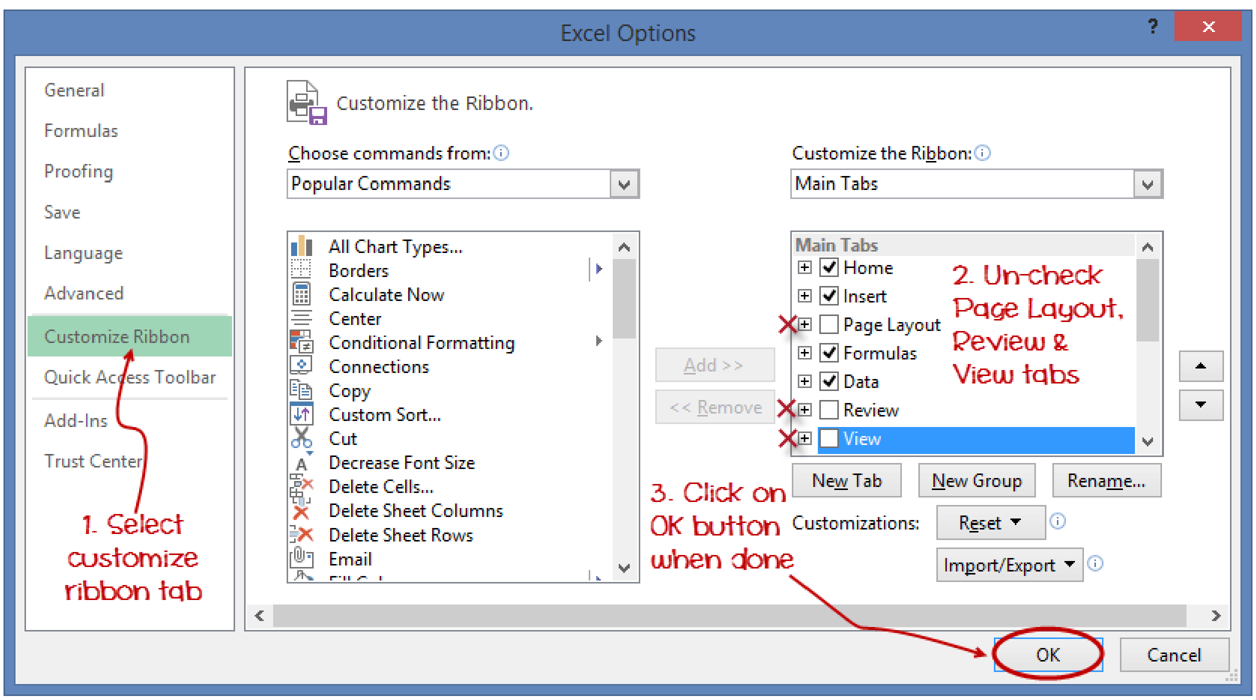
- Customization the ribbon
- Setting the color theme
- Proofing settings
- Save settings



CUSTOMIZATION OF RIBBON:

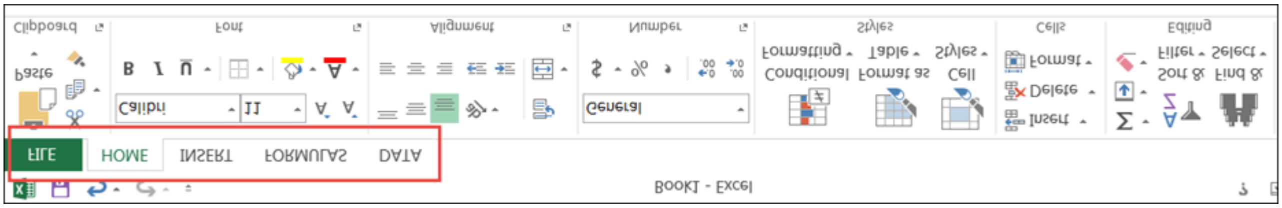
The above image shows the default ribbon in Excel 2013. Let's start with customization the ribbon, suppose you do not wish to see some of the tabs on the ribbon, or you would like to add some tabs that are missing such as the developer tab. You can use the options window to achieve this

- Click on the ribbon start button
- Select options from the drop down menu. You should be able to see an Excel Options dialog window.
- Select the customize ribbon option from the left-hand side panel as shown below.



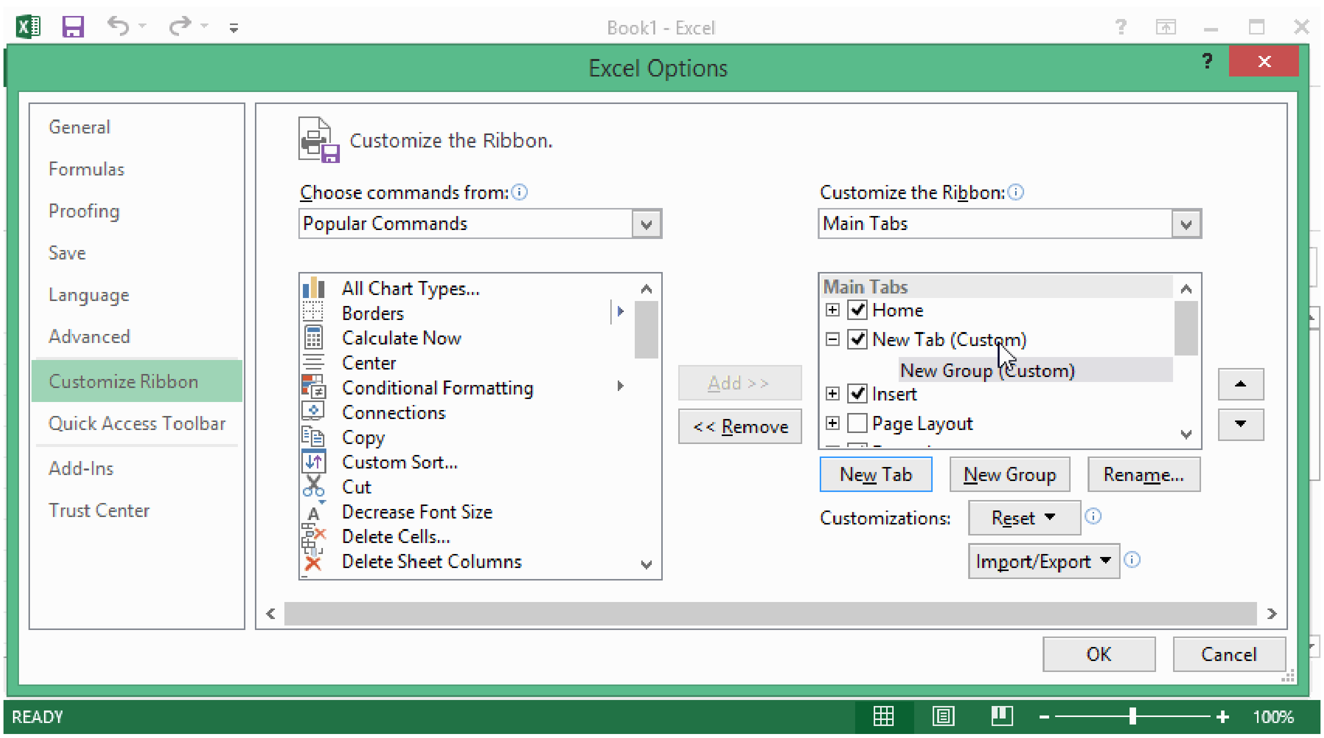
- On your right-hand side, remove the check marks from the tabs that you do not wish to see on the ribbon, For this example, we have removed Page Layout, Review, and View tab.
- Click on the "OK" button when you are done

Your ribbon will look as follows



ADDING CUSTOM TABS TO THE RIBBON

You can also add your own tab, give it a custom name and assign commands to it. Let's add a tab to the ribbon with the text Guru99



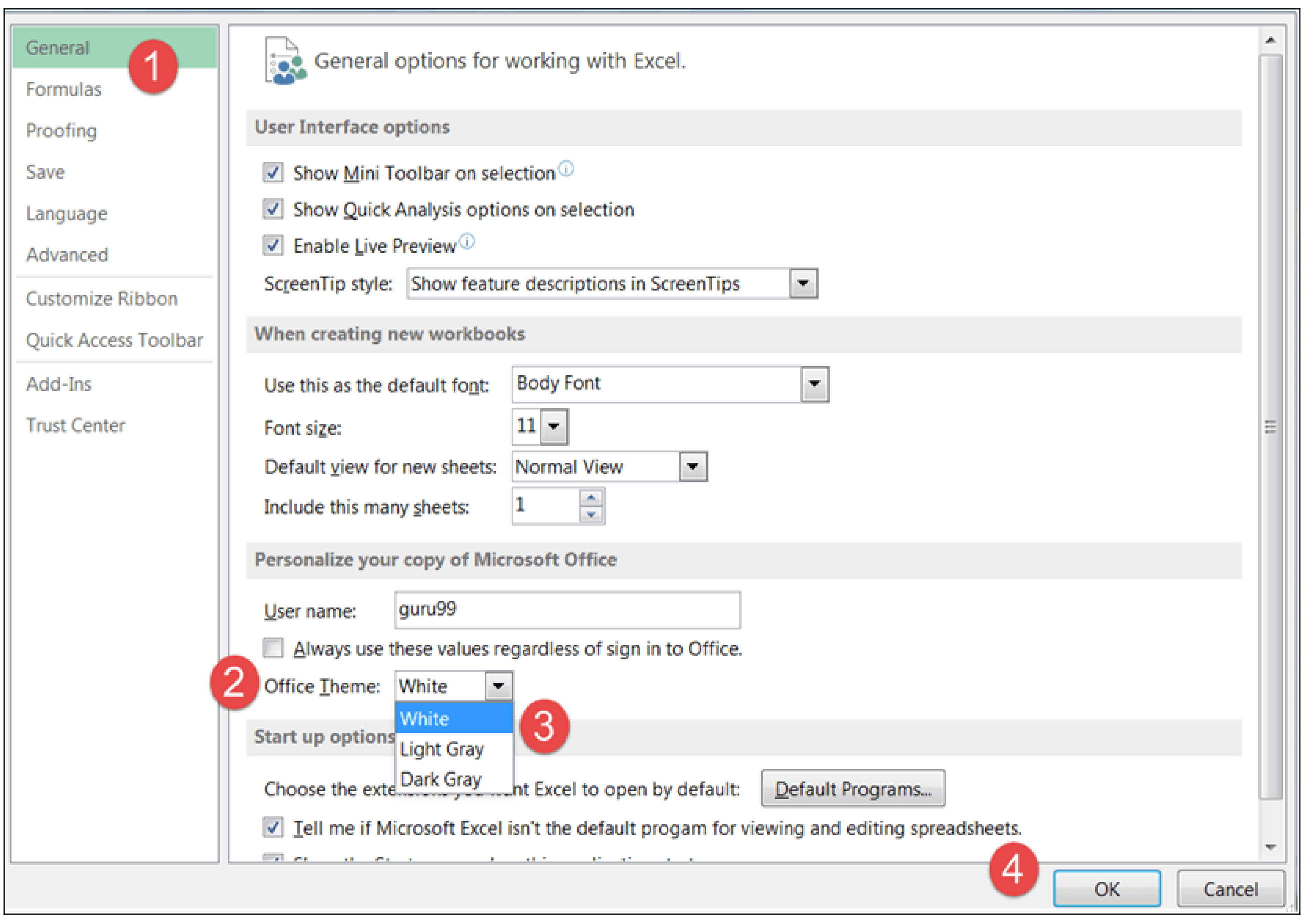
1. Right click on the ribbon and select Customize the Ribbon. The dialogue window show above will appear.
2. Click on new tab button as illustrated in the animated image below
3. Select the newly created tab
4. Click on Rename button
5. Give it a name of Guru99
6. Select the New Group (Custom) under Guru99 tab as shown in the image below
7. Click on Rename button and give it a name of My Commands
8. Let's now add commands to my ribbon bar
9. Select all chart types command and click on Add button

10. Click on OK

Your ribbon will look as follows:

SETTING THE COLOUR THEME:

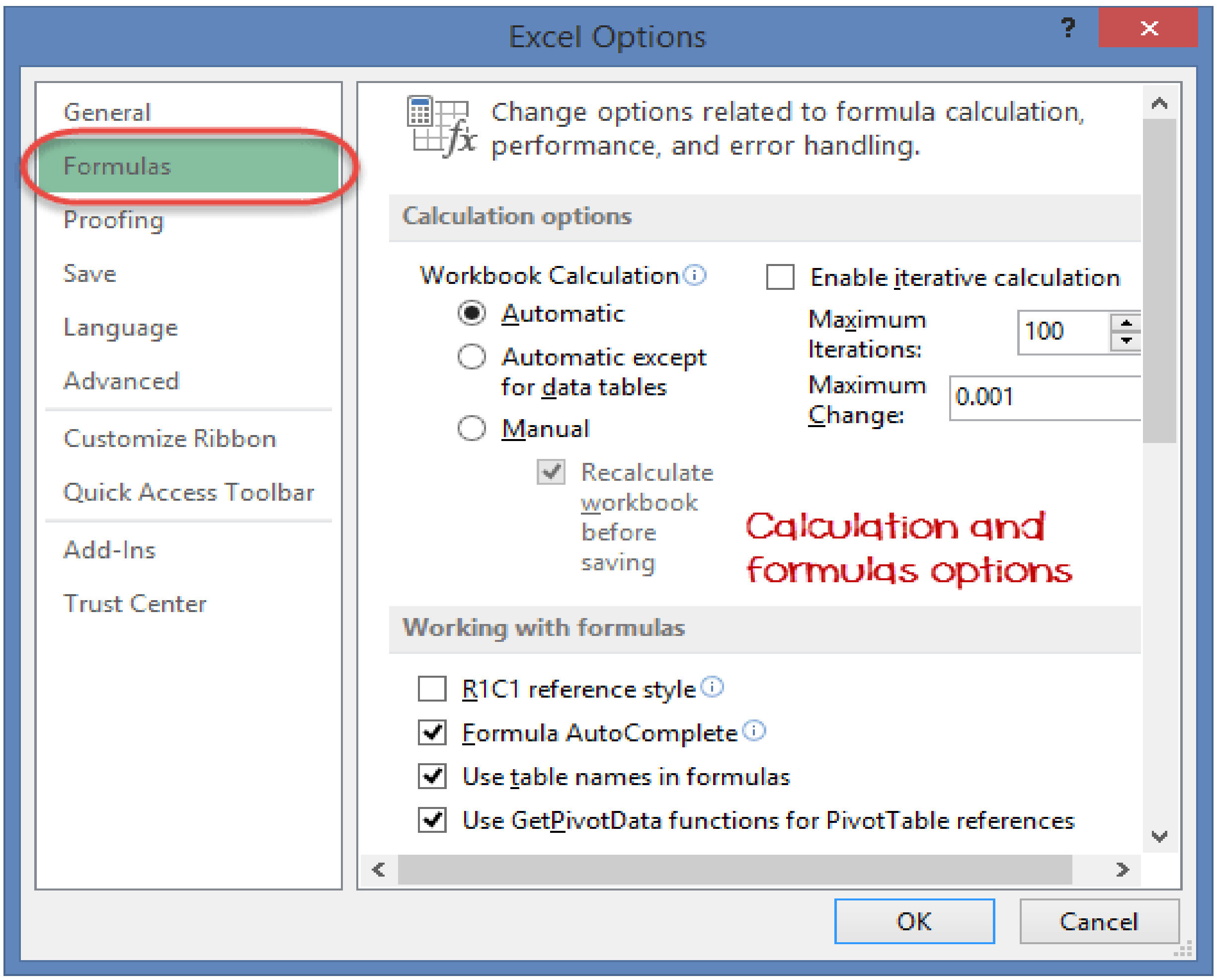
To set the color-theme for your Excel sheet you have to go to excel ribbon, and click on a File Option command. I will Open a window where you have to follow the following steps.



1. The general tab on the left-hand panel will be selected by default
2. Look for colour scheme under General Options for working with Excel
3. Click on the colour scheme drop-down list and select the desired colour
4. Click on OK button

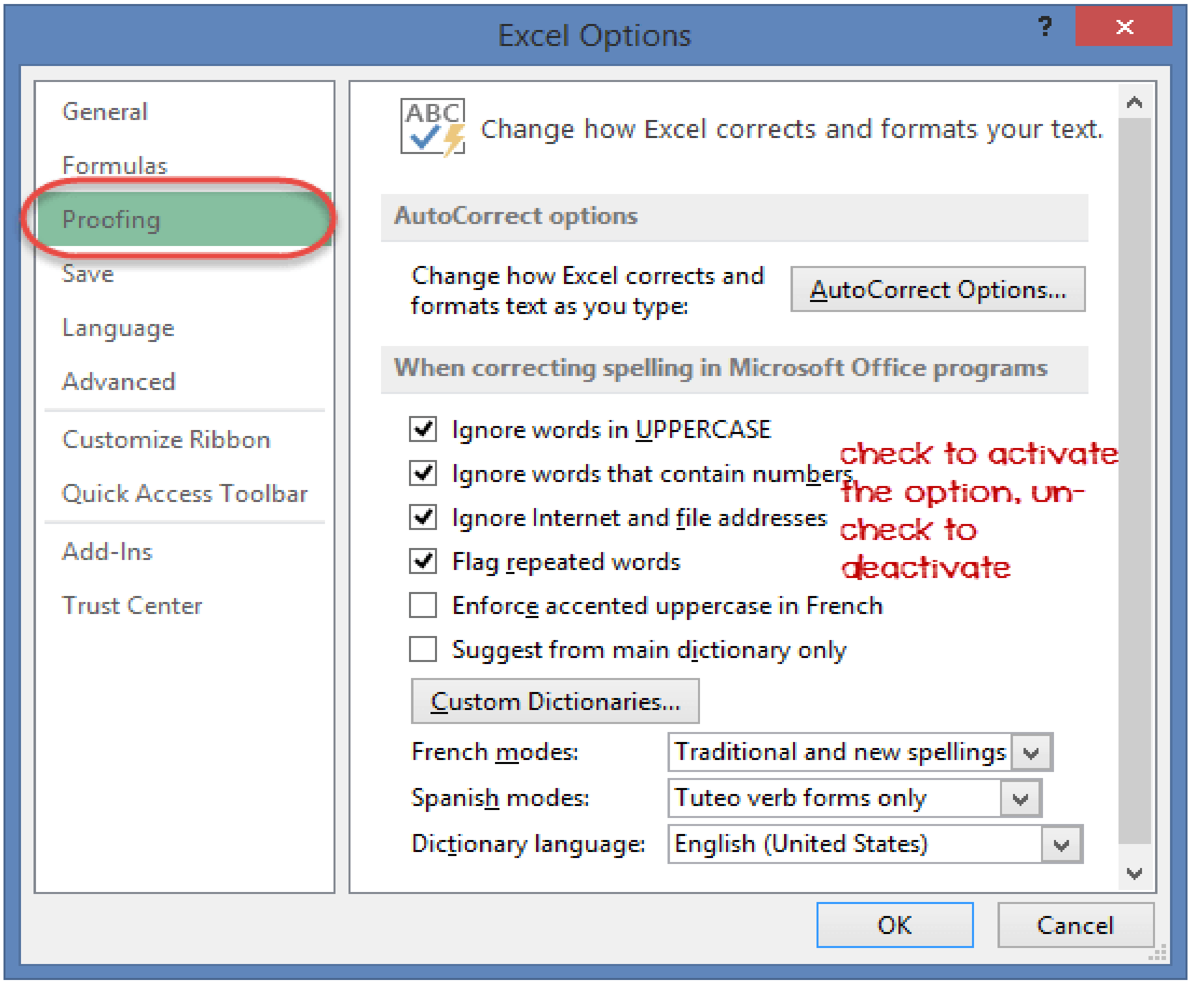
SETTING FOR FORMULAS

This option allows you to define how Excel behaves when you are working with formulas. You can use it to set options i.e. auto complete when entering formulas, change the cell referencing style and use numbers for both columns and rows and other options.



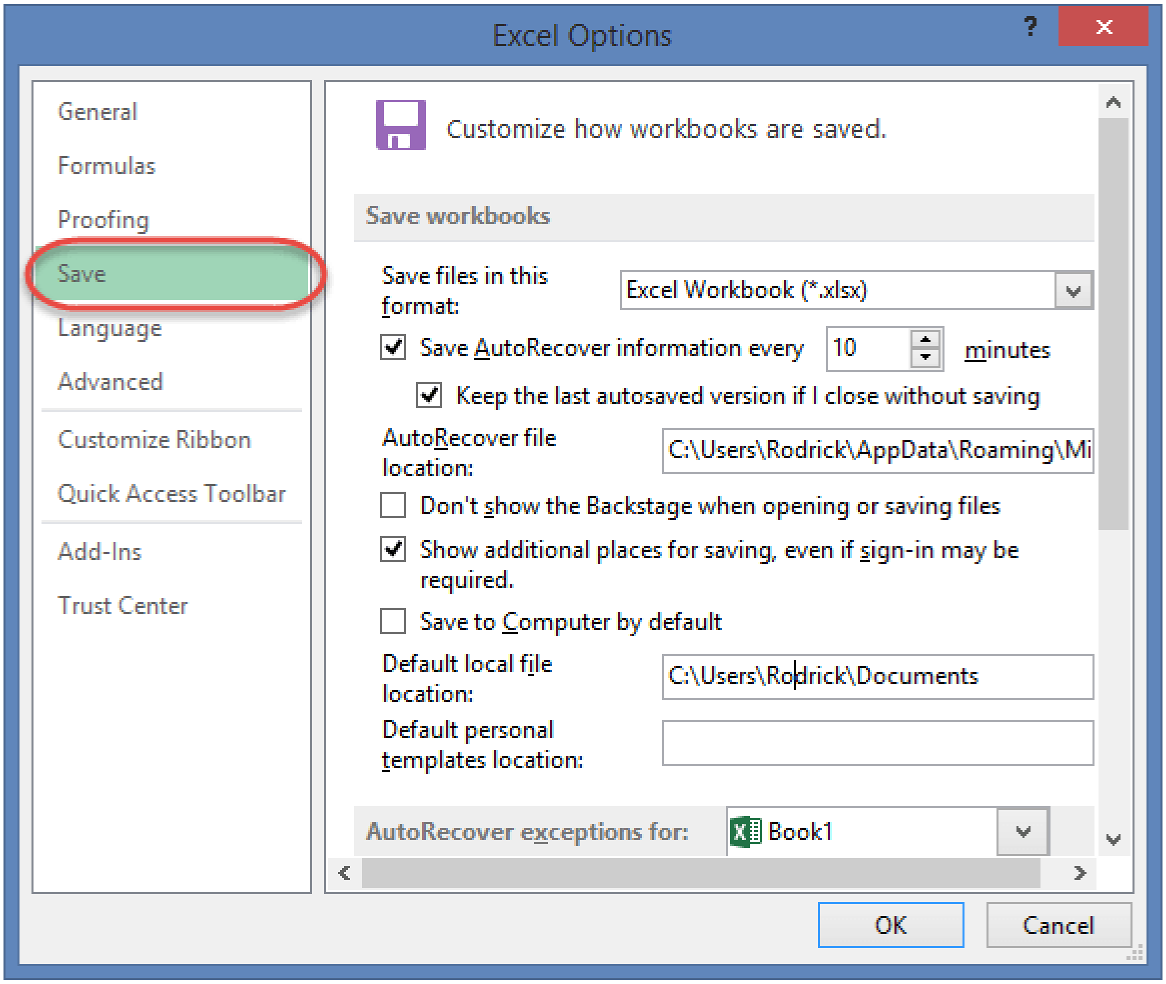
If you want to activate an option, click on its check box. If you want to deactivate an option, remove the mark from the checkbox. You can use this option from the Options dialoque window under formulas tab from the left-hand side panel.

PROOFING SETTINGS:



This option manipulates the entered text entered into excel. It allows setting options such as the dictionary language that should be used when checking for wrong spellings, suggestions from the dictionary, etc., You can use this option from the options dialogue window under the proofing tab from the left-hand side panel.

SAVE SETTINGS:



This option allows you to define the default file format when saving files, enables auto recovery in case your computer goes off before you could save your work, etc. You can used this option from the Options dialogue window under save tab from the left-hand side panel

IMPORTANT EXCEL SHORTCUTS:

Ctrl+P	:	used to open the print dialogue window
Ctrl+N	:	creates a new workbook
Ctrl+S	:	saves the current workbook
Ctrl+C	:	copy contents of current select
Ctrl+V	:	paste data from the clipboard

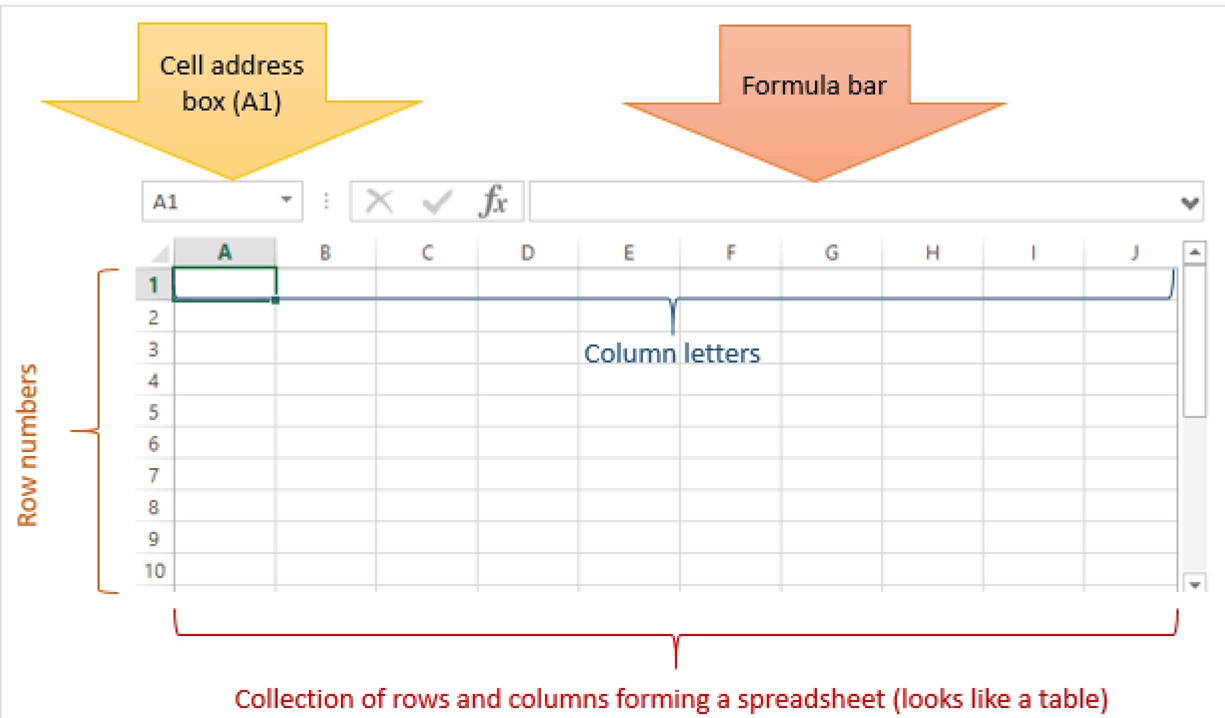
SHIFT+F3 : paste data from the clipboard

SHIFT+F11 : creates a new worksheet

F2 : check formula and cell range convered

Best Practices when working with Microsoft Excel

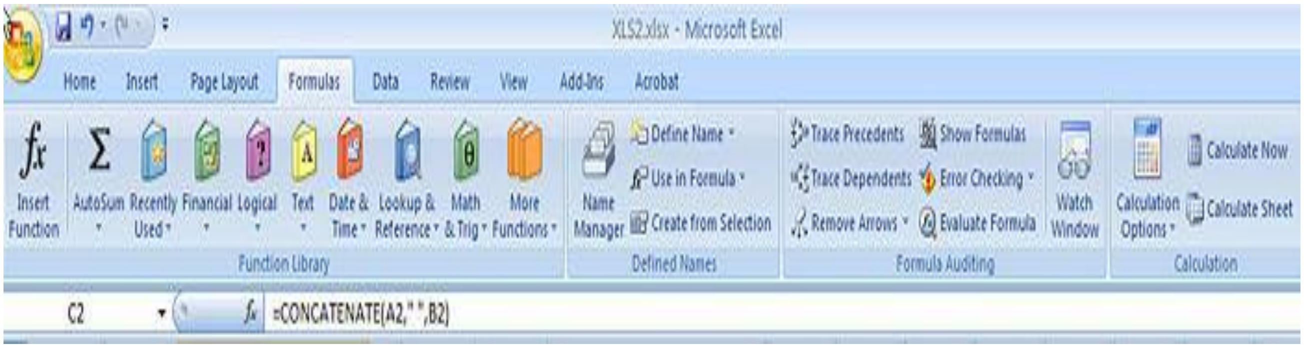
1. Save workbooks with backward compatibility in mind. If you are not using the latest features in higher versions of Excel, you should save your files in 2003*.xls format for backwards compatibility.
2. Use description names for columns and worksheets in a workbook.
3. Avoid working with complex formulas with many variables. Try to break them down into small managed results that you can used to build on.
4. Use built-in functions whenever you can instead of writing your own formulas.



Excel formatting data

UNDERSTANDING ADVANCED FEATURES OF EXCEL DATABASE FUNCTIONS IN EXCEL

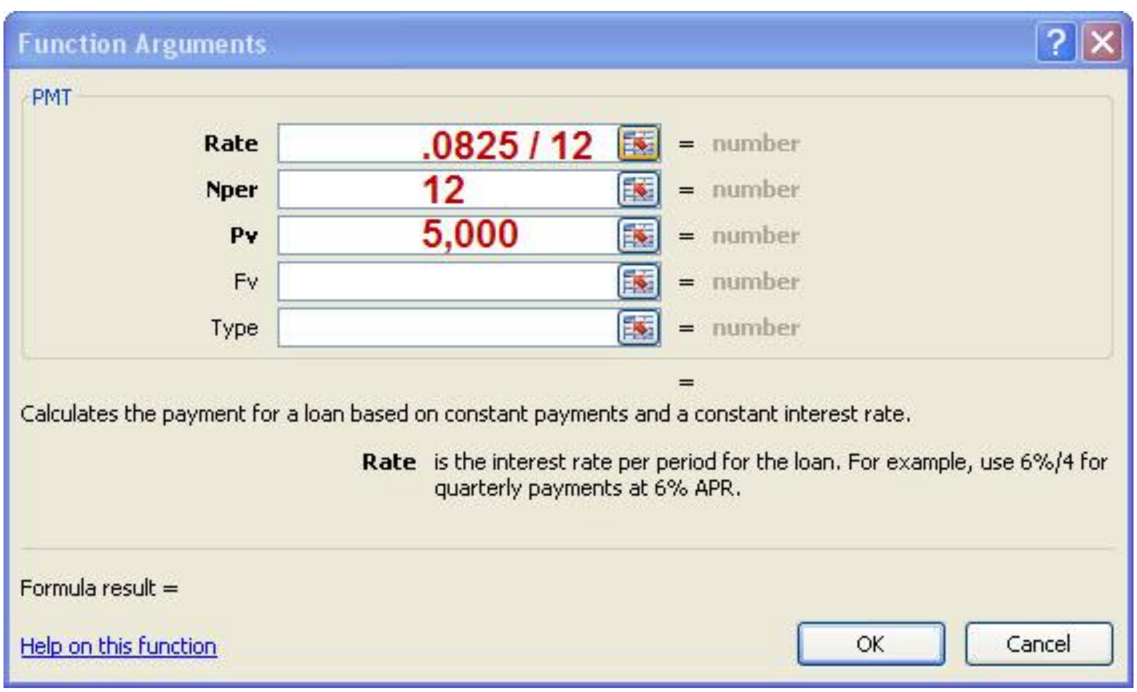
Excel provides an enormous number of established formulas and assistance in auditing and calculating your data. The primary groupings are financial, logical, text, date and time, lookup and reference, math and trigonometry, statistical, engineering, cube, and file-related information.



Financial Formulas

Financial functions are probably one of the most commonly used groups. You can calculate payment plans, interest rates, depreciation, and the yield on securities (just to name a few!). Excel simplifies the process by providing fill-in-the-blanks

Xls2 pmt.jpg



No higher resolution available.
Xls2_pmt.jpg (565 × 338 pixel, file size: 51 KB, MIME type: image/jpeg)

xls 2 tutorial image - payment

he following example returns a loan payment. The lower chart shows the balance if you pay a different amount.

Enter principle, interest and term in the yellow highlighted cells (C1, C3, C4). The PMT formula should refer to these cells and look like this: =PMT(C3/12,C4,C1). Enter the “actual payment” amount in D2.

Copy the following formulas into the table and drag down to populate the table.

- In cell E7 enter "=C1"
- In cell B8 enter "=$D$2"
- In cell C8 enter "=(E7*$C$3)/12"
- In cell D8 enter "=B8-C8"
- In cdll E8 enter "=E7-D8"

	A	B	C	D	E
1	Starting Amount		$5,000.00	Actual PMT	
2	PMT		($435.52)	$600.00	
3	Interest		8.25%		
4	Term (months)		12		
5					
6	Month	Payment	Interest	Principal	Balance
7					$5,000.00
8	1	600.00	34.38	565.63	4434.38
9	2	600.00	30.49	569.51	3864.86
10	3	600.00	26.57	573.43	3291.43
11	4	600.00	22.63	577.37	2714.06
12	5	600.00	18.66	581.34	2132.72
13	6	600.00	14.66	585.34	1547.38
14	7	600.00	10.64	589.36	958.02
15	8	600.00	6.59	593.41	364.61
16	9	600.00	2.51	597.49	-232.89

Text Functions

Concatenate:

The concatenate function strings together the contents of a series of cells (text1, text2). The order that you select the cells is the order that they are combined into the resulting cell.

Syntax: CONCATENATE (text1,text2,...)

Shortcut: The symbol “&” can also be used instead of the concatenate function (=A2&B2).

Example The following examples combines fields to create FullName and Address fields.

Cell Formula C2 = CONCATENATE(A2," ",B2) *note that [text2] is [quote space quote]* G2 = CONCATENATE(E2,”, TX”,F2) *note that [text2] is [quote comma space TX space quote]*

	A	B	C	D	E	F	G
1	**FirstName**	**LastName**	**FullName**		**City**	**Zip**	**Address**
2	Rebecca	Holte	Rebecca Holte		Austin	78756	=CONCATENATE(E2,", TX ",F2)
3	*Formula in cell C2 >>*		=CONCATENATE(A2," ",B2)		*Formula in cell G6 >>*		=CONCATENATE(E2,", TX ",F2)

Left, Right

LEFT and RIGHT are useful if you wish to remove extra characters from a cell AND if you are able to specify how many characters to remove from the left or right. The formula requires the cell reference (text) and the number of characters to return (num_chars).

MID performs a similar task of returning reduced characters. This function contains 3 qualifiers: cell reference (text), the position of the character where you wish the text to begin (start_num), and the number of characters to return (num_chars).

Syntax: =LEFT(text,num_chars) or RIGHT(text,num_chars) =MID(text,start_num,num_chars)

Example Cell B2: =LEFT(A2,5) Cell E2: =MID(A2,1,5)

	A	B	C	D	E
1	**Zip+4**	**Zip**		**Zip+4**	**Zip**
2	56001-1999	56001		56001-1999	56001
3	*Formula >>*	=LEFT(A2,5)		*Formula >>*	=MID(A2,1,5)

Conditional Functions

Conditional functions, like conditional formatting, are great features to help you highlight or manipulate select information based on specified criteria. Excel evaluates the source against the criteria, and returns a value if the logical test is “true” and a different value for “false”. In the same way, Excel will perform a function, like adding or counting, based on the logical test.

- The elements “value_if_true” and “value_if_false” may be a static value or another formula.
- Up to 7 functions may be nested to create some very elaborate tests.
- If, Countif, and Sumif perform the logical test using single criteria.
- Countifs, and Sumifs perform the logical test on a range of cells that meet multiple criteria.

If

IF is straightforward. The reference cell is tested against criteria and will return a value or perform another function if the test returns true or false. “Logical_test” includes both the cell reference and the criteria, such as “B4 is less than 20.”

Syntax: IF(logical_test,value_if_true,value_if_false)

Example In this example, we are testing against the width of a book. If the width is under .375 in (3/8 in), the book requires a pamphlet binding (pam). If the width were equal or over .375 in, the book would require library binding (LB).

Cell Formula C2 =IF(B2>0.375,"pam","LB")

	A	B	C
1	**Item**	**BookWidth (in)**	**ProtectiveEnclosure**
2	Book001	0.25	pam
3		*Formula >>*	=IF(B2<0.375,"pam","LB")

Countif, Countifs

Countif and Countifs literally count the number of times the test returns “true.” Other “count” functions: count – counts the number of cells that contain numbers, counta – counts the number of cells that are not empty, and countblank – counts the number of empty cells.

Syntax: COUNTIF(range,criteria) COUNTIFS(range1,criteria1,range2,criteria2,...)

Example: In the next example, we are counting how many books require 1) pamphlet binding (pam), 2) Library Binding (LB), and 3) how many books need both Library Binding and Spine Repair (LB/Repair).

Cell H2 =COUNTIF($C$2:$C$5,"pam") Cell H3 =COUNTIFS($D$2:$D$5,"good",$C$2:$C$5,"LB") Cell H4 =COUNTIFS($D$2:$D$5,"poor",$C$2:$C$5,"LB")

	A	B	C	D	E	F	G	H
1	Item	BookWidth	ProtectiveEnclosure	Openability		Requirements:	# books	*Formula*
2	Book001	0.25	pam	poor		PAM	1	=COUNTIF($C$2:$C$5,"pam")
3	Book002	1	LB	poor		LB	2	=COUNTIFS($D$2:$D$5,"good",$C$2:$C$5,"LB")
4	Book003	0.5	LB	good		LB / Repair	1	=COUNTIFS($D$2:$D$5,"poor",$C$2:$C$5,"LB")
5	Book003	0.75	LB	good				

Sumif, Sumifs

These functions return a sum of numbers that meet specified criteria. Range is the range of cells to compare against the criteria. A range of cells presented in this way: A2:A100 and an entire row looks like this: A:A. Criteria may be a value or range (“=30” or “=black” or “<2009”). Sum_range is used if the actual items to be added are in a different range than the compared range. If nothing is entered here, the original range is summed.

Syntax: SUMIF(range,criteria,sum_range)
SUMIFS(sum_range,criteria_range1,criteria1,criteria_range2,criteria2…)

Note: see that the sum_range comes FIRST in the SUMIFS formula.

Example: Calculate the cost of book repair based on condition of the item.

	A	B	C	D	E	F	G
1	Item	condition	costEstimate		Cost Estimate per Condition:		
2	Book001	good	$ -		good	$ -	
3	Book002	poor	$ 15.00		poor	$ 42.50	
4	Book003	poor	$ 7.50		repairNOW	$ 80.00	
5	Book004	repairNOW	$ 30.00		Total	$ 122.50	
6	Book005	repairNOW	$ 50.00		*C12 formula:*		
7	Book006	good	$ -		=SUMIF($B$2:$B$8,"good",$C$2:$C$8)		
8	Book007	poor	$ 20.00				
9	Total costEstimate		$ 122.50				

More Functions

There are many extremely useful functions - following are just a few more examples. Search the Excel Help for “functions” and you’ll find the “List of all functions by category” for a full list of statistical, database, math, financial, and many, many, many more function types.

Len

Syntax: =LEN(text)

- Returns the number of characters in a text string – spaces count as characters. Suggestion: use to determine lengths of each line of address on a label. The US Post office only allows 46 characters per line for mass mailings (as of 2008). Another use is to determine number of characters in a text block for web or print content.

Proper

Syntax: =PROPER(text)

- Capitalizes the first letter of every word (as in “Rebecca Holte”).

Trim

Syntax: =TRIM(text)

- Removes extra spaces from text strings – leaves a single space between words (“Rebecca Holte” = “Rebecca Holte”).

Rounding

- Adding/multiplying numbers obtained from formula sums, you may see different values than expected, due to the how many decimal points are used and when rounding occurs. You may wish to use a rounding or even/odd function. For “number” you can enter an actual number or cell reference, and “num_digits” indicates how many decimal places you require.

Roundup and Rounddown Syntax: = ROUNDUP(number,num_digits)

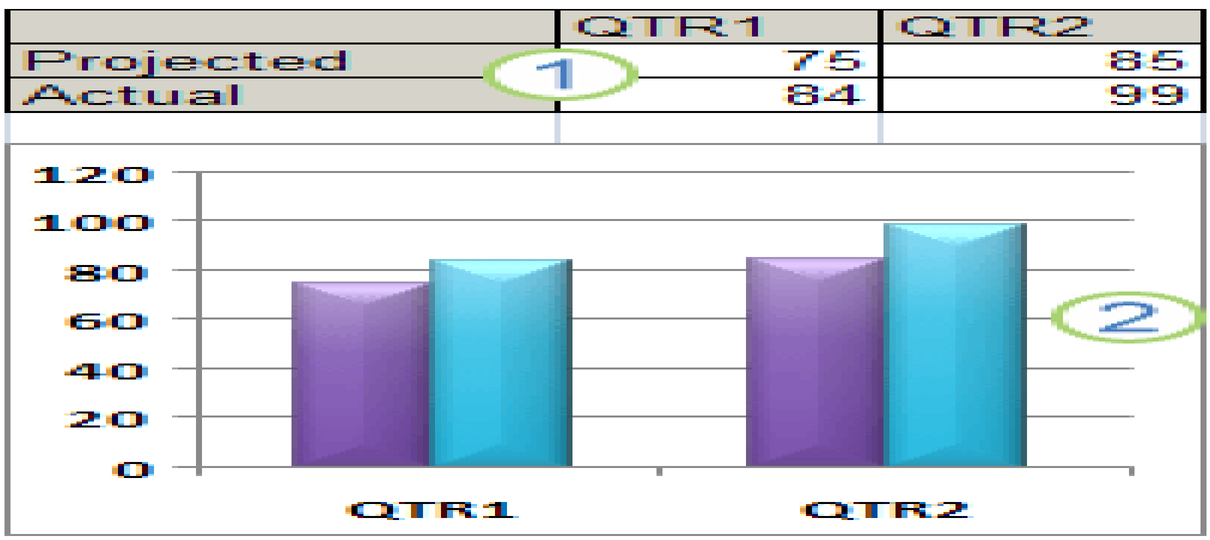
Even and Odd Syntax: =EVEN(number)

CREATING CHARTS:

you can create a basic chart by selecting any part of the range you want to be charted, then clicking the chart type that you want on the **Insert** tab in the **Charts** ribbon group. Or, simply press **Alt+F1** for Excel to automatically create a simple column chart for you. From there, you have multiple options to change the chart so it's just the way you want it.

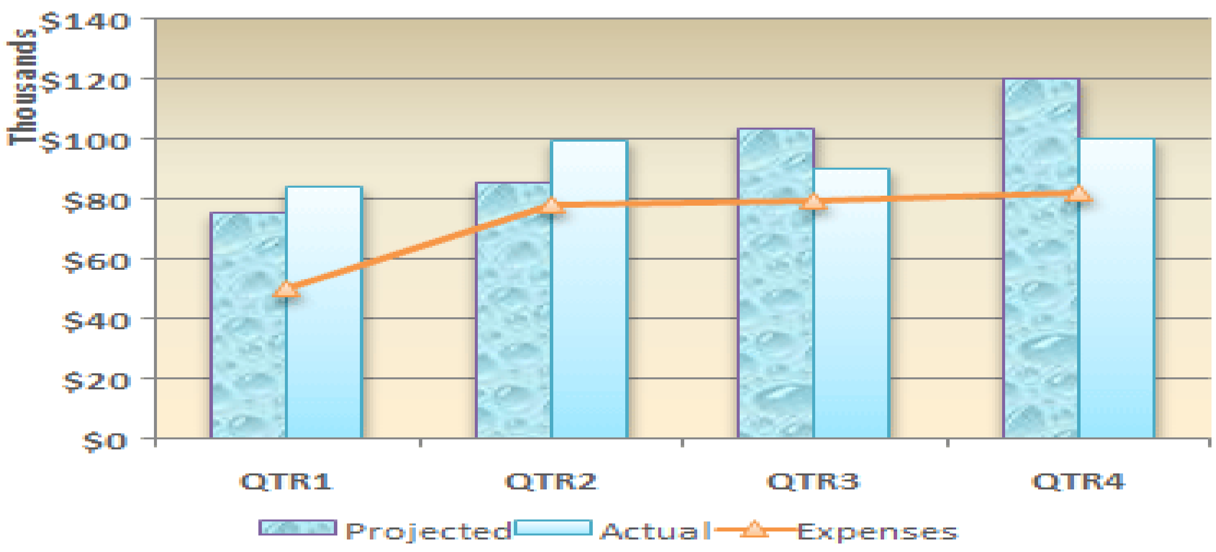
Charts are used to display series of numeric data in a graphical format to make it easier to understand large quantities of data and the relationship between different series of data.

To create a chart in Excel, you start by entering the numeric data for the chart on a worksheet. Then you can plot that data into a chart by selecting the chart type that you want to use on the **Insert** tab, in the **Charts**group.



1. Worksheet data
2. Chart created from worksheet data

Excel supports many types of charts to help you display data in ways that are meaningful to your audience. When you create a chart or change an existing chart, you can select from a variety of chart types (such as a column chart or a pie chart) and their subtypes (such as a stacked column chart or a pie in 3-D chart). You can also create a combination chart by using more than one chart type in your chart.



Example of a combination chart that uses a column and line chart type.
For more information about the chart types that you can select in Excel, see Available chart types.

Get to know chart elements:

A chart has many elements. Some of these elements are displayed by default, others can be added as needed. You can change the display of the chart elements by moving them to other locations in the chart, resizing them, or by changing the format. You can also remove chart elements that you do not want to display.

1. The chart area of the chart.
2. The plot area of the chart.
3. The data points of the data series that are plotted in the chart.
4. The horizontal (category) and vertical (value) axis along which the data is plotted in the chart.
5. The legend of the chart.

6. A chart and axis title that you can use in the chart.
7. A data label that you can use to identify the details of a data point in a data series.

Modify a basic chart to meet your needs

After you create a chart, you can modify any one of its elements. For example, you might want to change the way that axes are displayed, add a chart title, move or hide the legend, or display additional chart elements.

To modify a chart, you can do one or more of the following:

- **Change the display of chart axes** You can specify the scale of axes and adjust the interval between the values or categories that are displayed. To make your chart easier to read, you can also add tick marks to an axis, and specify the interval at which they will appear.
- **Add titles and data labels to a chart** To help clarify the information that appears in your chart, you can add a chart title, axis titles, and data labels.
- **Add a legend or data table** You can show or hide a legend, change its location, or modify the legend entries. In some charts, you can also show a data table that displays the legend keys and the values that are presented in the chart.
- **Apply special options for each chart type** Special lines (such as high-low lines and trendlines), bars (such as up-down bars and error bars), data markers, and other options are available for different chart types.

Top of Page

Apply a predefined chart layout and style for a professional look

Instead of manually adding or changing chart elements or formatting the chart, you can quickly apply a predefined chart layout and chart style to your chart. Excel provides a variety of useful predefined layouts and styles. However, you can fine-tune a layout or style as needed by making manual changes to the layout and format of individual chart elements, such as the chart area, plot area, data series, or legend of the chart.

When you apply a predefined chart layout, a specific set of chart elements (such as titles, a legend, a data table, or data labels) are displayed in a specific arrangement in your chart. You can select from a variety of layouts that are provided for each chart type.

When you apply a predefined chart style, the chart is formatted based on the document theme that you have applied, so that your chart matches your organization's or your own theme colors (a set of colors), theme fonts (a set of heading and body text fonts), and theme effects (a set of lines and fill effects).

You cannot create your own chart layouts or styles, but you can create chart templates that include the chart layout and formatting that you want.

Top of Page

Add eye-catching formatting to a chart

In addition to applying a predefined chart style, you can easily apply formatting to individual chart elements such as data markers, the chart area, the plot area, and the numbers and text in titles and labels to give your chart a custom, eye-catching look. You can apply specific shape styles and WordArt styles, and you can also format the shapes and text of chart elements manually.

To add formatting, you can use one or more of the following:

- **Fill chart elements** You can use colors, textures, pictures, and gradient fills to help draw attention to specific chart elements.
- **Change the outline of chart elements** You can use colors, line styles, and line weights to emphasize chart elements.
- **Add special effects to chart elements** You can apply special effects, such as shadow, reflection, glow, soft edges, bevel, and 3-D rotation to chart element shapes, which gives your chart a finished look.
- **Format text and numbers** You can format text and numbers in titles, labels, and text boxes on a chart as you would text and numbers on a worksheet. To make text and numbers stand out, you can even apply WordArt styles.

Top of Page

Reuse charts by creating chart templates

If you want to reuse a chart that you customized to meet your needs, you can save that chart as a chart template (*.crtx) in the chart templates folder. When you create a chart, you can then apply the chart template just as you would any other built-in chart type. In fact, chart templates are custom chart types — you can also use them to change the chart type of an existing chart. If you use a specific chart template frequently, you can save it as the default chart type.

Top of Page

Step 1: Create a basic chart

For most charts, such as column and bar charts, you can plot the data that you arrange in rows or columns on a worksheet into a chart. However, some chart types (such as pie and bubble charts) require a specific data arrangement.

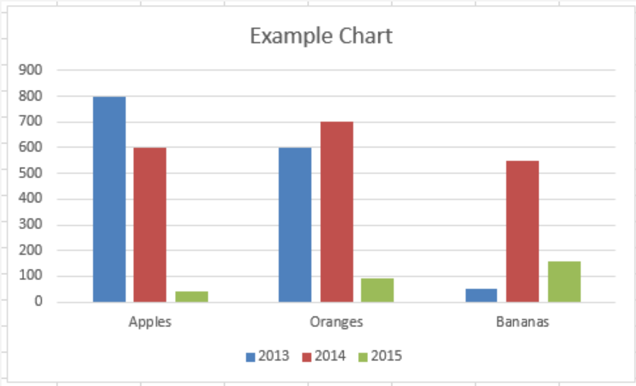
1. On the worksheet, arrange the data that you want to plot in a chart.

The data can be arranged in rows or columns — Excel automatically determines the best way to plot the data in the chart. Some chart types (such as pie and bubble charts) require a specific data arrangement.

How to arrange data on the worksheet

<table>
<tr><th>For this chart type</th><th>Arrange the data</th></tr>
<tr><td>Column, bar, line, area, surface, or radar chart</td><td>In columns or rows, such as:
<table>
<tr><th>Year</th><th>Apples</th><th>Oranges</th><th>Bananas</th></tr>
<tr><td>2013</td><td>800</td><td>600</td><td>50</td></tr>
<tr><td>2014</td><td>600</td><td>700</td><td>550</td></tr>
<tr><td>2015</td><td>50</td><td>90</td><td>150</td></tr>
</table>
</td></tr>
</table>

For this chart type	Arrange the data



Or:

Fruit	2013	2014	2015
Apples	800	600	50
Oranges	600	700	90
Bananas	50	90	150

Pie or doughnut chart

For one data series, in one column or row of data and
one column or row of data labels, such as:

A	1
B	2
C	3

Or:

A	B	C
1	2	3

For multiple data series, in multiple columns or
rows of data and one column or row of data labels,
such as:

A	1	2
B	3	4
C	5	6

Or:

A	B	C
1	2	3
4	5	6

XY (scatter) or bubble chart

In columns, placing x values in the first column and
corresponding y values and bubble size values in adjacent columns, such as:

X	Y	Bubble size

<table>
<tr><th>For this chart type</th><th>Arrange the data</th></tr>
<tr><td></td><td>
<table>
<tr><td>1</td><td>2</td><td>3</td></tr>
<tr><td>4</td><td>5</td><td>6</td></tr>
</table>
</td></tr>
<tr><td>Stock chart</td><td>
In columns or rows in the following order, using

names or dates as labels:

high values, low values, and closing values

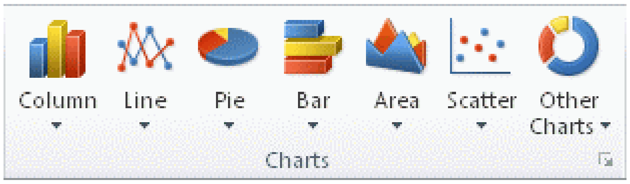
Like:
<table>
<tr><th>Date</th><th>High</th><th>Low</th><th>Close</th></tr>
<tr><td>1/1/2002</td><td>46.125</td><td>42</td><td>44.063</td></tr>
</table>
Or:
<table>
<tr><th>Date</th><th>1/1/2002</th></tr>
<tr><td>High</td><td>46.125</td></tr>
<tr><td>Low</td><td>42</td></tr>
<tr><td>Close</td><td>44.063</td></tr>
</table>
</td></tr>
</table>

2. Select any cell within the data range that you want to use for the chart.

Tip If you select only one cell, Excel automatically plots all cells that contain data that is adjacent to that cell. If the cells that you want to plot in a chart are not in a continuous range, you can select non-adjacent cells or ranges with **Ctrl+Left-Click**, as long as the selection forms a rectangle. You can also hide any rows or columns you don't want to plot in the chart.

Tip: To cancel a selection of cells, click any cell on the worksheet.

3. On the **Insert** tab, in the **Charts** group, do one of the following:
   - Click the chart type, and then click a chart subtype that you want to use.
   - To see all available chart types, click  to launch the **Insert Chart** dialog box, and then click the arrows to scroll through the chart types.



Tip A ScreenTip displays the chart type name when you rest the mouse pointer over any chart type or chart subtype. For more information about the chart types that you can use, see Available chart types.

4. By default, the chart is placed on the worksheet as an embedded chart. If you want to place the chart in a separate chart sheet, you can change its location by doing the following:
   a. Click anywhere in the embedded chart to activate it.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

   b. On the **Design** tab, in the **Location** group, click **Move Chart**.

   c. Under **Choose where you want the chart to be placed**, do one of the following:
      - To display the chart in a chart sheet, click **New sheet**.

Tip If you want to replace the suggested name for the chart, you can type a new name in the **New sheet** box.

      - To display the chart as an embedded chart in a worksheet, click **Object in**, and then click a worksheet in the **Object in** box.

Excel automatically assigns a name to the chart, such as **Chart1** if it is the first chart that you create on a worksheet. To change the name of the chart, do the following:

   d. Click the chart.
   e. On the **Layout** tab, in the **Properties** group, click the **Chart Name** text box.

Tip If necessary, click the **Properties** icon in the **Properties** group to expand the group.

   f. Type a new name.
   g. Press ENTER.

Notes

- To quickly create a chart that is based on the default chart type, select the data that you want to use for the chart, and then press ALT+F1 or F11. When you press ALT+F1, the chart is displayed as an embedded chart; when you press F11, the chart is displayed on a separate chart sheet.
- If you no longer need a chart, you can delete it. Click the chart to select it, and then press DELETE.

Top of Page

Step 2: Change the layout or style of a chart

After you create a chart, you can instantly change its look. Instead of manually adding or changing chart elements or formatting the chart, you can quickly apply a predefined layout and style to your chart. Excel provides a variety of useful predefined layouts and styles (or quick layouts and quick styles) that you can select from, but you can customize a layout or style as needed by manually changing the layout and format of individual chart elements.

Apply a predefined chart layout

1. Click anywhere in the chart that you want to format by using a predefined chart layout.
   This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Design** tab, in the **Chart Layouts** group, click the chart layout that you want to use.

Note When the size of the Excel window is reduced, chart layouts will be available in the **Quick Layout**gallery in the **Chart Layouts** group.

Tip To see all available layouts, click **More**  .

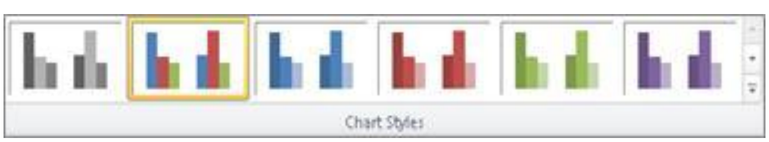
Top of Page

Apply a predefined chart style

1. Click anywhere in the chart that you want to format by using a predefined chart style.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Design** tab, in the **Chart Styles** group, click the chart style that you want to use.



Note When the size of the Excel window is reduced, chart styles will be available in the **Chart Quick Styles** gallery in the **Chart Styles** group.

Tip To see all predefined chart styles, click **More**  .

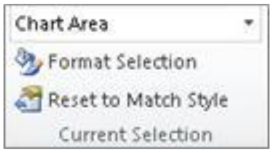
Top of Page

Change the layout of chart elements manually

1. Click the chart element for which you want to change the layout, or do the following to select it from a list of chart elements.

a. Click anywhere in the chart to display the **Chart Tools**.

b. On the **Format** tab, in the **Current Selection** group, click the arrow in the **Chart Elements** box, and then click the chart element that you want.



2. On the **Layout** tab, in the **Labels**, **Axes**, or **Background** group, click the chart element button that corresponds with the chart element that you selected, and then click the layout option that you want.

Note The layout options that you select are applied to the chart element that you have selected. For example, if you have the entire chart selected, data labels will be applied to all data series. If you have a single data point selected, data labels will only be applied to the selected data series or data point.

Top of Page

Change the format of chart elements manually

1. Click the chart element for which you want to change the style, or do the following to select it from a list of chart elements.

a. Click anywhere in the chart to display the **Chart Tools**.

b. On the **Format** tab, in the **Current Selection** group, click the arrow in the **Chart Elements** box, and then click the chart element that you want.

2. On the **Format** tab, do one or more of the following:

a. To format any selected chart element, in the **Current Selection** group, click **Format Selection**, and then select the formatting options that you want.

b. To format the shape of a selected chart element, in the **Shape Styles** group, click the style that you want, or click **Shape Fill**, **Shape Outline**, or **Shape Effects**, and then select the formatting options that you want.

c. To format the text in a selected chart element by using WordArt, in the **WordArt Styles** group, click a style. You can also click **Text Fill**, **Text Outline**, or **Text Effects**, and then select the formatting options that you want.

Note After you apply a WordArt style, you cannot remove the WordArt format. If you do not want the WordArt style that you applied, you can select another WordArt style, or you can click **Undo** on the**Quick Access Toolbar** to return to the previous text format.

Tip To use regular text formatting to format the text in chart elements, you can right-click or select the text, and then click the formatting options that you want on the **Mini toolbar**. You can also use the formatting buttons on the ribbon (**Home** tab, **Font** group).

Top of Page

Step 3: Add or remove titles or data labels

To make a chart easier to understand, you can add titles, such as a chart title and axis titles. Axis titles are typically available for all axes that can be displayed in a chart, including depth (series) axes in 3-D charts. Some chart types (such as radar charts) have axes, but they cannot display axis titles. Chart types that do not have axes (such as pie and doughnut charts) cannot display axis titles either.

You can also link chart and axis titles to corresponding text in worksheet cells by creating a reference to those cells. Linked titles are automatically updated in the chart when you change the corresponding text on the worksheet.

To quickly identify a data series in a chart, you can add data labels to the data points of the chart. By default, the data labels are linked to values on the worksheet, and they update automatically when changes are made to these values.

Add a chart title

1. Click anywhere in the chart to which you want to add a title.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Layout** tab, in the **Labels** group, click **Chart Title**.

3. Click **Centered Overlay Title** or **Above Chart**.
4. In the **Chart Title** text box that appears in the chart, type the text that you want.

Tip To insert a line break, click to place the pointer where you want to break the line, and then press ENTER.

5. To format the text, select it, and then click the formatting options that you want on the **Mini toolbar**.

Tip You can also use the formatting buttons on the ribbon (**Home** tab, **Font** group). To format the whole title, you can right-click it, click **Format Chart Title**, and then select the formatting options that you want.
Top of Page
Add axis titles

1. Click anywhere in the chart to which you want to add axis titles.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Layout** tab, in the **Labels** group, click **Axis Titles**.

3. Do one or more of the following:
   - To add a title to a primary horizontal (category) axis, click **Primary Horizontal Axis Title**, and then click the option that you want.

Tip If the chart has a secondary horizontal axis, you can also click **Secondary Horizontal Axis Title**.

   - To add a title to primary vertical (value) axis, click **Primary Vertical Axis Title**, and then click the option that you want.

Tip If the chart has a secondary vertical axis, you can also click **Secondary Vertical Axis Title**.

   - To add a title to a depth (series) axis, click **Depth Axis Title**, and then click the option that you want.

Note This option is only available when the selected chart is a true 3-D chart, such as a 3-D column chart.

4. In the **Axis Title** text box that appears in the chart, type the text that you want.

Tip To insert a line break, click to place the pointer where you want to break the line, and then press ENTER.

5. To format the text, select it, and then click the formatting options that you want on the **Mini toolbar**.

Tip You can also use the formatting buttons on the ribbon (**Home** tab, **Font** group). To format the whole title, you can right-click it, click **Format Axis Title** , and then select the formatting options that you want.

Notes

- If you switch to another chart type that does not support axis titles (such as a pie chart), the axis titles will no longer be displayed. The titles will be displayed again when you switch back to a chart type that does support axis titles.
- Axis titles that are displayed for secondary axes will be lost when you switch to a chart type that does not display secondary axes.

Top of Page

Link a title to a worksheet cell

1. On a chart, click the chart or axis title that you want to link to a worksheet cell.
2. On the worksheet, click in the formula bar, and then type an equal sign (=).
3. Select the worksheet cell that contains the data or text that you want to display in your chart.

Tip You can also type the reference to the worksheet cell in the formula bar. Include an equal sign, the sheet name, followed by an exclamation point; for example, **=Sheet1!F2**

4. Press ENTER.

Top of Page

Add data labels

1. On a chart, do one of the following:
   - To add a data label to all data points of all data series, click the chart area.
   - To add a data label to all data points of a data series, click anywhere in the data series that you want to label.
   - To add a data label to a single data point in a data series, click the data series that contains the data point that you want to label, and then click the data point that you want to label.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Layout** tab, in the **Labels** group, click **Data Labels**, and then click the display option that you want.

Note Depending on the chart type that you used, different data label options will be available.

Top of Page

Remove titles or data labels from a chart

1. Click the chart.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Layout** tab, in the **Labels** group, do one of the following:
   - To remove a chart title, click **Chart Title**, and then click **None**.
   - To remove an axis title, click **Axis Title**, click the type of axis title that you want to remove, and then click**None**.
   - To remove data labels, click **Data Labels**, and then click **None**.

Tip To quickly remove a title or data label, click it, and then press DELETE.

Top of Page

Step 4: Show or hide a legend

When you create a chart, the legend appears, but you can hide the legend or change its location after you create the chart.

1. Click the chart in which you want to show or hide a legend.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Layout** tab, in the **Labels** group, click **Legend**.

3. Do one of the following:
   - To hide the legend, click **None**.

Tip To quickly remove a legend or a legend entry from a chart, you can select it, and then press DELETE. You can also right-click the legend or a legend entry, and then click **Delete**.

- To display a legend, click the display option that you want.

Note When you click one of the display options, the legend moves, and the plot area automatically adjusts to make room for it. If you move and size the legend by using the mouse, the plot area does not automatically adjust.

- For additional options, click **More Legend Options**, and then select the display option that you want.

Tip By default, a legend does not overlap the chart. If you have space constraints, you might be able to reduce the size of the chart by clearing the **Show the legend without overlapping the chart** check box.

Tip When a chart has a legend displayed, you can modify the individual legend entries by editing the corresponding data on the worksheet. For additional editing options, or to modify legend entries without affecting the worksheet data, you can change the legend entries in the **Select Data Source** dialog box (**Design**tab, **Data** group, **Select Data** button).

Top of Page

Step 5: Display or hide chart axes or gridlines

When you create a chart, primary axes are displayed for most chart types. You can turn them on or off as needed. When you add axes, you can specify the level of detail that you want the axes to display. A depth axis is displayed when you create a 3-D chart.

When the values in a chart vary widely from data series to data series, or when you have mixed types of data (for example, price and volume), you can plot one or more data series on a secondary vertical (value) axis. The scale of the secondary vertical axis reflects the values for the associated data series. After you add a secondary vertical axis to a chart, you can also add a secondary horizontal (category) axis, which might be useful in an xy (scatter) chart or bubble chart.

To make a chart easier to read, you can display or hide the horizontal and vertical chart gridlines that extend from any horizontal and vertical axes across the plot area of the chart.

Display or hide primary axes

1. Click the chart for which you want to display or hide axes.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

2. On the **Layout** tab, in the **Axes** group, click **Axes**, and then do one of the following:
   - To display an axis, click **Primary Horizontal Axis**, **Primary Vertical Axis**, or **Depth** Axis (on a 3-D chart), and then click the axis display option that you want.
   - To hide an axis, click **Primary Horizontal Axis**, **Primary Vertical Axis**, or **Depth** Axis (on a 3-D chart), and then click **None**.

- To specify detailed axis display and scaling options, click **Primary Horizontal Axis**, **Primary Vertical Axis**, or **Depth Axis** (on a 3-D chart), and then click **More Primary Horizontal Axis Options**, **More Primary Vertical Axis Options**, or **More Depth Axis Options**.

Top of Page

Display or hide secondary axes

1. In a chart, click the data series that you want to plot along a secondary vertical axis, or do the following to select the data series from a list of chart elements:

a. Click the chart.

This displays the **Chart Tools**, adding the **Design**, **Layout**, and **Format** tabs.

b. On the **Format** tab, in the **Current Selection** group, click the arrow in the **Chart Elements** box, and then click the data series that you want to plot along a secondary vertical axis.

2. On the **Format** tab, in the **Current Selection** group, click **Format Selection**.
3. Click **Series Options** if it is not selected, and then under **Plot Series On**,
4. Click **Secondary Axis** and then click **Close**.
5. On the **Layout** tab, in the **Axes** group, click **Axes**.
6. Do one of the following:

○ To display a secondary vertical axis, click **Secondary Vertical Axis**, and then click the display option that you want.

Tip To help distinguish the secondary vertical axis, you can change the chart type for just one data series. For example, you can change one data series to a line chart.

To display a secondary horizontal axis, click **Secondary Horizontal Axis**, and then click the display option that you want.

Note This option is available only after you display a secondary vertical axis.

To hide a secondary axis, click **Secondary Vertical Axis** or **Secondary Horizontal Axis**, and then click**None**.

Tip You can also click the secondary axis that you want to delete, and then press DELETE.

Top of Page

1. .

2. Do the following:

○ To add horizontal gridlines to the chart, point to **Primary Horizontal Gridlines**, and then click the option that you want. If the chart has a secondary horizontal axis, you can also click **Secondary Horizontal Gridlines**.

○ To add vertical gridlines to the chart, point to **Primary Vertical Gridlines**, and then click the option that you want. If the chart has a secondary vertical axis, you can also click **Secondary Vertical Gridlines**.

○ To add depth gridlines to a 3-D chart, point to **Depth Gridlines**, and then click the option that you want. This option is only available when the selected chart is a true 3-D chart, such as a 3-D column chart.

○ To hide chart gridlines, point to **Primary Horizontal Gridlines**, **Primary Vertical Gridlines**, or **Depth Gridlines** (on a 3-D chart), and then click **None**. If the chart has a secondary axes, you can also click **Secondary Horizontal Gridlines** or **Secondary Vertical Gridlines**, and then click **None**.

- To quickly remove chart gridlines, select them, and then press DELETE.

Top of Page

Step 6: Move or resize a chart

You can move a chart to any location on a worksheet or to a new or existing worksheet. You can also change the size of the chart for a better fit.

Move a chart

- To move a chart, drag it to the location that you want.

Top of Page

Resize a chart

To resize a chart, do one of the following:

- Click the chart, and then drag the sizing handles to the size that you want.
- On the **Format** tab, in the **Size** group, enter the size in the **Shape Height** and **Shape Width** box.

Tip For more sizing options, on the **Format** tab, in the **Size** group, click  to launch the **Format Chart Area** dialog box. On the **Size** tab, you can select options to size, rotate, or scale the chart. On the **Properties** tab, you can specify how you want the chart to move or size with the cells on the worksheet.

Top of Page

Step 7: Save a chart as a template

If you want to create another chart such as the one that you just created, you can save the chart as a template that you can use as the basis for other similar charts

1. Click the chart that you want to save as a template.
2. On the **Design** tab, in the **Type** group, click **Save as Template**.

3. In the **File name** box, type a name for the template.

Tip Unless you specify a different folder, the template file (.crtx) will be saved in the **Charts** folder, and the template becomes available under **Templates** in both the **Insert Chart** dialog box (**Insert** tab, **Charts** group, **Dialog Box Launcher** ) and the **Change Chart Type** dialog box (**Design** tab, **Type** group, **Change Chart Type**).

Note A chart template contains chart formatting and stores the colors that are in use when you save the chart as a template. When you use a chart template to create a chart in another workbook, the new chart uses the colors of the chart template — not the colors of the document theme that is currently applied to the workbook. To use the document theme colors instead of the chart template colors, right-click the chart area, and then click **Reset to Match Style**.

Two ways to build dynamic charts in Excel

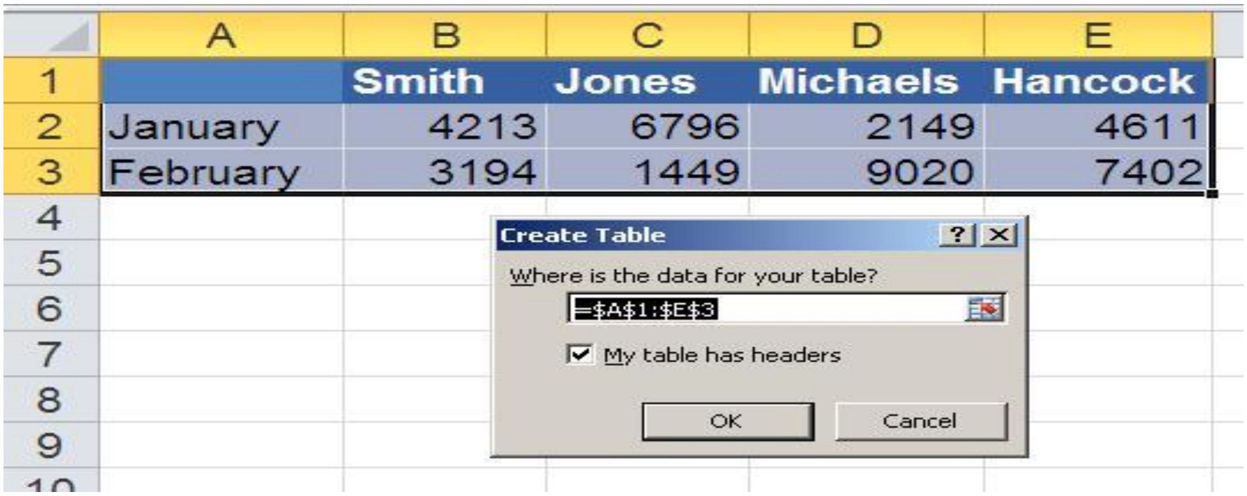
Users will appreciate a chart that updates right before their eyes. In Excel 2007 and 2010 it's as easy as creating a table. In earlier versions, you'll need the formula method.

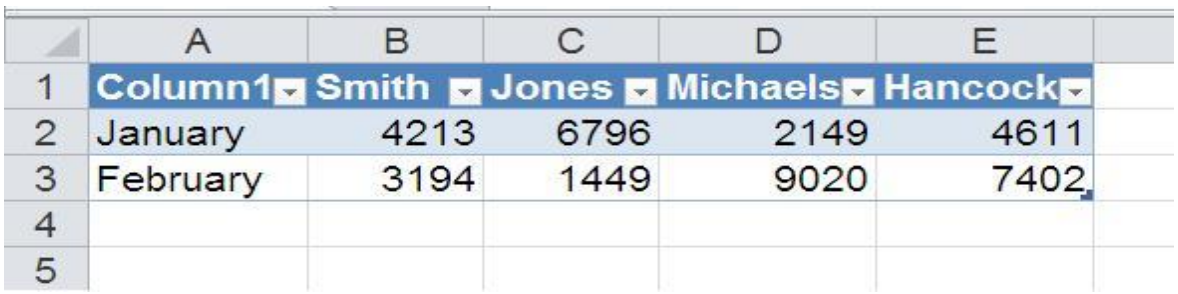
If you want to advance beyond your ordinary spreadsheet skills, creating dynamic charts is a good place to begin that journey. The key is to define the chart's source data as a dynamic range. By doing so, the chart will automatically reflect changes and additions to the source data. Fortunately, the process is easy to implement in Excel 2007 and 2010 *if* you're willing to use the table feature. If not, there's a more complex method. We'll explore both.

The table method

First, we'll use the table feature, available in Excel 2007 and 2010-you'll be amazed at how simple it is. The first step is to create the table. To do so, simply select the data range and do the following:

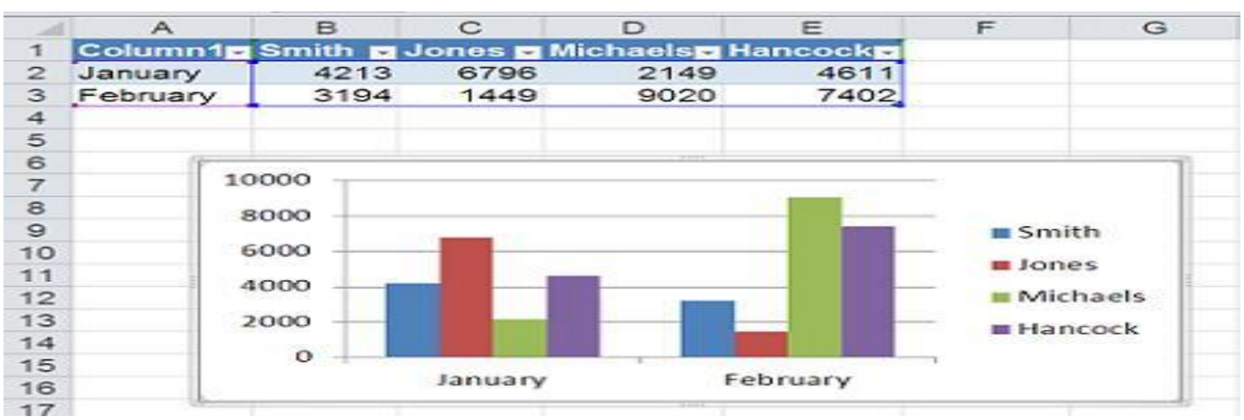
1. Click the Insert tab.
2. In the Tables group, click Table.
3. Excel will display the selected range, which you can change. If the table does *not* have headers, be sure to uncheck the My Table Has Headers option.
4. Click OK and Excel will format the data range as a table.



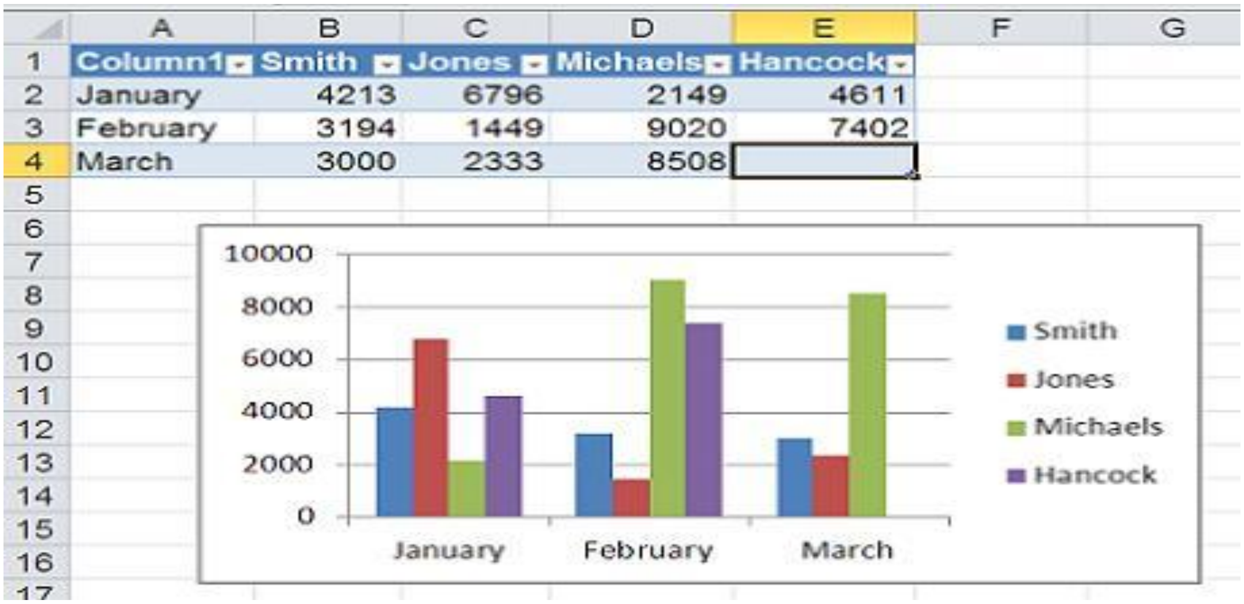


Any chart you build on the table will be dynamic. To illustrate, create a quick column chart as follows:

1. Select the table.
2. Click the Insert tab.
3. In the Charts group, choose the first 2-D column chart in the Chart dropdown.



Now, update the chart by adding values for March and watch the chart update automatically.



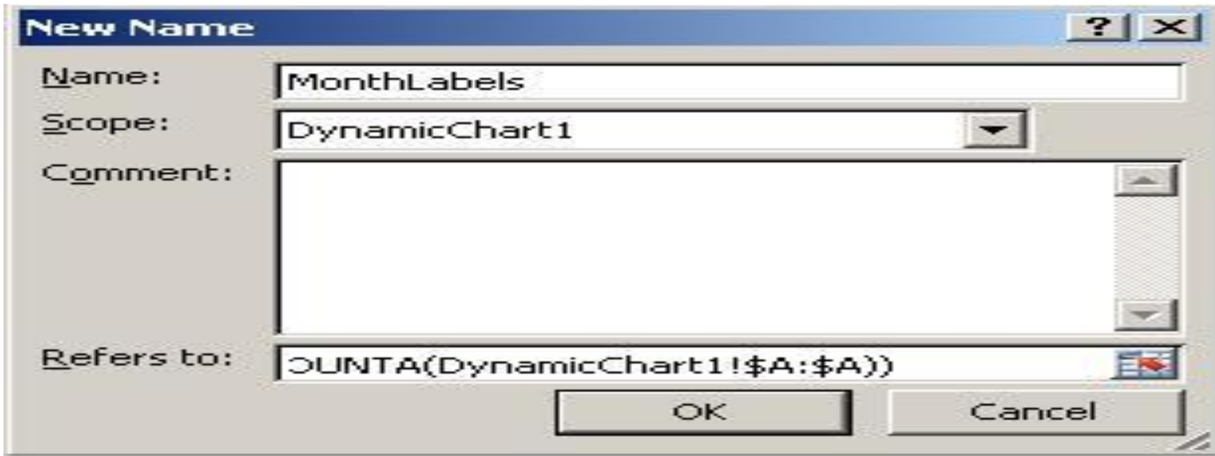
	A	B	C	D	E	F	G
1	Column1	Smith	Jones	Michaels	Hancock		
2	January	4213	6796	2149	4611		
3	February	3194	1449	9020	7402		
4	March	3000	2333	8508			

The dynamic formula method

You won't always want to turn your data range into a table. Furthermore, this feature isn't available in pre-ribbon versions of Office. When either is the case, there's a more complex formula method. It relies on dynamic ranges that update automatically, similar to the way the table does, but only with a little help from you.

Using our earlier sheet, you'll need five dynamic ranges: one for each series and one for the labels. Instructions for creating the dynamic range for the labels in column A follow. Then, use these instructions to create a dynamic label for columns B through E. To create the dynamic range for column A, do the following:

1. Click the Formulas tab.
2. Click the Define Names option in the Defined Names group.
3. Enter a name for the dynamic range, Month Labels.
4. Choose the current sheet. In this case, that's DynamicChart1. You can use the worksheet, if you like. In general, it's best to limit ranges to the sheet, unless you intend to utilize them at the workbook level.
5. Enter the following formula:
   =OFFSET(DynamicChart1!$A$2,0,0,COUNTA(DynamicChart1!$A:$A))
6. Click OK.



Now, repeat the above instructions, creating a dynamic range for each series using the following range names and formulas:

- **SmithSeries**: =OFFSET(DynamicChart1!$B$2,0,0,COUNTA(DynamicChart1!$B:$B)-1)
- **JonesSeries**: =OFFSET(DynamicChart1!$C$2,0,0,COUNTA(DynamicChart1!$C:$C)-1)
- **MichaelsSeries**: =OFFSET(DynamicChart1!$D$2,0,0,COUNTA(DynamicChart1!$D:$D)-1)
- **HancockSeries**: =OFFSET(DynamicChart1!$E$2,0,0,COUNTA(DynamicChart1!$E:$E)-1)

Notice that first range reference starts with row 2. That's because there's a row of headings in row 1. The second set of references refers to the entire column, enabling the formula to accommodate all values in the column, not just a specific range. The addition of the -1 component eliminates the heading cell from the count. The first formula (for the labels in column A) doesn't have this component.

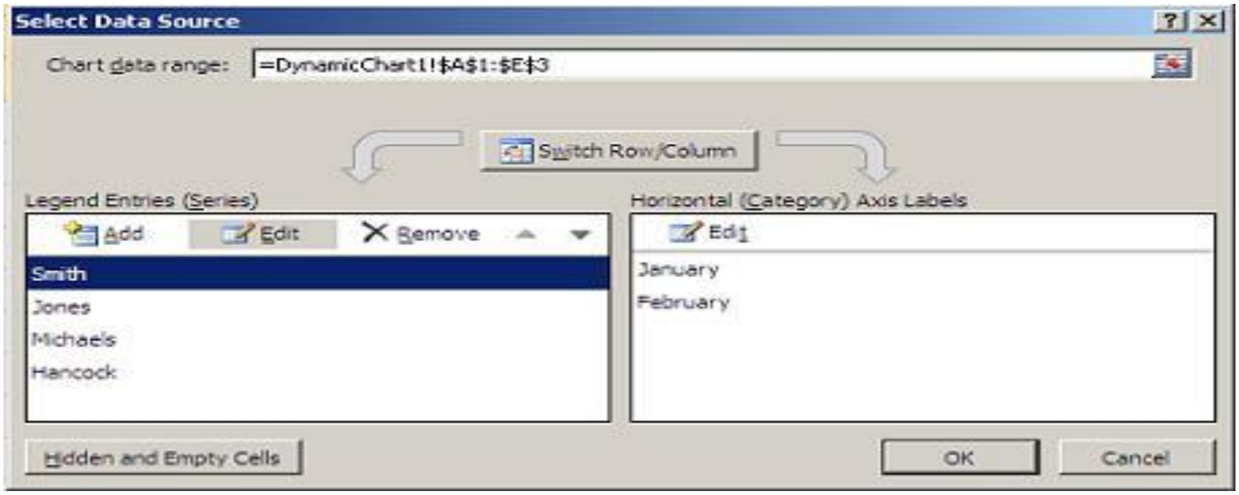
It's important to remember that you *must* enter new data in a contiguous manner. If you skip rows or columns, this technique won't work as expected.

You might be wondering why I added the Series label to each range name. Using the name, alone, will confuse Excel. The series headings in row 1 are also names. Because the chart defaults will use the label headings in each column for each series name, you can't use those labels to name the dynamic ranges. Don't use the same labels for both your spreadsheet headings and your dynamic range names.

Next, insert a column chart, as you did before. If you enter new data, the chart won't yet reflect it. That's because the chart, by default, references a specific data range, DynamicChart1:A1:E3. We need to change that reference to the dynamic ranges we just created, as follows:

1. In the chart, right-click any column.
2. From the resulting submenu, choose Select Data.
3. In the list on the left, select Smith and then click Edit. (Remember the naming conflict I mentioned? Excel uses the column heading (cell B1) to name the series.)
4. In the resulting dialog, enter a reference to Smith's dynamic range in the Series Values control. In this case, that's =DynamicChart1!SmithSeries.

5. Click OK.

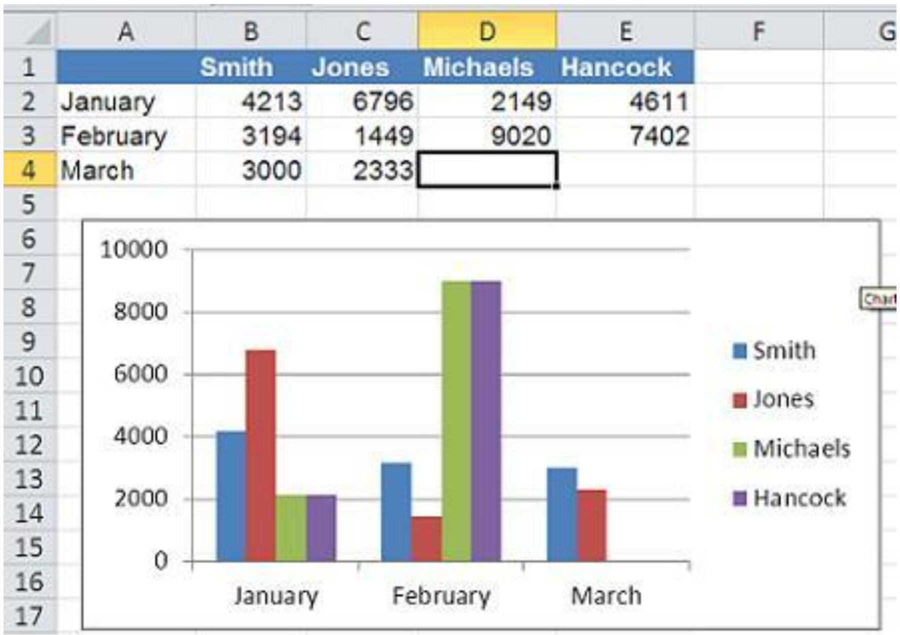


Repeat the above process to update the remaining series to reflect their dynamic ranges: DynamicChart1!JonesSeries;DynamicChart1!MichaelsSeries;and DynamicChart1!HancockSeries.

Next, update the chart's axis labels (column A), as follows:

1. In the Select Data Source dialog, click January (in the list to the right).
2. Then, click Edit.
3. In the resulting dialog, reference the axis label's dynamic range, DynamicChart1!Month Labels.
4. Click OK.

You don't have to update February; Excel does that for you. Now, start entering data for March and watch the chart automatically update! Just remember, you must enter data contiguously; you can't skip rows or columns.



This formula method is more complex than the table method. Be careful naming the dynamic ranges and updating the series references. It's easy to enter typos. If the chart doesn't update, check the range references.

----oooOooo---

UNIT-II

SENSITIVITY ANALYSIS USING EXCEL

Scenario manager, other sensitivity analysis features, simulation using excel different statistical distributions used in simulation generating random numbers that follow a particular distribution, building models in finance using simulation.

SENSITIVITY ANALYSIS USING EXCEL:

The main goal of sensitivity analysis is to gain insight into which assumptions are critical, i.e., which assumptions affect choice. The process involves various ways of changing input values of the model to see the effect on the output value. In some decision situations you can use a single model to investigate several alternatives. In other cases, you may use a separate spreadsheet model for each alternative.

MANUAL WHAT-IFANALYSIS:

Using this approach, you enter values into cells C4:C6 and see what the effect is on net cash flow. For example, with the predetermined price of $29, you may think that Units Sold will be in the range between 500 and 900 units. Keeping other input assumptions at base case, the corresponding Net Cash Flows are $1,500 and 56,900. When we vary a single input assumption. Keeping all other input assumptions at their base case values, we say we are doing "one at a time" or "single factor" sensitivity analysis

Figure 2.1 Model Display and Formula View

	A	B	C
1	Controllable Input		
2		Unit Price	$29
3	Uncontrollable Inputs		
4		Units Sold	700
5		Unit Variable Cost	$8
6		Fixed Costs	$12,000
7	Performance Measure		
8		Net Cash Flow	$2,700

	A	B	C
1	Controllable Input		
2		Unit Price	29
3	Uncontrollable Inputs		
4		Units Sold	700
5		Unit Variable Cost	8
6		Fixed Costs	12000
7	Performance Measure		
8		Net Cash Flow	=C4*(C2-C5)-C6

THRESHOLD VALUES:

You are usually interested in how the input assumptions eventually affect the recommended choice in the decision problem. In the professor's summer decision problem, the software alternative (uncertain payoff) is being compared with teaching MBA's (Payoff $4,300) and taking a vacation (payoff $0). An example of a threshold is to ask "How many units must I sell to do better with software than with teaching."

In other words, in the software spreadsheet model, what must the value of units sold in cell c4 be so that the value of Net Cash Flow in cell C8 is equal to $4,300? You could find the answer by involving one unknown. Or, you could let Excel find the answer.

GOAL SEEK:

To answer the question using an Excel feature, choose Tools| Goal Seek. In Excel 2007 or 2010, choose Data | What-if Analysis| Goal Seek. In Excel terminology, you want to “set cell” CS “To value” 4300 ”By changing cell” C4 Figure 2.2 shows the entries when you point to cells C8 and C4, in which case they appear in the range edit boxes as absolute references, indicated by the dollar signs.

Figure 2.2 Goal Seek Dialog Box

Alternatively, you could type C8 and C4 into the edit boxes instead of pointing. When you click OK. Excel displays a Goal Seek Status message, as shown in Figure 2.3. If there is a complex or discontinuous relationship between the changing cell and the set cell, the Goal Seek Status message may say that it was not able to fine a solution.

Alternatively, you could type C8 and C4 into the edit boxes instead of pointing. When you click OK, Excel displays a Goal Seek Status message, as shown in Figure 2.3. If there is a complex or discontinuous relationship between the changing cell and the set cell, the Goal Seek Status message may say that it was not able to find a solution.

Figure 2.3 Goal Seek Status

To dismiss the message, click OK, in is formatted to display integer values. The formula bas shows that the exact value is 776. which case Excel shows the results in the spreadsheet model Figure 2.4 shows that you must sell at least 776 units to hve higher cash flow with the software than teaching MBAs. Cell C41904716190476, using Excel’s precision of fifteen significant digits

Figure 2.4 Units Sold Threshold for $4,300 Net Cash Flow

	A	B	C
1	Controllable Input		
2		Unit Price	$29
3	Uncontrollable Inputs		
4		Units Sold	776
5		Unit Variable Cost	$8
6		Fixed Costs	$12,000
7	Performance Measure		
8		Net Cash Flow	$4,300

BREAKEVEN POINT

A special case of threshold analysis is the breakeven point, usually defined as the sales volume at which contribution to profit and overhead equals fixed cost. In the software model, the breakeven point is the value for Units Sold when Net Cash Flow is zero. Using Goal Seek (not shown here), the breakeven point is found to be 571. The professor must sell at least 571 units to have higher cash flow with the software than taking a vacation. You could also use single-factor sensitivity analysis to determine threshold values for the other input assumptions of the model.

ONE-VARIABLE DATA TABLE

For a model with numerical input and numerical output, use the One Input One Output feature of the SensIt sensitivity analysis add-in.

Use Excel's Data Table command to perform sensitivity analysis for ranges of values of a model input, not just specific points.

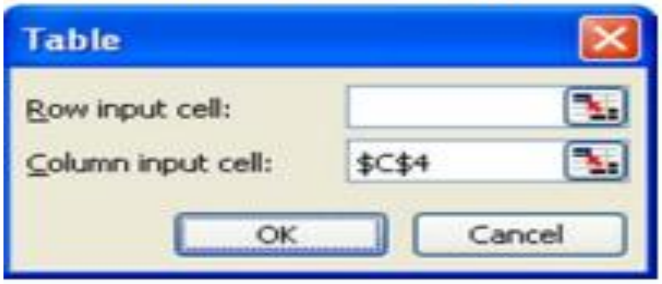
1. Enter a list of input values in a column, e.g., cells E3:E11 in Figure 2.5
2. Enter a reference to an output formula at top of adjacent column, e.g., = C8 in cell F2
3. Select entire table (two columns including formula), e.g., cells E2:F11

Figure 2.5 Setup for One-Variable Data Table

	A	B	C	D	E	F
1	Controllable Input				Units Sold	Net Cash Flow
2		Unit Price	$29			=C8
3	Uncontrollable Inputs				500	
4		Units Sold	700		550	
5		Unit Variable Cost	$8		600	
6		Fixed Costs	$12,000		650	
7	Performance Measure				700	
8		Net Cash Flow	$2,700		750	
9					800	
10					850	
11					900	

4. Choose Data |Table, in Excel 2007 or 2010, choose Data| What-If Analysis| Data Table
5. Since the list of values are in a column, use the "Column input cell" edit box to specify where those values should be input into the model, e.g., cell C4, as shown in Figure 2.6

Figure 2.6 Data Table Dialog Box for One-Variable Example



6. The results appear as shown in columns E and F in Figure 2.7
7. Select cell F2, right-click, choose Format Cells |Number| custom, and enter a three-semicolon custom formate so that the base case result is not displayed.
8. Use successive data table to refine the search for the $0 threshold

Figure 2.7 Data Table Results for One-Variable, Net Cash Flow = $0

	E	F	G	H	I	J	K	L
1	Units Sold	Net Cash Flow		Units Sold	Net Cash Flow		Units Sold	Net Cash Flow
2								
3	500	-$1,500		550	-$450		570	-$30
4	550	-$450		560	-$240		571	-$9
5	600	$600		570	-$30		572	$12
6	650	$1,650		580	$180		573	$33
7	700	$2,700		590	$390		574	$54
8	750	$3,750		600	$600		575	$75
9	800	$4,800					576	$96
10	850	$5,850					577	$117
11	900	$6,900					578	$138
12							579	$159
13							580	$180

Data tables are dynamic functions, so you could narrow the search by changing the Units Sold values in the original data table. Or, you could use multiple data tables to illustrate the search. We conclude that we must sell at least 572 units to break even.

Figure 2.8 Data Table Results for One-Variable, Net Cash Flow = $4300

	E	F	G	H	I	J	K	L
1	Units Sold	Net Cash Flow		Units Sold	Net Cash Flow		Units Sold	Net Cash Flow
2								
3	500	-$1,500		750	$3,750		770	$4,170
4	550	-$450		760	$3,960		771	$4,191
5	600	$600		770	$4,170		772	$4,212
6	650	$1,650		780	$4,380		773	$4,233
7	700	$2,700		790	$4,590		774	$4,254
8	750	$3,750		800	$4,800		775	$4,275
9	800	$4,800					776	$4,296
10	850	$5,850					777	$4,317
11	900	$6,900					778	$4,338
12							779	$4,359
13							780	$4,380

You can use the same approach to find the threshold value of units sold (777) for net cash flow of $4,300, as shown in Figure 2.8.

LINE CHART OR XY (SCATTER) CHART:

The results of the Data table command may be displayed using either a Line chart type or an XY (Scatter) chart type; both types have a continuous numerical vertical axis. However, the Line chart has a categorical horizontal axis, which means that the worksheet data is displayed as equally spaced text values. Only the XY (Scatter) chart has a numerical horizontal axis. Since the input values to a data table are usually equally-spaced, you can use either chart type to display the results. When the data for the horizontal axis are not equally-spaced, it is important to use the XY (Scatter) chart type.

TWO-VARIABLE DATA TABLE:

For ranges of values for two model inputs

Useful for examining possible relationships and threshold combinations

Steps: enter list of one input's values in a column
Enter list of other inputs' values in a row
Enter reference to output formula in top left corner

Figure 2.9 Setup for Two-Variable Example

	E	F	G	H	I	J	K	L	M	N	O
1											
2			Units Sold								
3		=C8	500	550	600	650	700	750	800	850	900
4	Unit	$6.00									
5	Variable	$6.50									
6	Cost	$7.00									
7		$7.50									
8		$8.00									
9		$8.50									
10		$9.00									
11		$9.50									
12		$10.00									
13		$10.50									
14		$11.00									

Select entire table, choose Data| Table or Data| What-If Analysis | Data Table specify two input cells of the model, click OK.

Figure 2.10 Data Table Dialog Box for Two-Variable Example

Figure 2.11 Data Table Results for Two-Variable Example

	E	F	G	H	I	J	K	L	M	N	O
1											
2	Net Cash Flow						Units Sold				
3			500	550	600	650	700	750	800	850	900
4	Unit	$6.00	-$500	$650	$1,800	$2,950	$4,100	$5,250	$6,400	$7,550	$8,700
5	Variable	$6.50	-$750	$375	$1,500	$2,625	$3,750	$4,875	$6,000	$7,125	$8,250
6	Cost	$7.00	-$1,000	$100	$1,200	$2,300	$3,400	$4,500	$5,600	$6,700	$7,800
7		$7.50	-$1,250	-$175	$900	$1,975	$3,050	$4,125	$5,200	$6,275	$7,350
8		$8.00	-$1,500	-$450	$600	$1,650	$2,700	$3,750	$4,800	$5,850	$6,900
9		$8.50	-$1,750	-$725	$300	$1,325	$2,350	$3,375	$4,400	$5,425	$6,450
10		$9.00	-$2,000	-$1,000	$0	$1,000	$2,000	$3,000	$4,000	$5,000	$6,000
11		$9.50	-$2,250	-$1,275	-$300	$675	$1,650	$2,625	$3,600	$4,575	$5,550
12		$10.00	-$2,500	-$1,550	-$600	$350	$1,300	$2,250	$3,200	$4,150	$5,100
13		$10.50	-$2,750	-$1,825	-$900	$25	$950	$1,875	$2,800	$3,725	$4,650
14		$11.00	-$3,000	-$2,100	-$1,200	-$300	$600	$1,500	$2,400	$3,300	$4,200

To display the results as a 3-D Column chart or 3-D surface chart, the cell at the intersection of the X labels and Y labels must be empty. If you clear the contents of F3, the values in the body of the data table change to zero. Copy the entire table., e.g., cells E1:O14, select cell Q1, and choose Edit| Paste Special| Values and number formats. Select cell R3, and choose Edit|clear contents Select R3:AA14 9in general, X labels on the left. Y labels on the top, Z values in the body of the table, and a blank cell in the top left corner of the range).

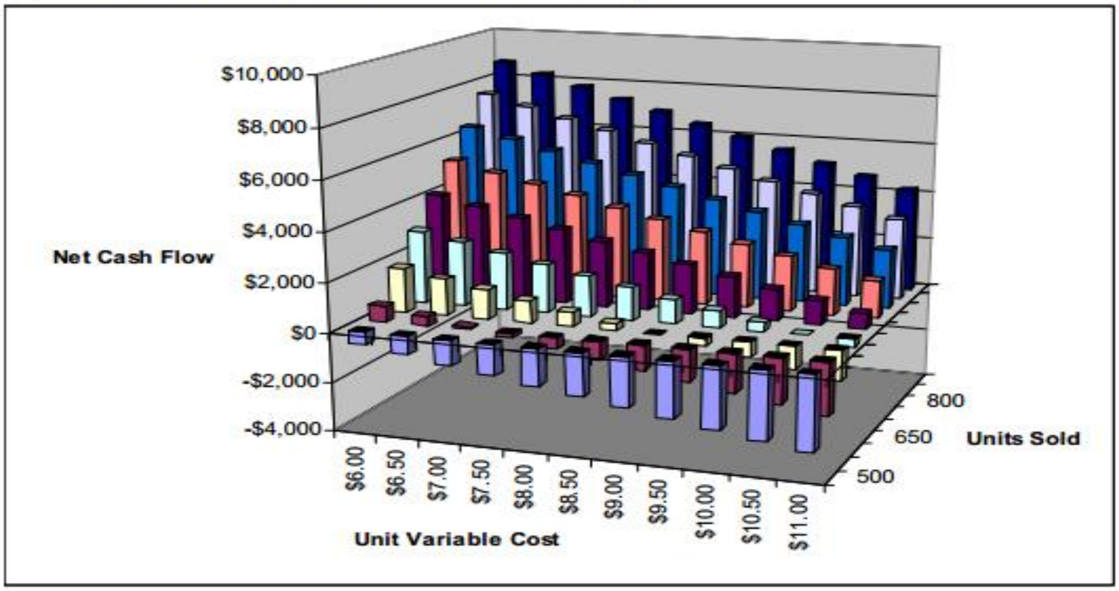
Figure 2.12 Data Values for Two-Variable Example

	Q	R	S	T	U	V	W	X	Y	Z	AA
1											
2	Net Cash Flow						Units Sold				
3			500	550	600	650	700	750	800	850	900
4	Unit	$6.00	-$500	$650	$1,800	$2,950	$4,100	$5,250	$6,400	$7,550	$8,700
5	Variable	$6.50	-$750	$375	$1,500	$2,625	$3,750	$4,875	$6,000	$7,125	$8,250
6	Cost	$7.00	-$1,000	$100	$1,200	$2,300	$3,400	$4,500	$5,600	$6,700	$7,800
7		$7.50	-$1,250	-$175	$900	$1,975	$3,050	$4,125	$5,200	$6,275	$7,350
8		$8.00	-$1,500	-$450	$600	$1,650	$2,700	$3,750	$4,800	$5,850	$6,900
9		$8.50	-$1,750	-$725	$300	$1,325	$2,350	$3,375	$4,400	$5,425	$6,450
10		$9.00	-$2,000	-$1,000	$0	$1,000	$2,000	$3,000	$4,000	$5,000	$6,000
11		$9.50	-$2,250	-$1,275	-$300	$675	$1,650	$2,625	$3,600	$4,575	$5,550
12		$10.00	-$2,500	-$1,550	-$600	$350	$1,300	$2,250	$3,200	$4,150	$5,100
13		$10.50	-$2,750	-$1,825	-$900	$25	$950	$1,875	$2,800	$3,725	$4,650
14		$11.00	-$3,000	-$2,100	-$1,200	-$300	$600	$1,500	$2,400	$3,300	$4,200

Use the chart Wizard to create a 3-D Column chart. In Excel 2007 or 2010, choose Insert | (Charts) Column. Do not choose the Stacked or Clustered types of 3-D Column charts.

Select the legend, and press the Delete key. To add axis title, click the chart to select it, and choose Chart| Chart Options | Titles. The X axis is Unit Variable Cost, the Y axis is Units Sold, and the Z axis is Zet Cash Flow. In Excel 2007 or 2010, select the chart, and choose. Chart Tools | Layout | (Labels) Axis Titles. The primary horizontal axis is Unit Variable Cost, the primary vertical axis is Net Cash Flow, and the depth axis is Units Sold.

Figure 2.13 3-D Column Chart for Two-Variable Example



OVERALL WORST CASE AND BEST CASE:

Figure 2.14 shows ranges for each uncontrollable input assumption. The decision maker may investigate the base case or best-guess assumption first. Next extreme values are specified for each input. Each of the extreme values is based on business judgment, perhaps by consulting with colleagues. The extreme values may be the absolute minimum and maximum that the decision maker thinks are possible. Or, if the decision maker can think about the uncertainty using probability, he or she may use the 120% fractile as a minimum value and the 90% fractile as the maximum. Or, the 5% fractile and 95% fractile may be specified. Whatever method is used, the extreme values for each input assumption should be equally extreme so that the results are comparable.

Figure 2.14 Extreme Values for Input Assumptions

	A	B	C	D	E	F	G
1	Controllable Input						
2		Unit Price	$29				
3	Uncontrollable Inputs				Minimum	Base Case	Maximum
4		Units Sold	700		500	700	900
5		Unit Variable Cost	$8		$6	$8	$11
6		Fixed Costs	$12,000		$10,000	$12,000	$15,000
7	Performance Measure						
8		Net Cash Flow	$2,700				

Figure 2.15 shows the net cash flow of $10,700 using the best case scenario: high values for revenue inputs and low values for cost inputs.

Figure 2.15 Best Case Scenario

	A	B	C	D	E	F	G
1	Controllable Input						
2		Unit Price	$29				
3	Uncontrollable Inputs				Minimum	Base Case	Maximum
4		Units Sold	900		500	700	900
5		Unit Variable Cost	$6		$6	$8	$11
6		Fixed Costs	$10,000		$10,000	$12,000	$15,000
7	Performance Measure						
8		Net Cash Flow	$10,700				

Figure 2.16 shows the net cash flow of -56,000 using the worst case scenario: low values for revenue input and high value for cost input.

Figure 2.16 Worst Case Scenario

	A	B	C	D	E	F	G
1	Controllable Input						
2		Unit Price	$29				
3	Uncontrollable Inputs				Minimum	Base Case	Maximum
4		Units Sold	500		500	700	900
5		Unit Variable Cost	$11		$6	$8	$11
6		Fixed Costs	$15,000		$10,000	$12,000	$15,000
7	Performance Measure						
8		Net Cash Flow	-$6,000				

SCENARIO MANAGER:

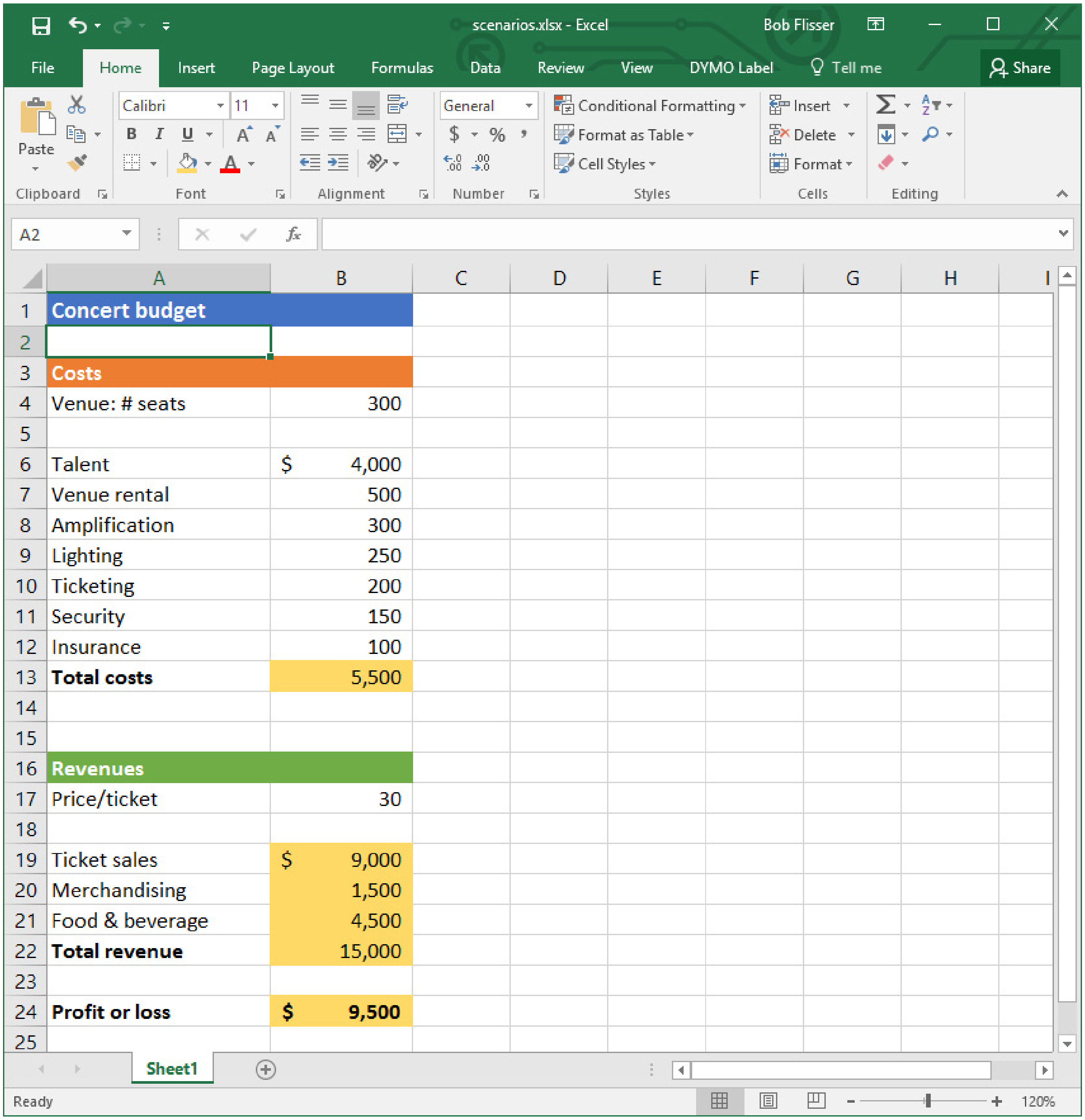
The Scenario Manager is a great, but often overlooked What-If Analysis feature of Excel that will let you swap multiple sets of data in a worksheet and even compare them side-by-side. This technique can help you decide between multiple courses of action or what the implications are among several possibilities.

For example, let's say we are concert promoters and want to produce a show. We need to decide what venue to use because that will determine costs, revenues, profit or loss, and what talent to contract for.

In this exercise, we'll use the Scenario Manager to compare four sets of numbers: small, medium, large and very large locations and their associated costs and revenues, assuming each show sells out.

Download the Practice Worksheet

You can re-create the sheet below or **download practice-files.zip**, which contains the **scenarios.xlsx** worksheet below and a worksheet of the completed Excel Scenario Manager exercise.



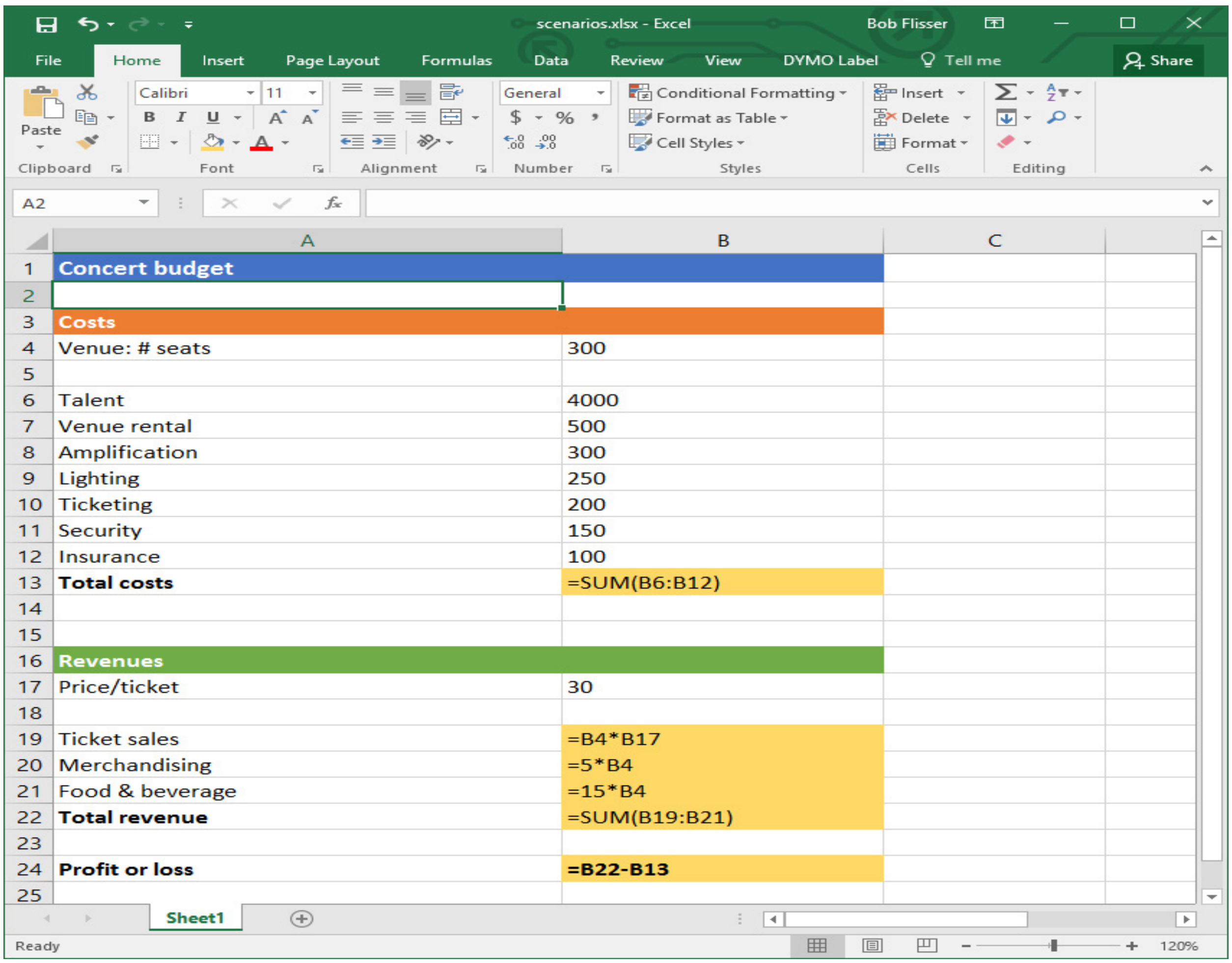
Excel What-If Analysis Scenerio Manager - Practice Worksheet

This sheet currently displays the smallest of the venues, which has 300 seats. The numbers in orange boxes are calculated, so we won't adjust them in the scenarios. Here are the formulas the calculated numbers use:

- B13: *Total costs* add the costs from the cells above.
- B19: *Ticket sales* multiplies the number of seats x ticket price (B4*B17).

- B20: *Merchandising* (t-shirts, souvenirs) assumes patrons purchase an average of $5/seat (5*B4).
- B21: *Food & beverage* assumes patrons purchase an average of $15/seat (15*B4).
- B22: *Total revenue* adds the revenues from the cells above.
- B24: *Profit or loss* subtracts total cost from total revenue (B22-B13).

Tip: press **Ctrl** + (accent mark) to display all the formulas on the sheet at once. Press **Ctrl** + ` again to return the sheet to normal. This shortcut is identical in both Windows and Mac.



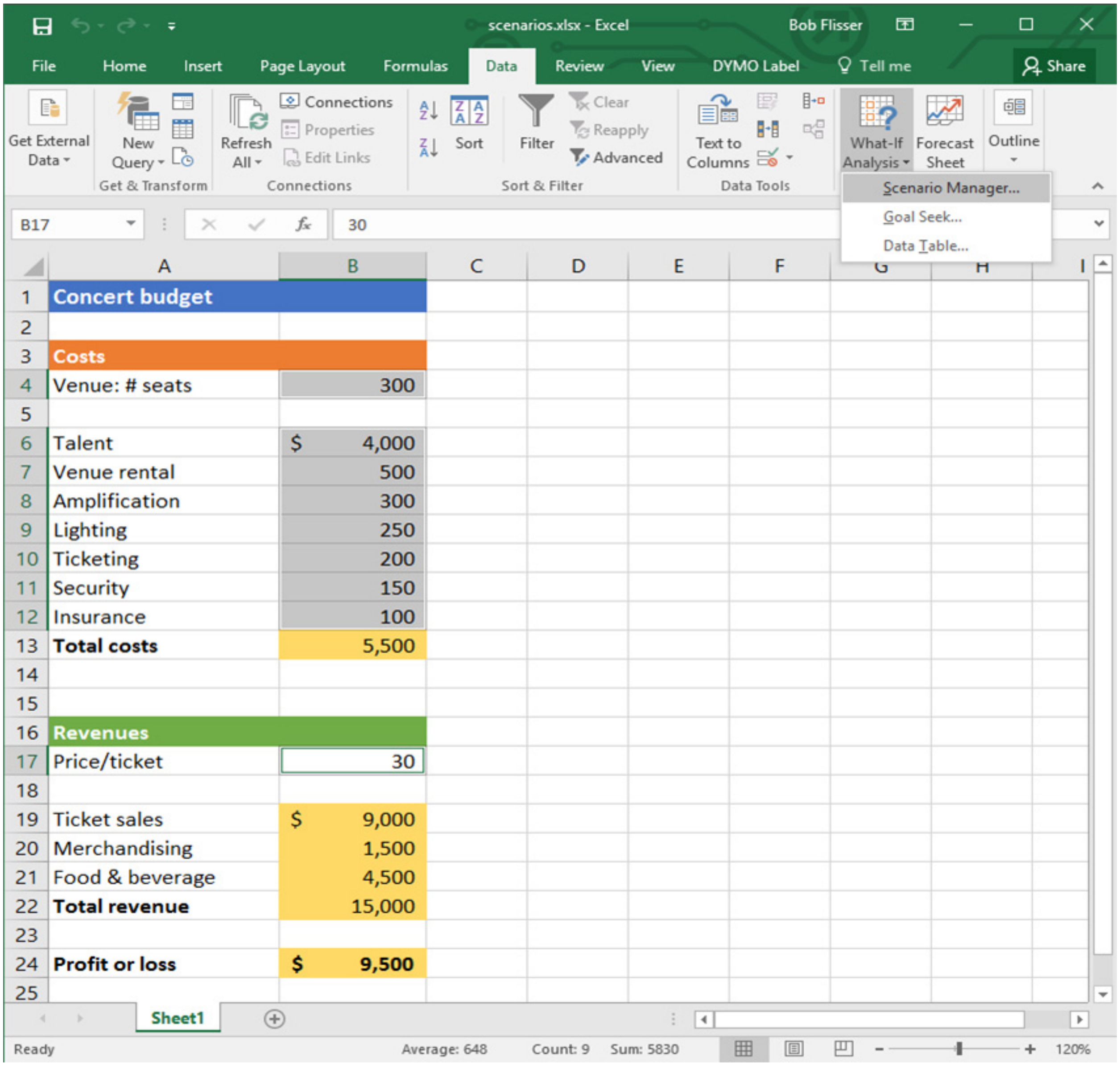
Display formulas using Excel keyboard shortcut

MAKE YOUR FIRST SCENARIO

Step 1: Set up the First Scenario

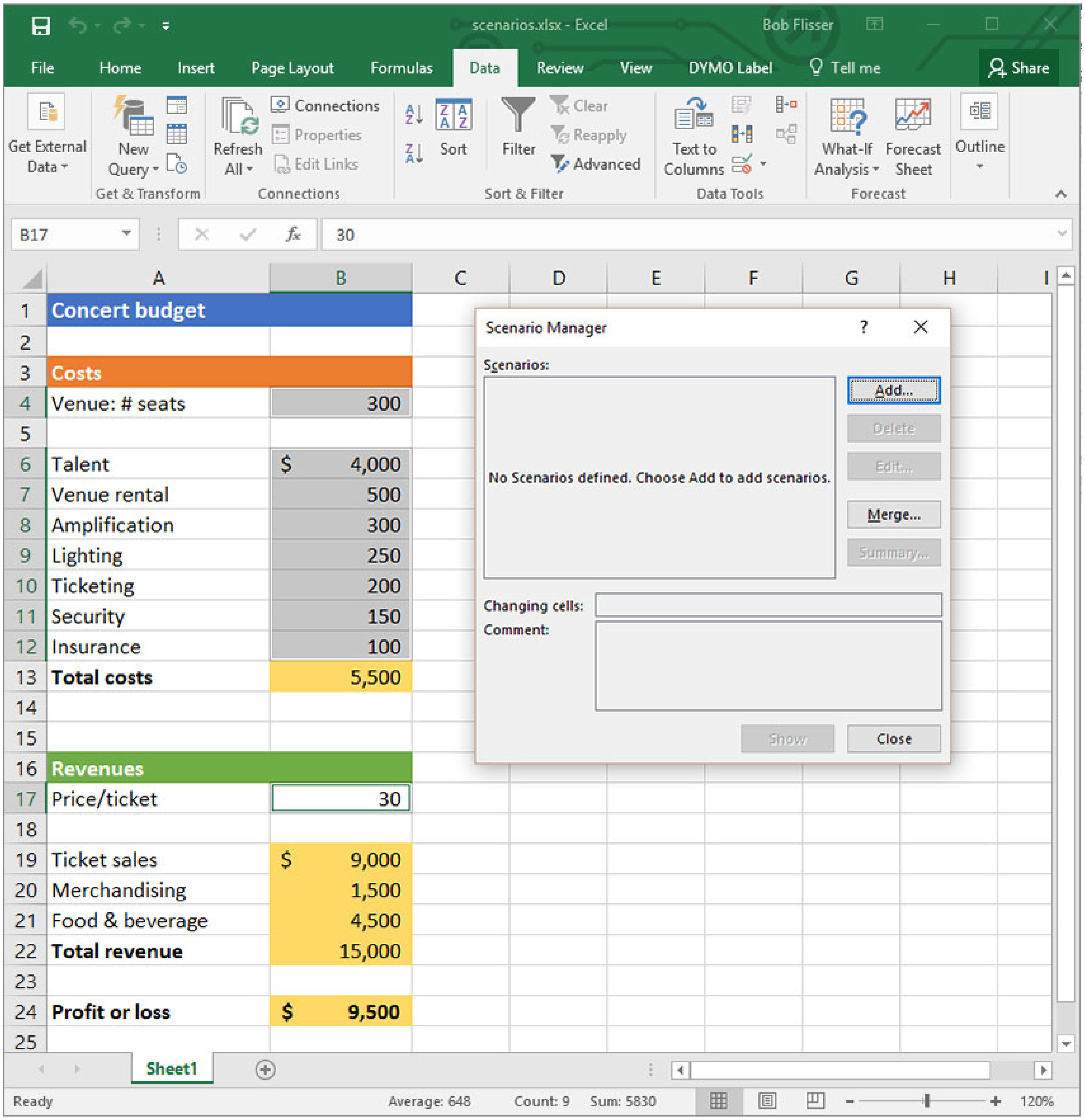
Now we'll dig into What-If Analysis in Excel. We'll open up the Scenario Manager and begin:

1. First, select all the cells that will change. To do that, click B4, hold the **Ctrl** key (**Command** key on the Mac) while dragging from B6 down to B12, then **Ctrl** + click (**Command** + click on the Mac) B17.
2. On the ribbon, select the **Data** tab > **What-If Analysis** > **Scenario Manager**.



Excel What-If Analysis: Scenario Manager

This displays the Scenario Manager dialog box. Since we haven't created any scenarios yet, it says there are none defined.



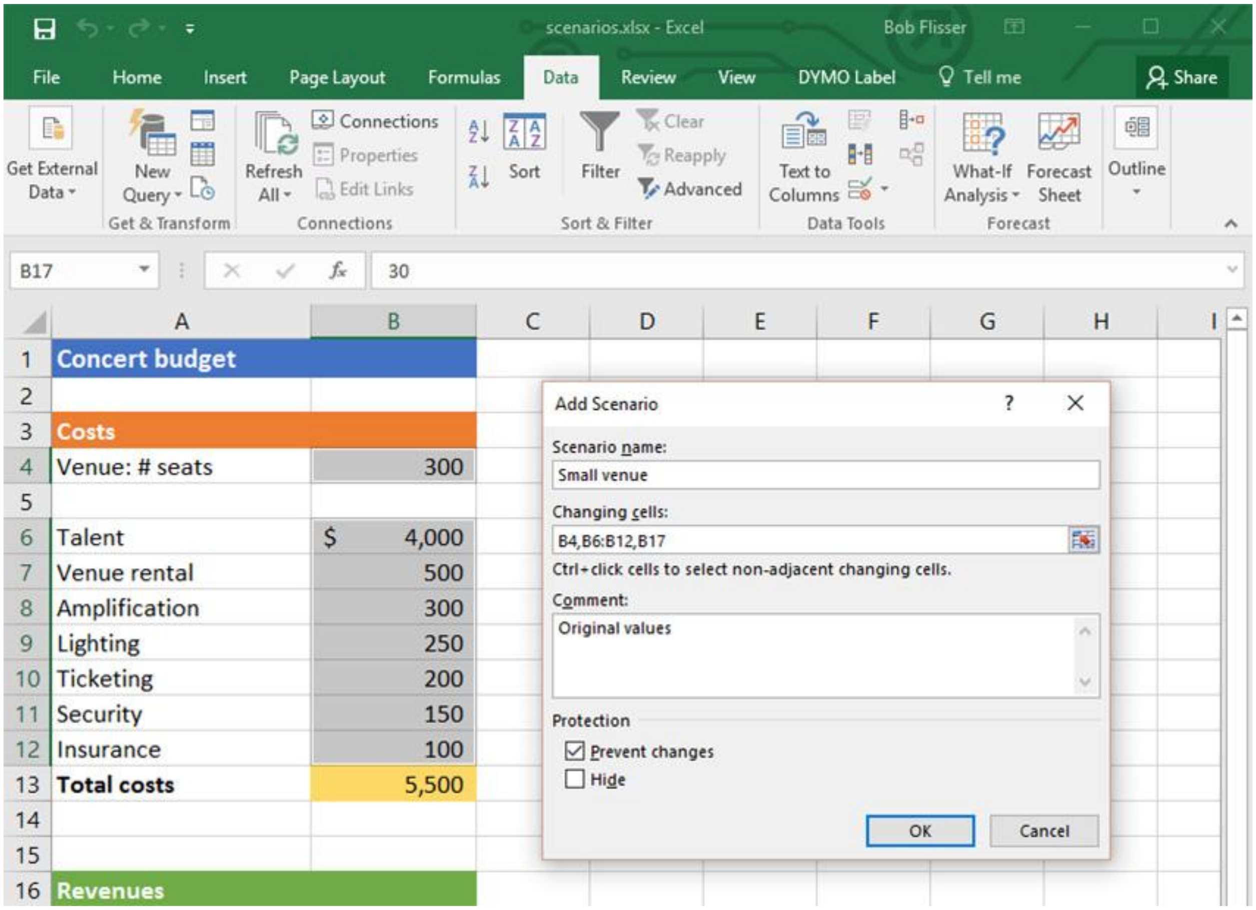
Scenario Manager dialog box

Each scenario will be a set of the cells you just selected, containing unique values. The first set will be the current values.

Step 2: Now Create the First Scenario

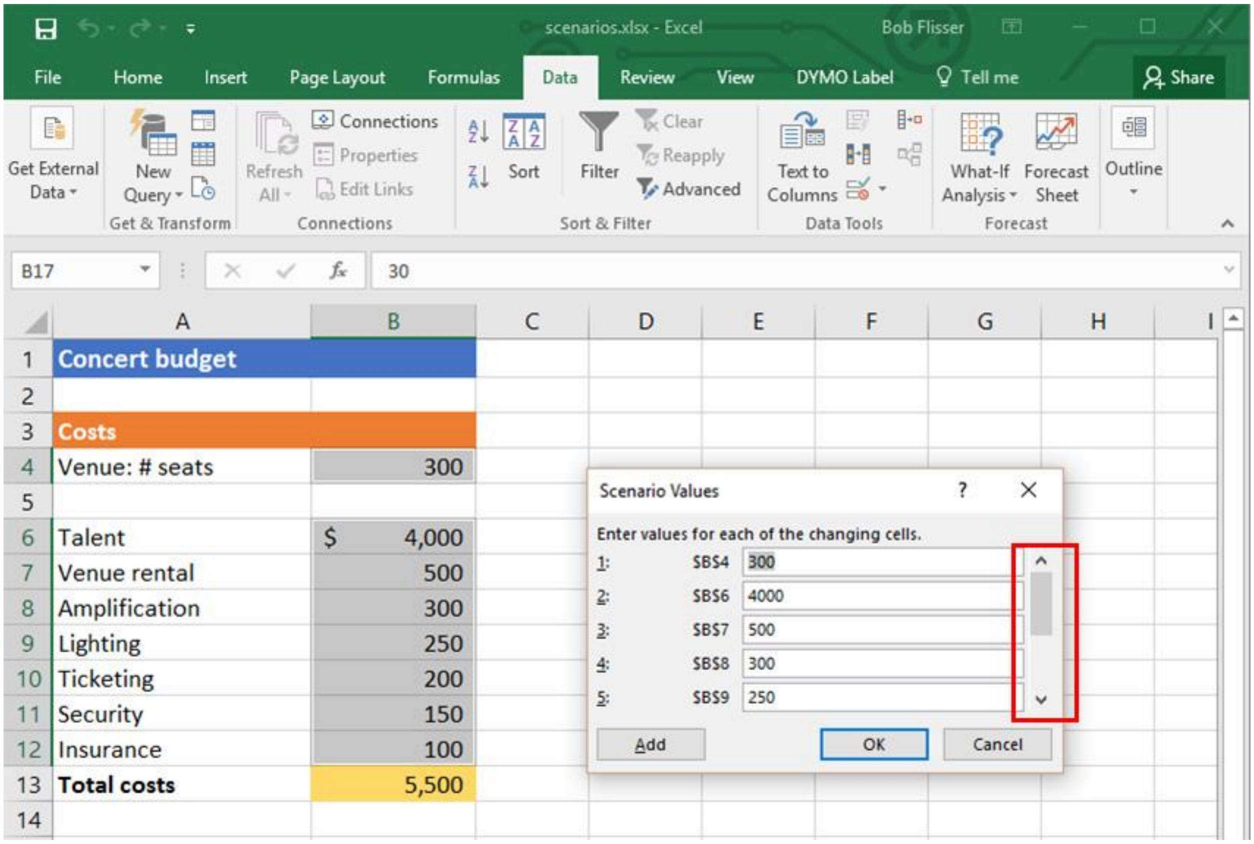
1. In the dialog box, click **Add**.
2. Enter the name **Original values**.
3. The changing cells are what you selected. If you selected different cells by mistake, you can enter the correct ones here (*see image below*).

4. Enter a comment if you want. This is optional.
5. The checkboxes for **Protection** are only if you want to protect the sheet from changes. We won't do that in this exercise, so ignore these choices.



Scenario Protections options

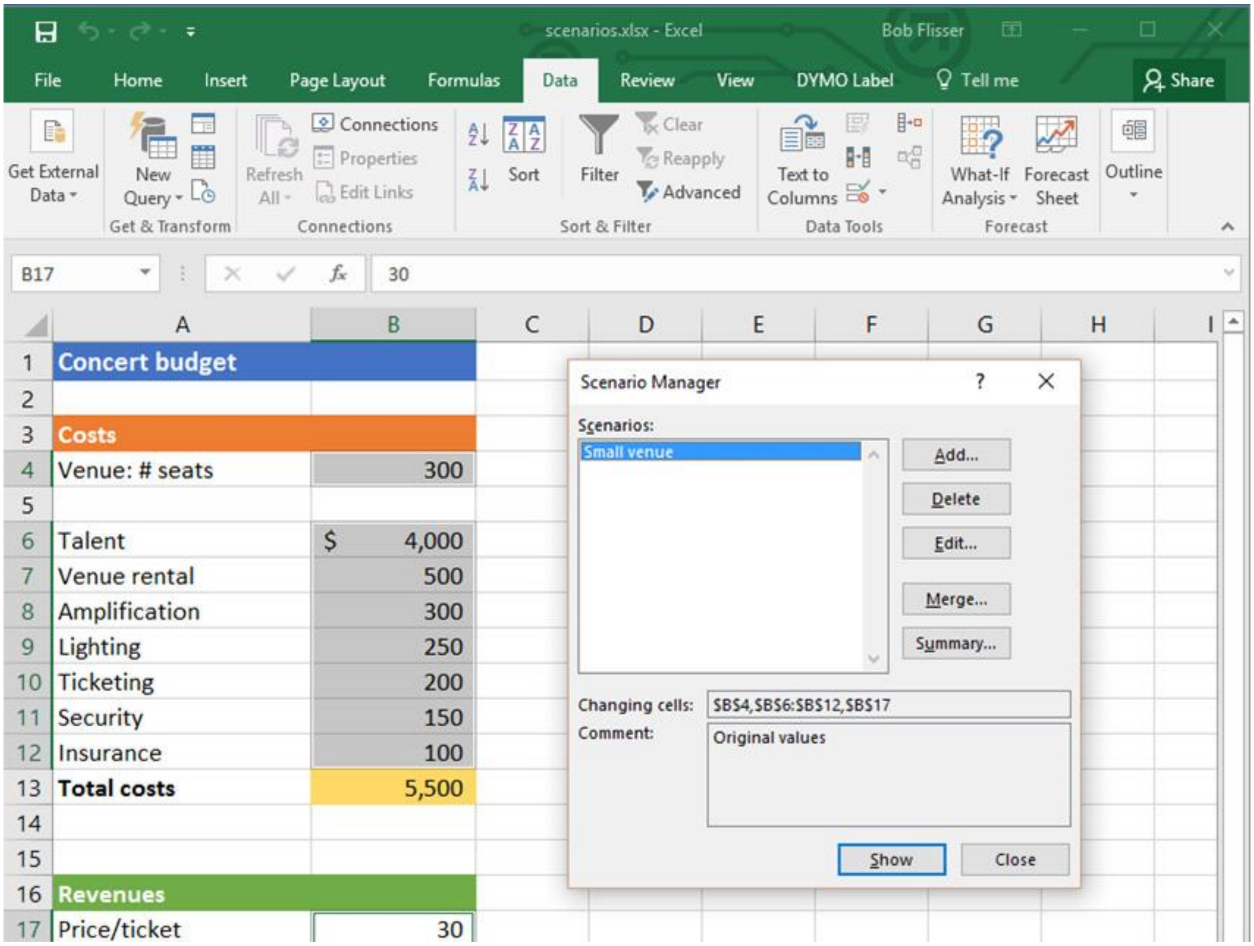
Click **OK**. The Scenario Values dialog box shows you a list of all the cells in the scenario and what their current values are. Note that you can't resize this box, so use its scrollbar to see all of them.



Scenario Values dialog box

For now, there's nothing to change, but note the **Add** button. A quick way of creating several scenarios one after another is to click this **Add** button after entering values. That will immediately display the **Add Scenario** screen.

For now, click **OK**. That brings back the main Scenario Manager dialog, showing the first one listed.



Back to the main Scenario Manager dialog box

The Manager has buttons for adding a new scenario, deleting one, editing one, merging in a scenario from another open workbook, and creating a summary. The summary is the coolest part, and we'll do that below.

CREATE ADDITIONAL SCENARIOS:

Step 1: Add More Scenarios

Click **Add**. This is the same thing as clicking the **Add** button in the previous step.

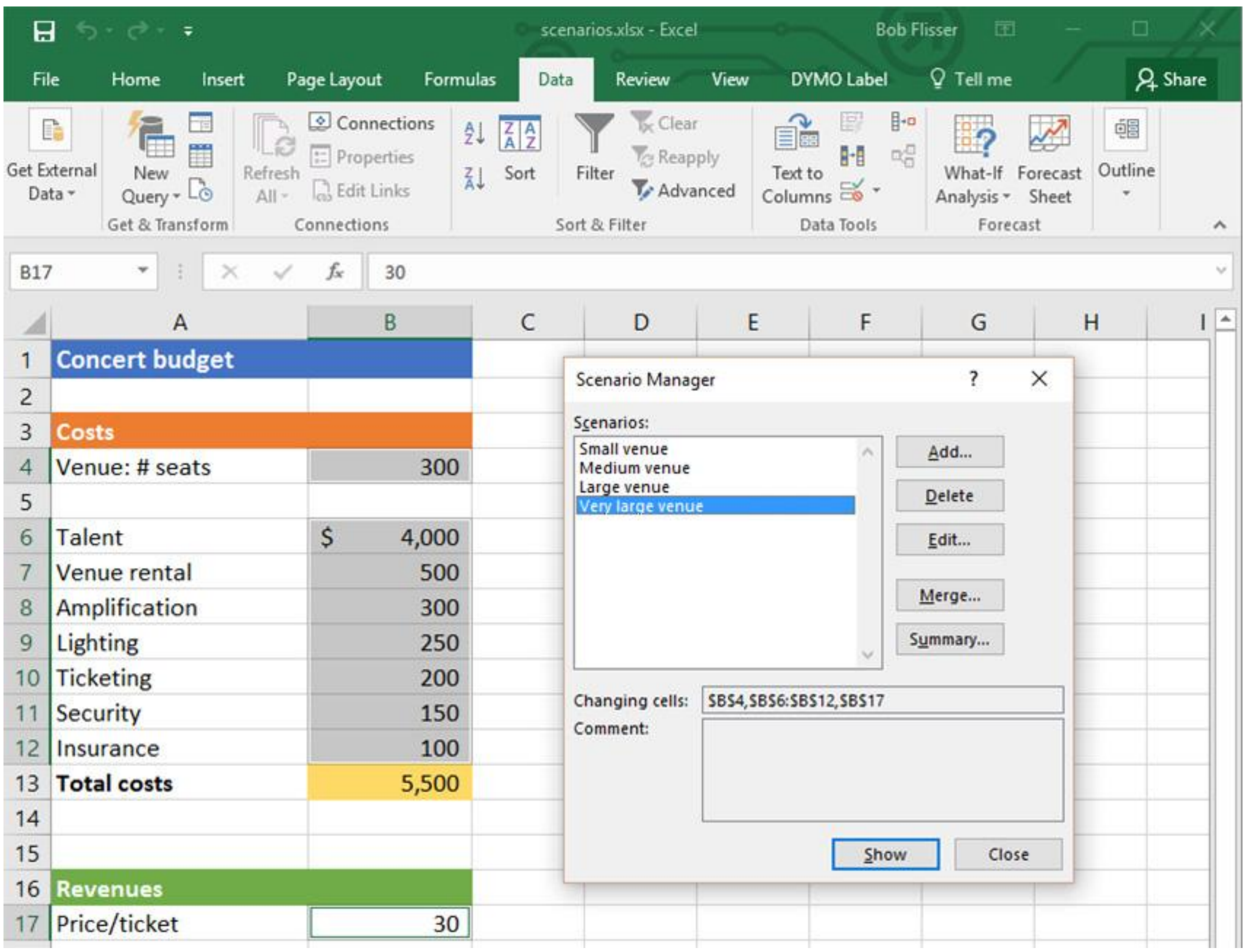
Create 3 more scenarios using the data from the table below. The general concept is that larger venues will have higher costs – not always in proportion – along with the ability to charge higher ticket prices resulting in greater revenues. For the sake of simplicity, assume that if a concert has more than one act, they're combined in the **Artist** category.

The fastest way of entering the numbers is not to use the mouse. Just type a number, press the **Tab** key, type another number, press the **Tab** key, and so on.

Description	Value
Scenario name	Medium venue
B4 (# of seats)	800
B6 (artist)	7500
B7 (venue rental)	1000
B8 (amplification)	600
B9 (lighting)	350
B10 (ticketing)	250
B11 (security)	300
B12 (insurance)	250
B17 (ticket price)	35
Scenario name	Large venue
B4 (# of seats)	1500
B6 (artist)	12000
B7 (venue rental)	3500
B8 (amplification)	1000
B9 (lighting)	700
B10 (ticketing)	350
B11 (security)	1000
B12 (insurance)	500
B17 (ticket price)	50
Scenario name	Very large venue
B4 (# of seats)	5000
B6 (artist)	25000
B7 (venue rental)	10000
B8 (amplification)	2500

B9 (lighting)	2000
B10 (ticketing)	500
B11 (security)	2500
B12 (insurance)	2500
B17 (ticket price)	50

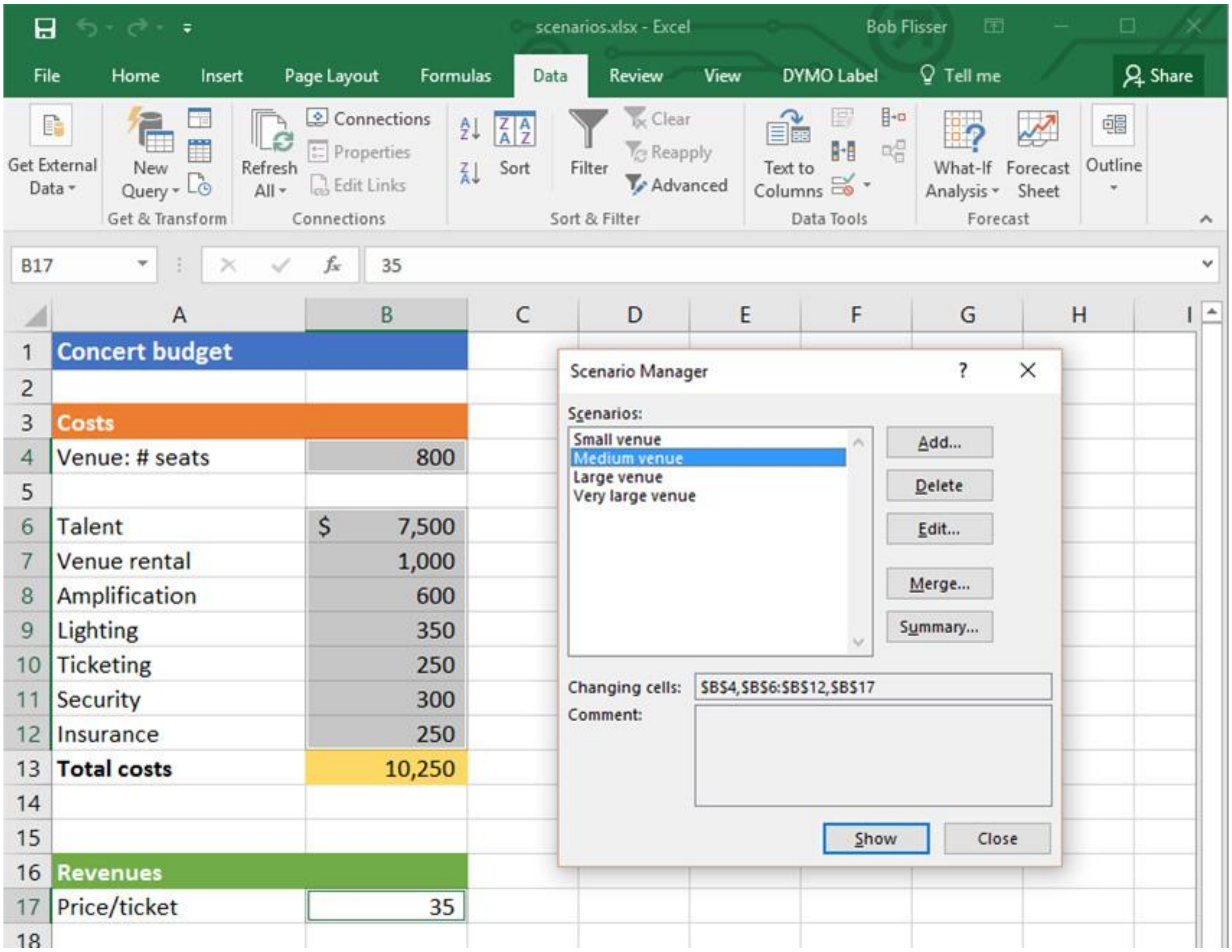
After entering the last scenario, click **OK** to return to the main Scenario Manager screen. It should look like this:



Scenario Manager screen

Step 2: Switch Between

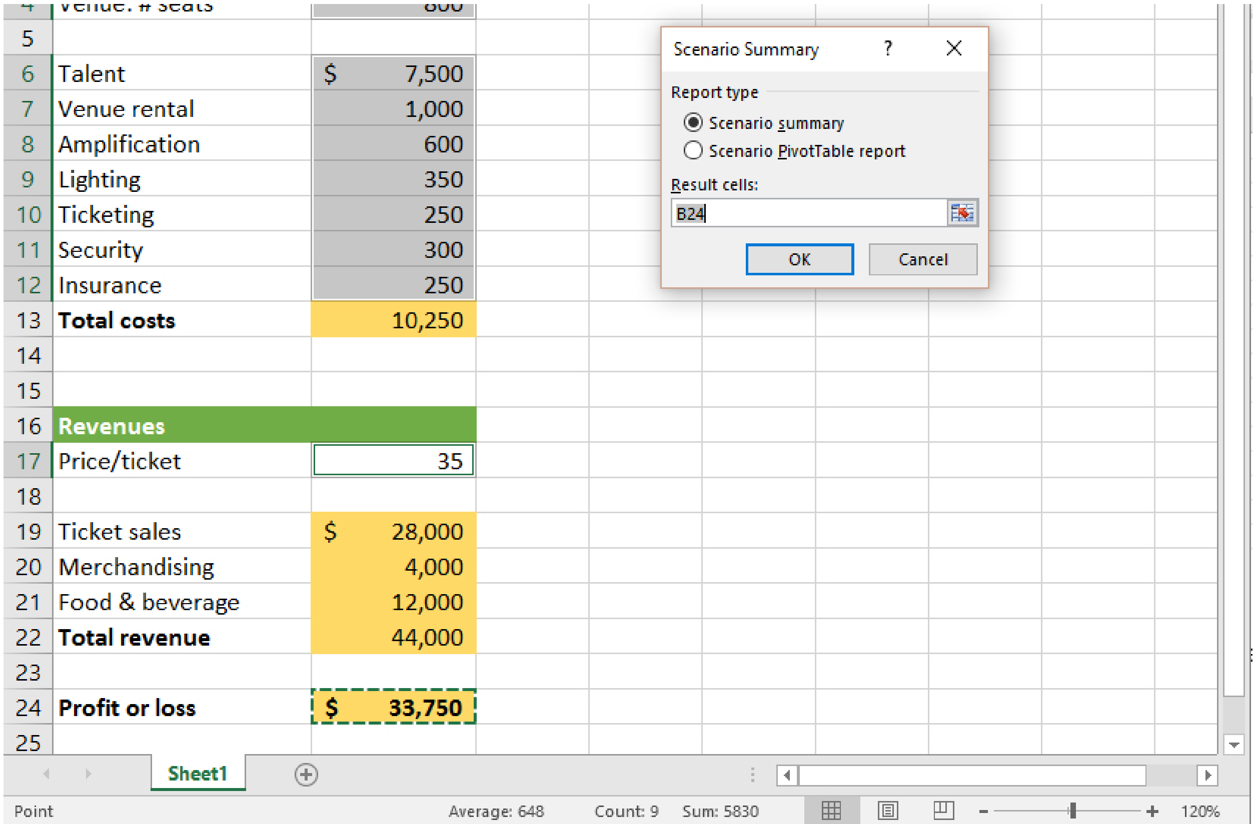
The sheet still shows the original values, so here's the first cool feature: **Double-click** one of the scenario names in the list. The sheet updates with those values.



Updated values

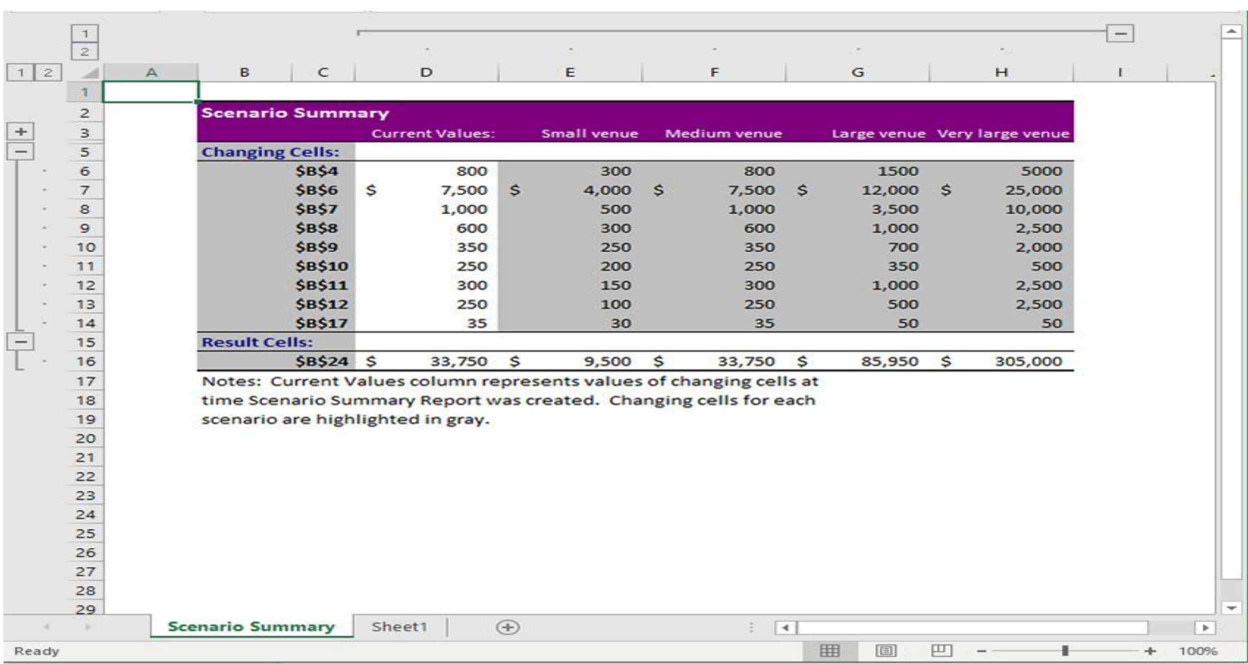
Step 3: View All the Scenarios at Once

1. Click the **Summary** button.
2. That confirms you want to create a summary, not a PivotTable, so leave the default radio button selected.
3. It also confirms the main result cell is the **Profit or Loss** in **B24**.



Profit or Loss cell Result

Click **OK**. That creates a new sheet in the workbook, called **Scenario Summary**.



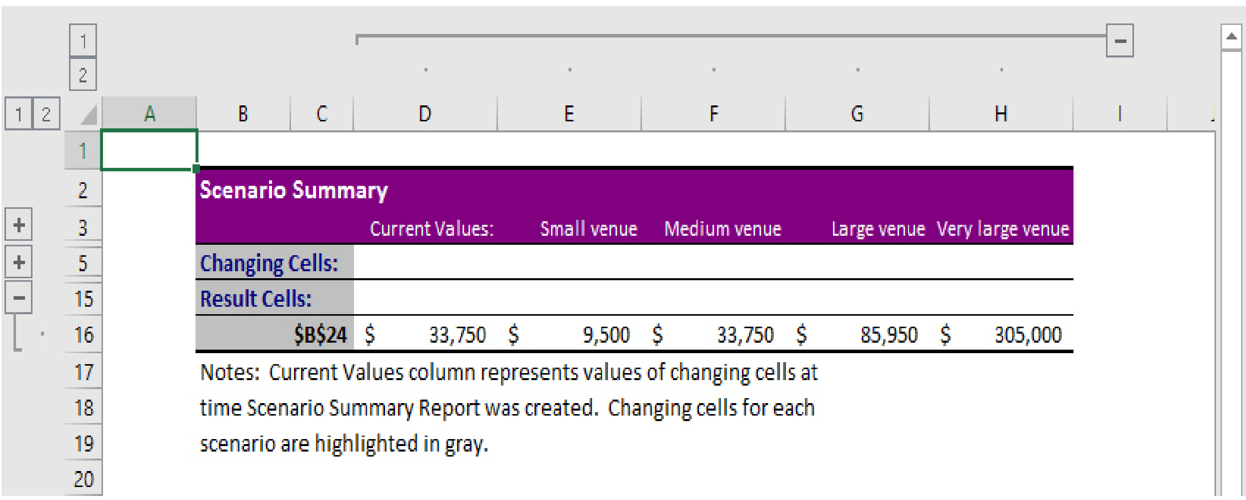
Scenario Summary worksheet

Step 4: Engaging With the Scenario Summary

This shows the values that the sheet currently displays (you could have changed these manually) as well as the sets of numbers from all four scenarios.

Notice the small **plus** and **minus** symbols in the margins. These are part of Excel's Group and Outline feature, which you can use separately from Scenario Manager. The **Outline** button is also on the ribbon's**Data** tab, all the way on the end.

Click any of the **minus** signs to collapse the sheet so it shows only summary data, or click the **plus** signs to expand and show detail.



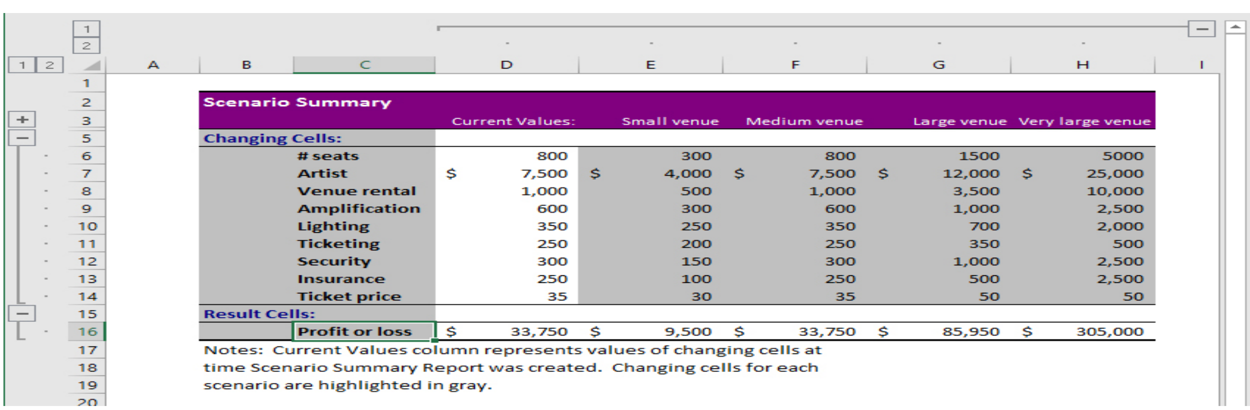
Scenario Summary						
		Current Values:	Small venue	Medium venue	Large venue	Very large venue
Changing Cells:						
Result Cells:						
	$B$24	$ 33,750	$ 9,500	$ 33,750	$ 85,950	$ 305,000

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

Outline features

Step 5: Two Things to Be Aware Of

1. None of the values are dynamic. If you change the underlying data on the original sheet, the values on this sheet will *not* change. You will need to create a new summary.
2. Down **column C**, you see Excel lists the cell references, not their labels (**Artist, Venue rental**, etc.). If you want to see the labels, stretch out **column C** and type them manually.



Scenario Summary						
		Current Values:	Small venue	Medium venue	Large venue	Very large venue
Changing Cells:						
	# seats	800	300	800	1500	5000
	Artist	$ 7,500	$ 4,000	$ 7,500	$ 12,000	$ 25,000
	Venue rental	1,000	500	1,000	3,500	10,000
	Amplification	600	300	600	1,000	2,500
	Lighting	350	250	350	700	2,000
	Ticketing	250	200	250	350	500
	Security	300	150	300	1,000	2,500
	Insurance	250	100	250	500	2,500
	Ticket price	35	30	35	50	50
Result Cells:						
	Profit or loss	$ 33,750	$ 9,500	$ 33,750	$ 85,950	$ 305,000

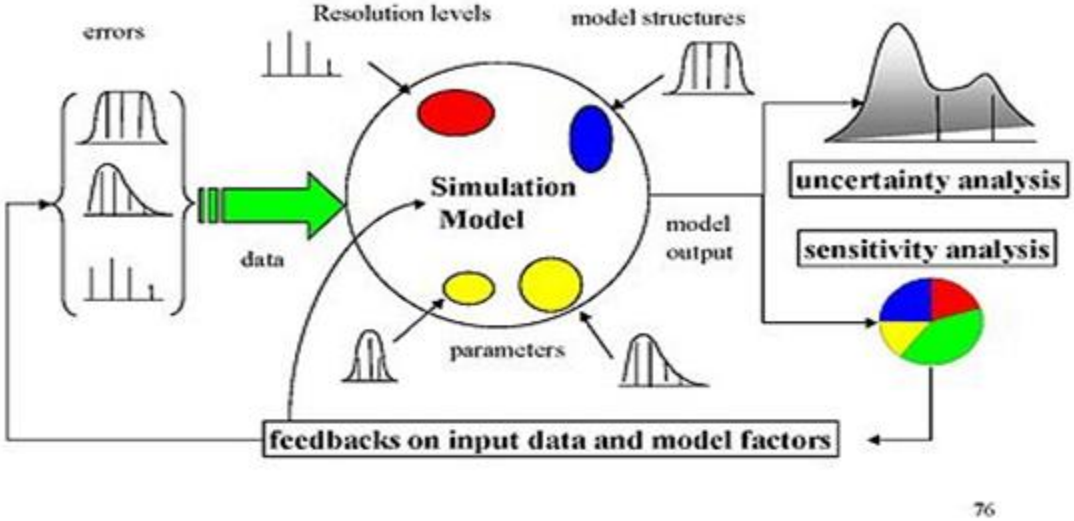
Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

SENSITIVITY ANALYSIS

A sensitivity analysis is a technique used to determine how different values of an independent variable impact a particular dependent variable under a given set of assumptions. This technique is used within specific boundaries that depend on one or more input variables, such as the effect that changes in interest rates have on bond prices.

Sensitivity Analysis Example

Assume Sue, a sales manager, wants to understand the impact of customer traffic on total sales. She determines that sales are a function of price and transaction volume. The price of a widget is $1,000 and Sue sold 100 last year for total sales of $100,000. Sue also determines that a 10% increase in customer traffic increases transaction volume by 5%, which allows her to build a financial model and sensitivity analysis around this equation based on what-if statements. It can tell her what happens to sales if customer traffic increases by 10%, 50% or 100%. Based on 100 transactions today, a 10%, 50% or 100% increase in customer traffic equates to an increase in transactions by 5, 25 or 50. The sensitivity analysis demonstrates that sales are highly sensitive to changes in customer traffic.



SIMULATION USING EXCEL DIFFERENT STATISTICAL DISTRIBUTIONS USED IN SIMULATION GENERATING RANDOM NUMBERS THAT FOLLOW A PARTICULAR DISTRIBUTION:

Whether you're building a model or trying to simulate a scenario within your analysis, at some point in your Excel career, you're going to need to use a randomized set of data. If you need to create a purely random set of numbers, with no specific constraints or parameters, you can just use the RAND function in Excel to generate those numbers for you.

While Excel's random number generating formula will help you some situations, there are many analysis and simulation cases where it simply won't be realistic. For example, let's say that I wanted to simulate the test scores for a group of students on an exam and I know from past history that the average score is a 80. The lowest possible score is 0 and the highest possible score is 100.

While I want a randomized result, I know that the test scores are not going to be uniformly distributed between 0 and 100. However, if we used Excel's basic RAND formula without any adjustments, that is the output that Excel would create for us.

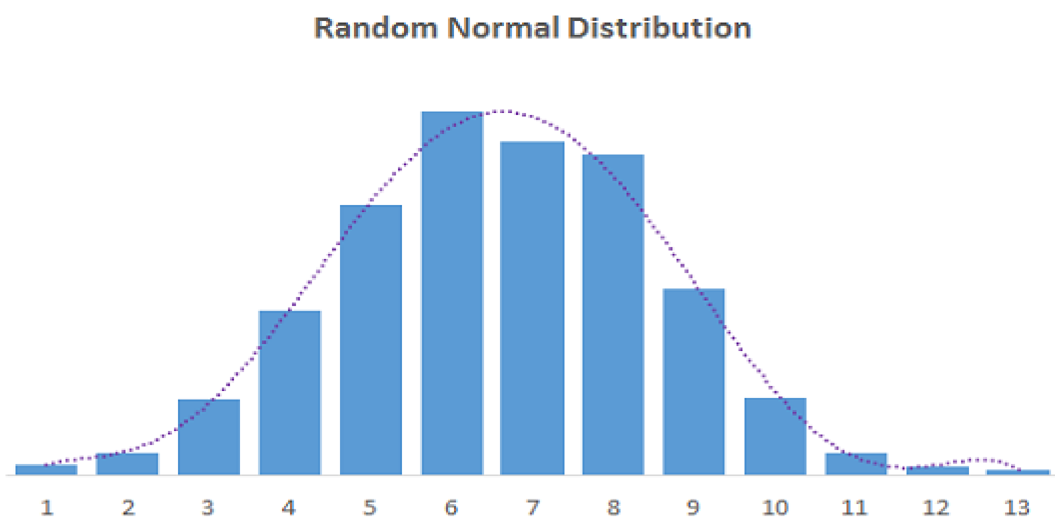
The Random Normal Distribution

Before we go further, please note that this is an Excel blog and not a statistics blog. Therefore, I'm not going to spend much time on statistical proofs or mentioning famous mathematicians. I'll try to keep it as simple as possible and focus on Excel execution.

The normal distribution, also commonly referred to as a bell curve, is based on the assumption that a distribution of values generally cluster around an average. Within the distribution, very high and very low values are still possible, but are less frequent than the ones closer to the average.

In nature, we know that this type of clustering occurs, as on the aforementioned test example, as generally a lot of people will score near the average, and generally fewer people will have very high and very low scores.

A "random" normal distribution is just a random set of data that collectively matches the characteristics of a normal distribution. The random normal distribution is one the most common data sets that you'll want to use to make your data look realistic for real life situations.



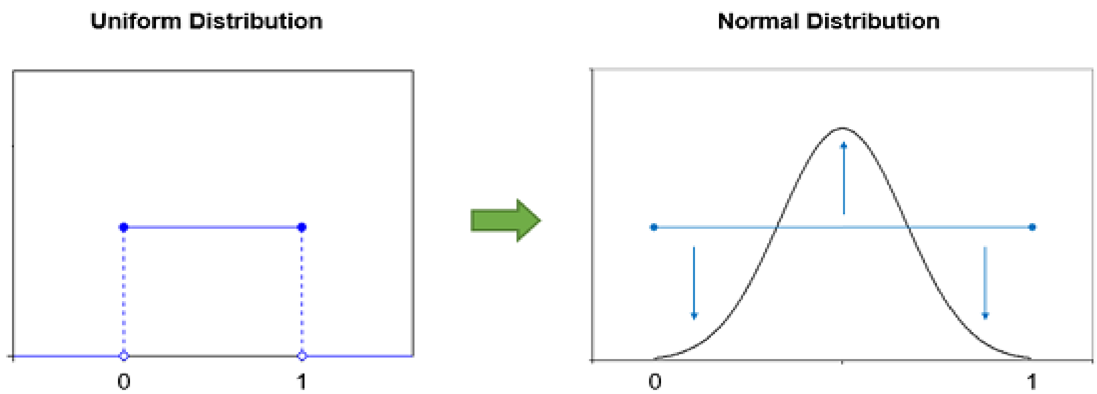
The two key parameters you need to know about the normal distribution / bell curve are:

- **The mean** – what the average of the normal distribution will be, and simplifying greatly, where roughly the middle of your chart top of that bell curve is
- **The standard deviation** – again, simplifying greatly, how wide the bell curve will be; the higher this number, the wider the bell curve will be

How it Works

To create a normally distributed set of random numbers in Excel, we'll use the NORMINV formula. The NORMINV formula is what is capable of providing us a random set of numbers in a normally distributed fashion. The syntax for the formula is below:

= NORMINV (**Probability** , **Mean** , **Standard Deviation**)



The key to creating a random normal distribution is nesting the RAND formula inside of the NORMINV formula for the probability input

Let's go through the inputs to explain how it works:

- **Probability** – for the probability input, you just want to input the RAND function. If you look at the uniform graph to the left this is what the RAND function would produce by itself – an output where all values have the same probability of occurring. **What the NORMINV function does is convert this uniform distribution into a normal one, by making values closer to the mean more likely and values further from the mean less likely**. It does so using the next set of inputs as context.
- **Mean** – as mentioned before, this is the average that your random values will cluster around. Because you're using a random set of numbers to generate your distribution, this most likely won't end up being your actual average or the actual apex of your bell curve.

- **Standard Deviation** – the standard deviation will determine you wide your distribution is. The higher the number, the wider your distribution of values.

Based on the syntax, what Excel creates a normally distributed set of data based on the mean and standard deviation you provided. The probability input of the syntax is what determines the actual data value that is returned. For the probability input, Excel is expecting a number between 0 and 1 which is exactly what the RAND provides.

To summarize, what Excel does is take the value from our RAND function, which by itself provides a random set of numbers uniformly distributed between 0 and 1, and forces it to instead to create a normally distributed set of numbers based on a mean and standard deviation we provide.

Process Walkthrough

We've gone through the theory, so let's go through the test example we've referenced to put the NORMINV formula into practice:

Step 1: Determine how many numbers you'll need in your sample

For our example, we'll assume we only need 15 values.

Step 2: Input the mean and standard deviation you want

You can put these directly in the formula, but generally it's better to have them in a separate cell, as it makes it easier to do mass updates to large sets of random numbers.

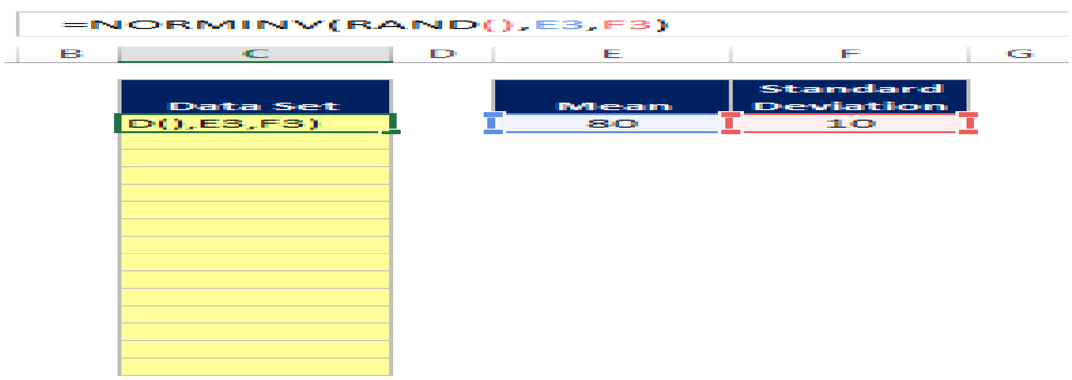
Using our previous example, we'll assume that the average of our sample should be **80** and the standard deviation should be **10**.

Step 3: Write the Normal Inverse Formula using the RAND formula and referencing the mean and standard deviation you documented

= NORMINV (**Probability** , **Mean** , **Standard Deviation**)

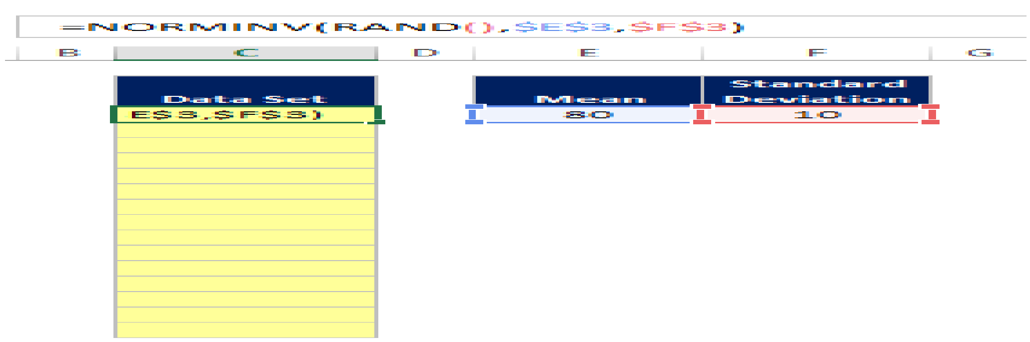
For the NORMINV function, your parameter inputs should be:

- **Probability** = RAND()
- **Mean** = reference the cell with 80
- **Standard Deviation** = reference the cell with 10



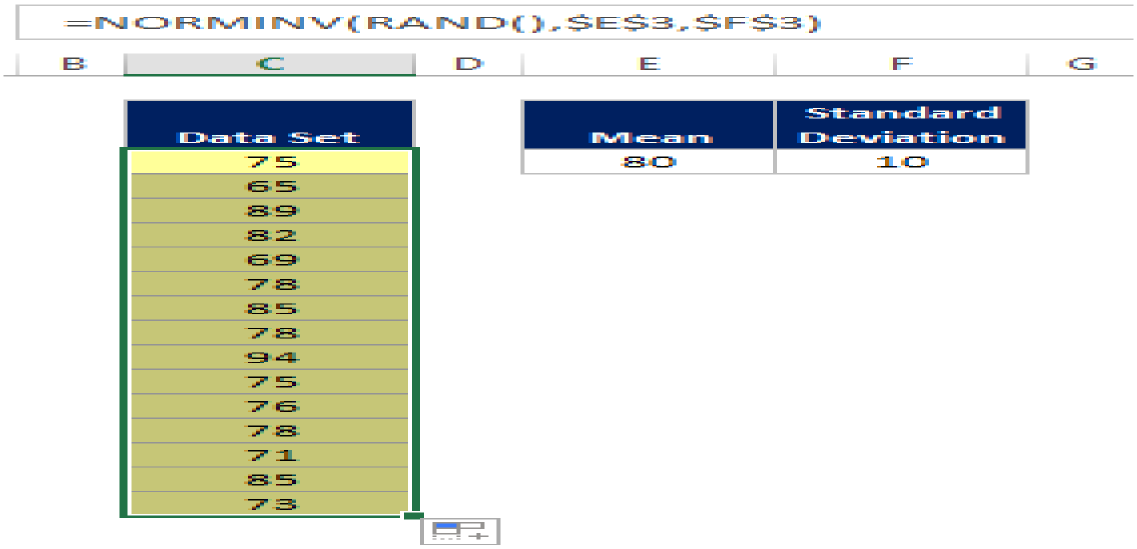
Step 4: Reference Lock your mean and standard deviation references

This is a very important step, as generally, you'll want to use this formula for multiple cells. You can do this by clicking into the cell reference within the formula and hitting the F4 key.



Step 5: Copy your formula down

You can do this by double clicking the lower right hand corner of the cell.



Step 6: Hardcode your values

Now that you've created your random number set, you probably don't want it to change every time you update a cell. Therefore, go ahead and copy your data set values, and perform a Paste Special (ALT → E → S → V) to hard code the values.

You now have a normally distributed set of random numbers, based on a defined mean and standard deviation.

Normally Distributed Random Number Template

We've gone through the process of creating a random normal distribution of numbers manually.

But I've also built a simple Excel template that will help make this process a lot easier.

All you need to do is download the file and input the following parameters:

- Mean
- Standard Deviation
- Sample Count (up to 1000)
- Minimum
- Maximum
- Bin Size

The template uses the same formula described above, but also has a separate formula that delimits minimums and maximums. (Unfortunately, NORMINV does not have any parameters within its syntax to let you set a minimum or maximum return value)

Once you've set your values, one of the key features of the template is providing you a quick of the distribution of the random data you've created. This is done with the "Count" cells to the right, which are conditionally formatted with data bars. This basically provides you a histogram on its side. I didn't want to go through the trouble of creating a graph because this is supposed to be a flexible, quick and dirty view of your data. It would defeat the purpose if you had to mess around with chart formatting as you were playing with your inputs.

Input Parameters & Distribution of Data

Mean	Standard Deviation	Sample Count (max 1000)
80	10	500

Minimum	Maximum	Bin Size
50	100	5

Bin Number	Bin Minimum	Count
1	50	4
2	55	11
3	60	20
4	65	48
5	70	68
6	75	89
7	80	99
8	85	64
9	90	48
10	95	27
11	100	22
12	105	0
13	110	0
14	115	0
15	120	0
16	125	0
17	130	0
18	135	0
19	140	0
20	145	0

Excel Template Settings & Notes

- To adjust the "histogram"'view, you should change the minimum and bin size to get the right view of your data. I've included 20 bins for you to work with, but this can be increased by appending bin numbers and copying the two other formulas down.
- I've nested the NORMINV formula inside the ROUND function so that the random values returned are always integers. You can remove this or change the number of decimal places returned by adjusting the formula.
- For the Minimum and Maximum limitations, I've made the assumption that if the NORMINV formula comes up with a value either less than the minimum or greater than the maximum, it'll simply return the minimum or maximum respectfully. If this is not desired, you can simply change the logic in the "Accounting for Min and Max Limits" field.
- If you need to add more numbers to your random sample (more than 1,000 values), you can simply insert rows into the data portion of the template and copy down the formulas.
- Note that any time you recalculate you save or add new values, your data set will change because the RAND function will recalculate.
- To save your values, all you need to do is copy from the green cells and do a **Paste Special → Values** to hardcode the numbers. I chose not to build in a macro to do this since this is intended to be a relatively simple template.

BUILDING MODELS IN FINANCE USING SIMULATION:

The projection model we will be developing is one that you might find as the starting point in many forms of analysis. The model will have these key features:

1. It will have historical and forecast numbers for modeling an industrial type of company or business. Forecast numbers can be entered as "hard-coded" numbers (e.g., sales will be 1053 this year and 1106 next year, etc.) or as assumptions (e.g., sales growth next year will be 5 percent, etc.).
2. The income statement, balance sheet, and a cash flow statement follow GAAP.
3. The balance sheet balances: the total assets must equal the total liabilities and net worth. This balancing is done through the use of "plug" numbers (see Chapter 7). With the accounting interrelationships correctly in place, the cash flow numbers will also "foot" (see Chapter 11), i.e., the changes in cash flow must equal the change in the cash on the balance sheet.

----ooOoo----

UNIT-III

EXCEL IN ACCOUNTING

Preparing common size statements directly from trial balance, forecasting financial statements using excel, analyzing financial statements by using spreadsheet model, excel in project appraisal, determining project viability.

Risk analysis in project appraisal, simulation in project appraisal, excel in valuation, determination of value drivers, discontinued cash flow valuation, risk analysis in valuation.

EXCEL IN ACCOUNTING:

Microsoft Office Excel was designed to support accounting functions such as budgeting, preparing financial statements and creating balance sheets. It comes with basic spreadsheet functionality and many functions for performing complex mathematical calculations. It also supports many add-ons for activities such as modeling and financial forecasting, and seamlessly integrates with external data to allow you to import and export banking information and financial data to and from other accounting software platforms.

Budgeting and Statements

Microsoft Office Excel ships with templates for creating budgets, cash-flow statements and profit-and-loss statements, which are some of the most basic documents used in accounting. In addition, you can download more complex budgeting and statement templates from the Office website, or purchase specialized templates from third-party vendors and install these in the application. If you need to create complex or custom budgets or financial statements, you can either customize an existing template and re-use its elements, or create one from scratch using the functionality built into Excel.

Spreadsheets

Performing line calculations is a basic accounting task, and Excel spreadsheets are designed to contain data in a tabular format that supports both in-line and summation calculations, replacing the need for ticker tape and special accounting calculators. The data in the spreadsheet is reusable and storable, making Excel more flexible than an accounting calculator for performing simple calculations and summations. Additionally, you can create charts and graphs from the spreadsheet data, creating a media-rich user experience and different views of the same data. You can also use add-ons to mine the data and create models and financial forecasts.

External Data

You can import data from many different data sources into Excel. This is especially useful for accounting as you can pull sales data, banking data and invoices from many sources into one central workbook to support your accounting activities. The data can be stored in different databases and file formats prior to importing, allowing you to access data from many different areas of your business without having to do additional data entry

Integration

Excel integrates with many popular accounting software applications. For example, you can use the wizards that ship with your preferred accounting software package to map Excel spreadsheets to your accounting data so you can perform push and pull data operations from both Excel and your accounting package on demand.

PREPARING COMMON SIZE STATEMENTS DIRECTLY FROM TRIAL BALANCE:

What the Common-Size Reveals?

The biggest benefit of a common-size analysis is that it can let an investor identify large or drastic changes in a firm's financials. Rapid increases or decreases will be readily observable, such as a rapid drop in reported profits during one quarter or year.

In IBM's case, its results overall have been relatively steady. One item of note is the Treasury stock in the balance sheet, which has grown to more than a negative 100% of total assets. But rather than alarm investors, it indicates the company has been hugely successful in generating cash to buy back shares, which far exceeds what it has retained on its balance sheet.

A common-size analysis can also give insight into the different strategies that companies pursue. For instance, one company may be willing to sacrifice margins for market share, which would tend to make overall sales larger at the expense of gross, operating or net profit margins. Ideally the company that pursues lower margins will grow faster. While we looked at IBM on a stand-alone basis, like the R&D analysis, IBM should also be analyzed by comparing it to key rivals.

Common size statements directly from trial balance:

A common-size financial statement is displays line items as a percentage of one selected or common figure. Creating common-size financial statements makes it easier to analyze a company over time and compare it with its peers. Using common-size financial statements helps investors spot trends that a raw financial statement may not uncover.

All three of the primary financial statements can be put into a common-size format. Financial statements in dollar amounts can easily be converted to common-size statements using a spreadsheet, or they can be obtained from online resources like *Mergent Online*. Below is an overview of each statement and a more detailed summary of the benefits, as well as drawbacks, that such an analysis can provide investors.

Balance Sheet Analysis:

The common figure for a common-size balance sheet analysis is total assets. Based on the accounting equation, this also equals total liabilities and shareholders' equity, making either term interchangeable in the analysis. It is also possible to use total liabilities to indicate where a company's obligations lie and whether it is being conservative or risky in managing its debts.
The common-size strategy from a balance sheet perspective lends insight into a firm's capital structure and how it compares to rivals. An investor can also look to determine an optimal capital structure for an industry and compare it to the firm being analyzed. Then he or she can conclude whether debt is too high, excess cash is being retained on the balance sheet, or inventories are growing too high. The goodwill level on a balance sheet also helps indicate the extent to which a company has relied on acquisitions for growth.

It is important to add short-term and long-term debt together and compare this amount to total cash on hand in the current assets section. It lets the investor know how much of a cash cushion is available or if a firm is dependent on the markets to refinance debt when it comes due.

IBM - COMMON SIZE BALANCE SHEET							
	2010-12	2011-12	2012-12		2010-12	2011-12	2012-12
Assets				**Liabilities**			
Current assets				***Current liabilities***			
Total cash	10.27%	10.24%	9.34%	Short-term debt	5.97%	7.27%	7.70%
Receivables	10.55%	10.87%	10.52%	Accounts payable	6.88%	7.31%	6.67%
Inventories	2.16%	2.23%	1.92%	Taxes payable	3.72%	2.85%	4.15%
Deferred income taxes	1.38%	1.38%	1.19%	Accrued liabilities	8.98%	8.27%	8.05%
Prepaid expenses	3.72%	4.51%	3.38%	Deferred revenues	10.21%	10.48%	10.03%
Other current assets	14.33%	14.51%	15.13%	**Total current liabilities**	35.75%	36.18%	36.59%
Total current assets	42.41%	43.74%	41.47%	***Non-current liabilities***			
Non-current assets				Long-term debt	19.26%	19.63%	20.21%
Property, plant and equipment				Deferred revenues	3.23%	3.30%	3.77%
Gross property, plant and equipment	35.51%	34.46%	33.97%	Pensions and other benefits	14.08%	15.78%	17.13%
Accumulated Depreciation	-23.09%	-22.54%	-22.23%	Other long-term liabilities	7.25%	7.73%	6.38%
Net property, plant and equipment	12.42%	11.92%	11.74%	**Total non-current liabilities**	43.93%	46.53%	47.59%
Equity and other investments	5.09%	4.20%	4.21%	**Total liabilities**	79.69%	82.70%	84.18%
Goodwill	22.16%	22.51%	24.53%	**Stockholders' equity**			
Intangible assets	3.07%	2.91%	3.18%	Common stock	40.03%	41.34%	42.03%
Deferred income taxes	2.84%	3.01%	3.33%	Retained earnings	81.56%	90.06%	98.68%
Other long-term assets	12.00%	11.70%	11.54%	Treasury stock	-84.76%	-95.30%	-103.29%
Total non-current assets	57.59%	56.26%	58.53%	Accumulated other comprehensive income	-16.52%	-18.80%	-21.61%
Total assets	100.00%	100.00%	100.00%	***Total stockholders' equity***	20.31%	17.30%	15.82%
				Total liabilities and stockholders' equity	100.00%	100.00%	100.00%

Analyzing the Income Statement

The common figure for an income statement is total top-line sales. This is actually the same analysis as calculating a company's margins. For instance, a net profit margin is simply net income divided by sales, which also happens to be a common-size analysis. The same goes for calculating gross and operating margins. The common-size method is appealing for research-intensive companies, for example, because they tend to focus on research and development (R&D) and what it represents as a percent of total sales.

Below is a common-size income statement for IBM. We will cover it in more detail below, but notice the R&D expense that averages close to 6% of revenues. Looking at the peer group and companies overall, according to a Booz & Co. analysis, this puts IBM in the top five among tech giants and the top 20 firms in the world (2013) in terms of total R&D spending as a percent of total sales.

IBM - COMMON SIZE INCOME STATEMENT			
	2010-12	2011-12	2012-12
Revenue	100.00%	100.00%	100.00%
Cost of revenue	53.93%	53.11%	51.87%
Gross profit	46.07%	46.89%	48.13%
Operating expenses			
Research and development	6.03%	5.85%	6.03%
Sales, General and administrative	21.87%	22.07%	22.54%
Total operating expenses	27.90%	27.92%	28.57%
Operating income	18.17%	18.97%	19.56%
Interest Expense	0.37%	0.38%	0.44%
Other income (expense)	1.94%	1.06%	1.83%
Income before taxes	19.75%	19.64%	20.96%
Provision for income taxes	4.90%	4.81%	5.07%
Net income	14.85%	14.83%	15.89%

Source: Morningstar.com

Common Size and Cash Flow:

In similar fashion to an income statement analysis, many items in the cash flow statement can be stated as a percent of total sales. This can give insight on a number of cash flow items, including capital expenditures (capex) as a percent of revenue. Share repurchase activity can also be put into context as a percent of the total top line. Debt issuance is another important figure in proportion to the amount of annual sales it helps generate. Because these items are calculated as a percent of sales, they help indicate the extent to which they are being utilized to generate overall revenue.

Below is IBM's cash flow statement in terms of total sales. It generated an impressive level of operating cash flow that averaged 19% of sales over the three-year period from 2010 to 2012. Share repurchase activity was also impressive at more than 11% of total sales in each of the three years. You may also notice the first row, which is net income as a percent of total sales, which matches exactly with the common-size analysis from an income statement perspective. This represents the net profit margin.

IBM - COMMON SIZE CASH FLOW STATEMENT			
	2010-12	2011-12	2012-12
Net income	14.85%	14.83%	15.89%
Depreciation & amortization	4.84%	4.50%	4.47%
Deferred income taxes	1.30%	1.13%	0.76%
Stock based compensation	0.63%	0.65%	0.66%
Inventory	0.09%	-0.15%	0.27%
Accounts payable	0.17%	0.42%	-0.21%
Accrued liabilities	-1.97%	-1.28%	-0.96%
Other working capital	0.46%	-1.22%	-1.43%
Other non-cash items	-0.80%	-0.32%	-0.70%
Net cash provided by operating activities	19.57%	18.56%	18.74%
Cash Flows From Investing Activities			
Investments in property, plant, and equipment	-4.19%	-3.84%	-3.91%
Property, plant, and equipment reductions	0.77%	0.57%	0.39%
Acquisitions, net	-5.87%	-1.68%	-2.99%
Purchases of investments	-6.14%	-1.49%	-3.93%
Sales/Maturities of investments	7.89%	3.13%	3.01%
Investments in technologies	-0.57%	-0.52%	-0.61%
Other investing activities	-0.40%	-0.27%	-0.58%
Net cash used for investing activities	-8.52%	-4.11%	-8.62%
Cash Flows From Financing Activities			
Debt issued	8.07%	9.35%	11.71%
Debt repayment	-6.53%	-8.37%	-9.14%
Common stock issued	3.78%	2.29%	0.00%
Common stock repurchased	-15.39%	-14.07%	-11.48%
Dividend paid	-3.18%	-3.25%	-3.61%
Other financing activities	0.82%	1.24%	1.05%
Net cash provided by (used for) financing activities	-12.45%	-12.81%	-11.46%
Effect of exchange rate changes	-0.14%	-0.46%	-0.11%
Net change in cash	-1.52%	1.18%	-1.45%
Cash at beginning of period	12.20%	9.97%	11.41%
Cash at end of period	10.67%	11.15%	9.96%
Free Cash Flow			
Operating cash flow	19.57%	18.56%	18.74%
Capital expenditure	-4.19%	-3.84%	-3.91%
Free cash flow	15.38%	14.72%	14.84%

FORECASTING FINANCIAL STATEMENTS USING EXCEL:

KEY PRINCIPLES

- Good forecasts must be consistent with historical performance and the current industry outlook.

- Look at historical numbers in relationship to others and use these ratios, particularly the operating ratios, to make your projections.
- All forecasts are estimates and approximations. Spend the time thinking and developing your ideas about the big picture, not the third decimal place.
- If the forecast looks too good to be true, it probably is.
- Re-examine your assumptions.

INCOME STATEMENT ACCOUNTS

Revenues

For industrial/manufacturing types of companies, revenues drive the other numbers in the model. Here are things to think about as you make your forecast:

Revenues are the result of three main components: price, industry growth, and market share. Isolating the price growth from inflation will give you the measure for volume growth. Understand that in the context of the economic cycle, and then concentrate on what the drivers for future industry growth and market share might be.

Add back the inflation component (typically very low at 1–2 percent in the United States) to get the full estimate of future revenues growth.

Unless you are looking at new industries (new drugs, new telecommunications), most businesses are mature and should grow at around the growth of the economy. Gross domestic product (GDP) growth rates would be a good proxy. Your particular company’s sales growth will also be affected at different points of the product cycle by new entrants and competing new technologies. Remember also that fast-growing businesses have very dramatic price and volume falls as the demand reaches a certain point. If your company does not have a position of advantage, it will lose market share, and your volume estimates must reflect that.

If your company has product lines that have very different characteristics, it would be worthwhile to forecast the individual product lines. Where they are similar enough, it is better to think in broad aggregate terms and forecast only one revenue line. There is no need to get super precise price and volume numbers for the forecast years.

Take into account the characteristics of the industry your company is in. Some industries have price controls or restrictions, which would limit your own forecasts.

Margin Assumptions

- Analyze the trends in the historical accounts, such as cost of goods sold as percentage of sales, SG&A (sales, general & administrative) as percentage of sales, etc. Your forecasts should be consistent with these trends, while taking into account what you know of any improvements or changes in the company’s operating systems.
- If there have been striking changes in the margins, you should try to understand the reason.
- Look at the trends in the context of the economic and product cycles.

Depreciation

- Although it can be convenient to forecast depreciation as a percentage of sales, the relationship to sales is indirect.
- Depreciation is determined by net PPE (plant, property, and equipment), which, in turn, is affected by capital expenditures. Capex typically vary with sales.
- If some precision is required, the best way to model depreciation is to lay out the depreciation that is associated with each year's new capital investments. This will mean creating a "depreciation triangle" as shown in Table 13-1. The longer the forecast period, the "deeper" the triangle has to be. However, it is generally acceptable to use the recent relationship between depreciation and the net PPE of the prior year.
- Depreciation for tax purposes and for book purposes can be different. This will lead to the creation of deferred taxes.

Year	0	1	2	3	4	5
Capital expenditures	80	70	100	90	110	120
Depreciation schedule of:						
Capex of year 0	0	8	8	8	8	8
Capex of year 1			7	7	7	7
Capex of year 2				10	10	10
Capex of year 3					9	9
Capex of year 4						11
Capex of year 5						
Total depreciation	0	8	15	25	34	45
Gross PPE	80	150	250	340	450	570
Accumulated depreciation	0	8	23	48	82	127
Net PPE	80	142	227	292	368	443
Dep'n % prior net PPE		10%	15.3%	19.2%	24.1%	28.2%

Assumptions:

Ten-Year Life, with Straight-Line Depreciation be the actual interest earnings rate. Many companies keep cash as an operational cushion, and it is not necessarily in the bank earning interest. However, this effective interest rate is usually good enough for projections.

Interest on cash should be less than the interest on debt.

Interest Expense

Companies usually pay close to market rates, so get estimates of the benchmark being used (LIBOR, Prime, etc.) and then apply a spread over that. Check with the relationship banker or the debt pricing desk about what this spread should be. Generally speaking, the bigger and, therefore, the more creditworthy the company, the smaller the spread. Spreads are usually quoted as *basis points*. One basis point is one one-hundredth of a percent. So 100 basis points is equivalent to 1 percent.

Check also the historical effective interest rates that the company has been paying. (Remember to do so by dividing the interest expense by the average of the beginning and ending total debt.) If these rates seem very high, they may be due to seasonal borrowings. The company draws down on its line of credit during the year and, therefore, pays interest, but pays off the debt before the reporting date. The result is that there is a record of the interest expense in the income statement, but no record on the balance sheet of the debt that produced it. This is normal operating procedure, by the way, and there is nothing sneaky about it.

Taxes

Taxes should be taxed at statutory rates, and they should also reflect local rules in effect for the company. If there are any deviations from these rates, you should try to find out the reasons why, and if they are sustainable.

Deferred taxes occur when the provision for taxes in the book basis is different from the actual taxes paid on the tax basis. These occur usually because of different book-basis and tax-basis depreciation schedules that the company has adopted, or from net operating losses. Their complexity puts them beyond the scope of this chapter.

Extraordinary Items:

This is a tricky line since, by its very nature, items here are not easily forecast. If you have specific information about these items from the company, by all means include it. Otherwise, it may be best not to try to do any forecasts.

Dividends:

The best way to forecast dividends is by multiplying the num- ber of shares by a historic dividends per share number grown at a reasonable rate. You should watch out for the following, though:

Use the correct number of shares, which is the *weighted average* shares outstanding. The plain shares outstanding refers to the number at the reporting date, but this does not take into account that there may have been changes in the shares outstanding over the year. It is also important to reflect the timing of the changes, which is why the weighted average number is used. Typically, this information is available in the annual reports. If you do not have this number, a proxy is to take the average of the shares outstanding at the beginning and the end of the reporting period.

Compute the historic dividends per share numbers yourself. If they reconcile with the historic figures, then you have a good basis for using them as the basis for calculations of future dividends, plus a growth rate that roughly equals the growth of the economy and/or the industry. If they do not reconcile, it may be because of stock splits or rights issues. Companies' dividends usually grow at a steady rate, but the growth can stop if earnings go into a dip.

BALANCE SHEET

Cash

There are two kinds of cash account in the model. One is the cash that the company needs to have on hand to handle day-to-day expenses. We can think of this as "minimum cash." You can attach an interest rate to this, but more likely than not, this cash is not kept in the bank and so it is not earning interest. Because this cash also reflects operational needs, it makes sense to forecast this as a percentage of sales.

The other is the cash that is automatically produced by the model when liabilities and equity exceed assets—the Surplus funds row. You do not forecast this account directly. Rather, is a result of the forecast assumptions you make for other parts of the balance sheet and indeed the income statement, too. (It may be that your assumptions will create a need for additional debt, in which case you would not see the Surplus funds line.) To the extent that you will have Surplus funds, make sure that you enter an interest rate.

Short-Term Investments

If your company has this account, you may want to forecast the same level going forward, without any growth. By holding it steady, you will be able to see more clearly the rate of buildup in Surplus funds or Necessary to finance.

Operating Assets and Liabilities

A large part of the balance sheet is there to support sales. As sales grow, these operating assets and operating liabilities must also grow by a more-or-less proportionate rate. As a result, you can forecast them based on a relationship to revenues in the income statement.

- The operating assets are:
- Accounts receivable
- Inventory
- Other current assets
- Net PPE

Other assets. You should check if these are related to operations or investments; if the latter, they should be forecast at some growth rate, not as a percentage of sales.

- The operating liabilities are:
- Accounts payable
- Other current liabilities

You can project these items on the basis of the last historical year, but you should take into account any variations from trends that are booming or reversing. Any unusual or extreme change is a call for delving further into the information to find out what the reasons may be.

The net PPE number is a tricky one to forecast, and the forecast numbers are determined by two main flows: capital expenditures (which add to the gross PPE number) and deprecia- tion (which flows into accumulated depreciation and reduces the gross PPE number). The production base to support sales is a function of many things, including the product being produced, the technology in place, and the scale of production. These—and other factors—represent a ‘habit’ of the production systems in the company. The net result is a net PPE number that should have some discernible and steady relationship to sales. Thus, a good way to forecast net PPE is first to determine the net PPE to sales ratio and then to use that as the basis of forecasting net PPE. If we have a depreciation schedule, then, in fact, the capital expenditures number becomes the “plug” number in the calculation of net PPE.

Some pointers:

u If the latest net PPE to sales ratio is high, this probably reflects recent investments to modernize the plant. We can let this ratio trend down to the historical rates, and, as a result, future capex will also show a downward trend until the ratio meets the historical levels.

u If the ratio is low, this probably means that there will be a need for heavy investments soon.

u This measure of net assets to sales should be relatively steady over the forecast period. The logical test is to extend the projection period into perpetuity. If this ratio is trending upward, then we will have a company that will be extremely asset intensive. Likewise, if it is trending downward, we will have a company that will generate huge revenues on a sliver of a PPE base.

ANALYZING FINANCIAL STATEMENTS BY USING SPREADSHEET MODEL:

Spreadsheets provide a roadmap of analysis. The maps present the big picture and delineate the “territories,” i.e., the major components of analysis. These maps help users keep the big picture in mind as they work through the details. The spreadsheets provide a template that can be filled in with real data for hands-on illustrations. The power of spreadsheets becomes apparent when one compares them to the traditional sequence of text narratives, algebraic derivations, numerical examples, and computations of metrics for real cases. Spreadsheets condense this teaching material by an order of magnitude and enable what-if analyses. In addition to condensing the material and presenting it using spreadsheets, our materials also clean up the terminology and provide a logical sequence of otherwise disparate topics. They show how valuation drives FSA.

As to the use of the materials for actual investment analysis, these spreadsheets have three distinct uses. First, they provide three new metrics namely long-run return on book equity (ROBE), adjusted cash earnings (ACE), and excess implied return (EIR). Second, they summarize otherwise detailed models. Investment managers often face models that are too detailed and overwhelming. By bolting our summary spreadsheets and metrics as “dashboards” on top of these detailed models, the investment managers can internalize the key drivers of these models. Third, the spreadsheets show the equivalence of various valuation approaches used in practice. This helps investment managers reconcile apparent differences between various approaches.

There are four spreadsheets on FSA and four on valuation. They are arranged in the increasing level of sophistication. The spreadsheets are accompanied by text narratives, which total about 60 pages. We elaborate upon the materials below:

Objective 1: Illustrate the concepts as well as their practical application

Much effort has been put into condensing the material. Key features are:

- Each spreadsheet lays out the conceptual map by delineating the (i) inputs required from financial statements, (ii) the building blocks of analysis and valuation, and (iii) the equations and the steps required to produce key analytical outputs.
- The spreadsheets are parsimonious. Multiple variations of a key ratio are omitted because they slow down an understanding of the relevant concepts. The spreadsheets require few inputs that can be easily extracted from financial statements. This speeds up real case analysis.
- Spreadsheets enable "what if" analyses, which are hard to do using a traditional approach.
- The technology and design of spreadsheets reduce the need for extensive textual narratives. Accordingly, the narratives are an order of magnitude shorter than a typical textbook.
- The materialsomit accounting and finance details. A rigorous prior course in financial accounting and another in finance should suffice. The spreadsheets highlight "advanced" sections that may be skipped.

Objective 2: Provide a coherent framework and terminology

The logical flow of spreadsheets provides an organizing framework for FSA and valuation. The flow underscores how valuation motivates FSA and how FSA supports valuation. The framework lists specific steps for conducting "hands on" FSA and valuation. Core concepts are highlighted and reinforced repeatedly.

The spreadsheets use consistent terminology that ties in to valuation precepts. They clean up and standardize the somewhat inconsistent and diverse terminology used in practice. Specifically, we do not use the term "operating" because of its ambiguous usage in GAAP and in practice. We categorize all line items in the financial statements into enterprise versus financial items.

Objective 3: Provide new metrics based on latest research

The spreadsheets incorporate the latest research ideas in accounting-based valuation. They also develop new concepts that have not yet been discussed in research and practice.

Organization and brief description of the spreadsheets

The spreadsheets comprise two sets – FSA and valuation. The table below summarizes their brief headings:

FSA	Valuation
FSA1: Enterprise vs. financial activities	VAL1: Forecasting and valuation of cash flows
FSA2: Extracting recurring enterprise income	VAL2: Dividends, book values, and earnings
FSA3: Long-run historical ROE and IRR	VAL3: Adjusted analyst forecasts
FSA4: Adjusted Cash Earnings (ACE)	VAL4: Excess Implied Return (EIR)

[No one-to-one correspondence between FSA and valuation spreadsheets is implied.]

FSA and valuation are intertwined.Valuation requires projecting future performance. One of the ingredients of such projections is analysis of the past performance gleaned from FSA. Thegoal that FSA shouldsupport valuation helps narrow the scope of the FSA spreadsheets; we leave out analyses from the perspective of regulators, lenders, and consumers, etc.

The foundation: FSA1 and VAL1

FSA1 and VAL1 explain the core concepts necessary to understand the remaining spreadsheets.FSA1 provides the historical metrics necessary for projecting the key inputs in VAL1, and thus the relevance of FSA1becomes apparent when one studies VAL1. Conversely, VAL1 relies on terminology and derivations explained in FSA1. Therefore, one should refer back and forth between FSA1 and VAL1 to understand both.

FSA1: Enterprise vs. financial activities

This spreadsheet is the foundation for FSA. It does the following:

- Categorizes all items in the balance sheet and income statement into enterprise versus financial items.
- Derives enterprise cash flows as enterprise profits after tax minuschange in net enterprise assets.
- Showshow enterprise cash flows have been financed if they are negative, or how they have been disbursed if they are positive.
- Computes key enterprise performance metrics such asenterprise profit margin after tax, net enterprise assets needed to generate sales, and return on invested capital. These enterprise performance metricsare used as inputs inforecasting future enterprise cash flows in VAL1.
- Shows how return on equity depends on return on invested capital and leverage.

VAL1: Equity valuation using the discounted cash flows model

The spreadsheet provides the framework for making the decision to invest in a stock. The first part of the spreadsheet computes intrinsic value using the DCF valuation model and the second step develops net income forecasts, which can be compared with analyst forecasts and are used to compute the forward PE ratio.The spreadsheet does the following:

Part 1: The DCF model

- Forecasts enterprise cash flows by projecting the drivers of enterprise cash flows identified in FSA1. These drivers are – sales, enterprise profit margin after tax, and net enterprise assets needed.
  - Enterprise cash flows = enterprise profit after tax – change in net enterprise assets
  - Sales = sales * (1 + ***forecasted sales growth***)
  - Enterprise profit after tax = sales * ***forecasted enterprise profit margin after tax***
  - Net enterprise assets = sales * ***forecasted ratio of net enterprise assets to sales***
- Discounts the enterprise cash flows at the enterprise cost of capital (wacc) to arrive at enterprise value
- Derives equity value by subtracting net financial liabilities from enterprise value

Part 2: Forecasting of net income and dividends for relative valuation

- Net financial liabilities = net enterprise assets * ***forecasted ratio of net financial liabilities to net enterprise assets***
- Net financial expense = net financial liabilities * ***forecasted net financial expense rate***
- Net income = enterprise profit after tax - net financial expense after tax. These forecasts of net income can be compared to net income forecasts provided by analysts.
- Computes three key valuation metrics for relative valuation: forward PE ratio, forward dividends to price ratio, and the price to book ratio

The three remaining FSA spreadsheets

These remaining FSA spreadsheets are self-contained once the reader is familiar with FSA1 and VAL1.

FSA2: Extracting data needed to forecast enterprise cash flows

FSA1 and VAL1 highlight that margins, growth, and net enterprise asset intensity drive enterprise cash flows. This spreadsheet computes these drivers for historical financial statements. Historical values are a starting point for forecasting these drivers going forward.

This spreadsheet does the following:

- Separatesrecurring items from non-recurring items and primary activities from secondary activities.
- Computes the primary and secondary enterprise profit margin, and their related tax rates. These margins and tax rates are key inputsin the forecasting of enterprise profit after tax.
- Computes the net enterprise assets needed relative to salesfrom primary activities. The ratio of enterprise profits after tax to net enterprise assets yields RNEA or ROIC.
- Computes the growth rate in sales and compares it to the growth rate in enterprise profits.

FSA3: Historical Long-run Return on Equity and IRR

Short-term metrics such as ROE are sensitive to accounting idiosyncrasies, which diminishes their usefulness as performance benchmarks. This spreadsheet develops long-run ROE and ROIC measures to remedy these problems. Specifically, this spreadsheet does the following:

- Shows how to compute historical ROE over multiple periods. This multi-period ROE is less sensitive to accounting idiosyncrasies compared to annual ROE, and thus is a better predictor of future ROE.
- Compares this multi-period historical ROE to historical IRR, which is a market-value based measure of historical performance over multiple periods.
- A separate spreadsheet shifts the analysis to the enterprise level and shows how to compute historical multi-period ROIC and unleveraged internal rate of return.

FSA4: Adjusted Cash Earnings (ACE)

This spreadsheet develops a new measure of earnings, which we call Adjusted Cash Earnings (ACE). The difference between reported earnings and ACE measures the potential bias in reported earnings. A positive biaspredictsa decline in future profit margin, and vice versa. Specifically, the spreadsheet does the following:

- Defines hard assets and hard liabilities. Some assets and liabilities are "hard" in the sense that they are objectively measurable, while others are "soft" in the sense that their valuation requires judgments. Examples of hard items are cash and marketable securities, and short-duration accounts receivables and payables. Examples of soft items are inventories, PP&E, intangible assets, deferred taxes, reserves and allowances, and deferred revenues.

  The susceptibility of accounting income to the measurement errors in these "soft" items has led some to ignore ALL accounting accruals and focus just on cash. They define cash earnings as change in cash minus net dividends. This view is too narrow and misses the reality that many items on the balance sheet are as hard as cash.

- Derive hard earnings: We define "hard" equity as "hard" assets minus "hard" liabilities. We define hard earnings as change in hard equity minus net dividends.
- Derive adjusted hard earnings, which we call Adjusted Cash Earnings: Considering changes in only the hard equity is too narrow especially for growth firms. The soft equity, which is difference between reported equity and hard equity, grows with sales.We therefore define adjusted hard earnings as hard earnings plus growth in soft equity in proportion to sales growth. We call these adjusted hard earnings as Adjusted Cash Earnings to connect with the use of the term Cash Earnings in the real world.

The three remaining valuation spreadsheets

Following VAL1 (and FSA1), the remaining valuation spreadsheets (2-4) are essentially self-contained. However, we recommend that they be read in order.

VAL2: Valuation anchored on dividends, book values, and earnings

Many valuation approaches are often used in practice. This spreadsheet shows the conceptual equivalence of these approaches. It then explains why different equivalent approaches are still useful by showing how each approach connects with a popular valuation metrics such as the dividend yield, market to book ratio, and the P/E ratio. Specifically, this spreadsheet does the following:

- Describes the three transformations of the dividend discount model (DDM). These three transformations are the dividend growth model, book value growth model (aka RIV), and earnings growth model (aka AEG).
- Demonstrates the equivalence of these three transformations for equity valuation.
- Explains how these transformations explain the drivers of the three valuation metrics used in practice – dividend yield, price to book ratio, and price to earnings ratio.
- A separate spreadsheet provides an enterprise-level version of VAL2.

Transformation of DDM	Valuation metric used by practitioners	Anchor: Starting point in valuation
Dividend growth model	Dividend yield	Forthcoming dividend/cost of equity
Book value growth model	Price to book ratio	Current book value
Earnings growth model	Price to forthcoming earnings ratio	Forthcoming earnings/cost of equity

VAL3: Adjusted analyst forecasts

Analyst forecasts can be optimistic. This spreadsheet shows how the analyst forecasts can be adjusted to correct for some of the common biases. Specifically, this spreadsheet does the following:

- Adjusts analyst forecasts by removing expectations of margin expansion. Such adjustments are useful if one considers margin expansion to be optimistic.
- Adjusts earnings growth for earnings foregone on dividends paid. This adjustment facilitates the comparison of earnings growth across firms.

VAL4: Excess Implied Return (EIR)

This spreadsheet develops a screen to identify stocks that appear mispriced considering their risk. It does the following:

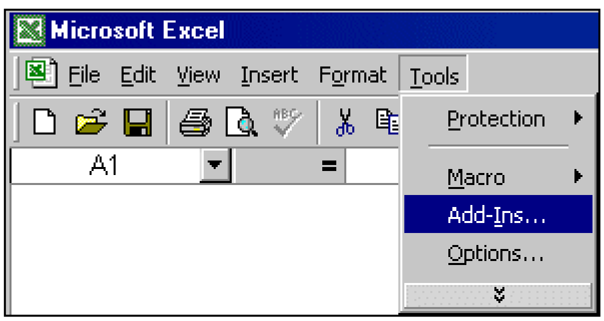
- Infer the implied return from the current stock price and earnings forecasts. The implied return is the discount rate that makes the present value of expected future financial outcomes equal to the current stock price. Thus, the implied return is an IRR that measures expected return. Our approach differs from the traditional one in the following ways:
- We work directly with analyst earnings forecasts and dividend payout forecasts instead of developing a DCF model as in VAL1.

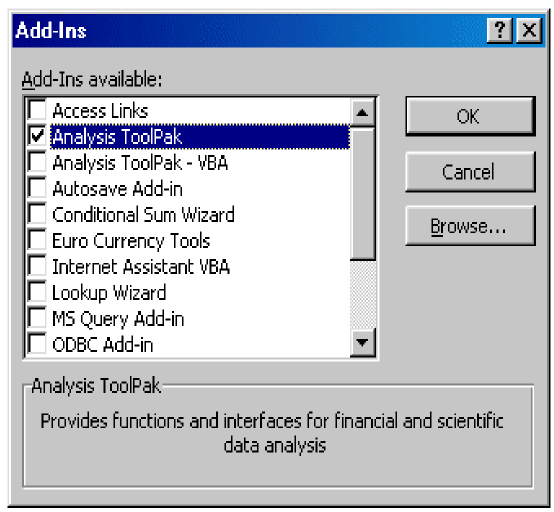
- We set the terminal growth rate equal to the implied return minus the earnings yield to capture the idea that risk and growth go together.
- Compute the required return via the CAPM.
- We use the implied market risk premium rather than the historical market risk premium. The former equals implied return on the market portfolio minus the risk free rate.
- Excess Implied Return = implied return – return required based on CAPM. EIR can be viewed as excess return. A positive EIR suggests under pricing, and vice versa. Of course, this is only an initial screen that identifies stocks that need further study.

There are three requirements for making this template function properly:

1) Enable all imbedded macros by single-clicking on the 

button displayed when opening the template file.
2) All financial statement data must be entered. If a line item does not have an explicit template line item match, include the amount as part
of a formula on an 'Other…' line item such as 'Other current assets' or 'Other operating expenses'.
3) Ensure Analysis ToolPak add-in is active.
Verify by selecting the menu path Tools > Add-Ins…, and ensure the 'Analysis ToolPak' add-in is checked.





NOTE: If the Add-Ins option is unavailable, it will have to be installed from your original Microsoft Office/Excel CD.

Three buttons are common to each of the enterable financial statement worksheets – It is important to understand their function because all sheets are protected to preserve the integrity of total totals and ratio formulas.

Edit - Allows entry of data into appropriate cells and displays entry hints

Review - Displays printable versions of financial statements and hides entry hints

Clear - Clears values from all enterable cells and prepares the worksheet for data entry

The Cover worksheet should be completed first. It is enterable and also contains a Clear button.

Ratios / Balance Sheet C.S. / Income Statement C.S. / Summary of Cash Flows

The remaining worksheets – are automatically generated by the template. No entry is required or permitted.
The template is flagged as 'read-only' to permit reuse. If you save your work, you will be prompted to rename the file.

Recommendations:

Set monitor resolution to 1024 x 768 to minimize scrolling during data entry.

Use a formula statement [= *n* + *n* + *n*] rather than a hand-calculated summary amount when combining multiple financial statement lines into a single template cell. This will aid when troubleshooting entry errors that could result in mismatched check figures.

Use the TAB key to navigate between cells. The active cell is automatically moved to the next cell which accepts data.

Cover

worksheet supplemental information

Colored fields have special significance. Only cells with borders permit data entry.

– financial statement header information

– special data needed for ratios that cannot be found as line items on financial statements

– check figures for financial statement summary comparisons

An unbordered, colored cell on any sheet indicates Cover worksheet data has not been entered or a summary total on a financial statement does ***not*** compare favorably to its associated Cover worksheet check figure.

Rent Expense - Amounts can usually be found in the 'Notes to consolidated financial statements' section of a company's annual report or 10K. Rent expense amounts are generally discussed under a note heading titled 'Commitments' or 'Commitments and Contingencies' and sometimes included under a note heading titled 'Leases'.

Dividends per Share - Amounts can usually be found on one of following statements: Statement of Stockholders' Equity, Statement of Cash Flows, or Statement of Operations. Dividends per share amounts are also often included in the 'Notes to consolidated financial statements' section of a company's annual report or 10K under note headings titled 'Selected Financial Data', 'Five Year Summary Data', or 'Quarterly Financial Data'.

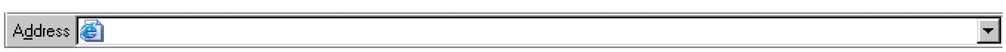
End of Year Stock Price – the template supports researching a company’s year-end stock price when following these steps:

a) Enter the company’s Stock Ticker Symbol

b) Enter the year end dates for the three years covered on the annual report

c) Copy the contents from one year’s URL cell to the clipboard

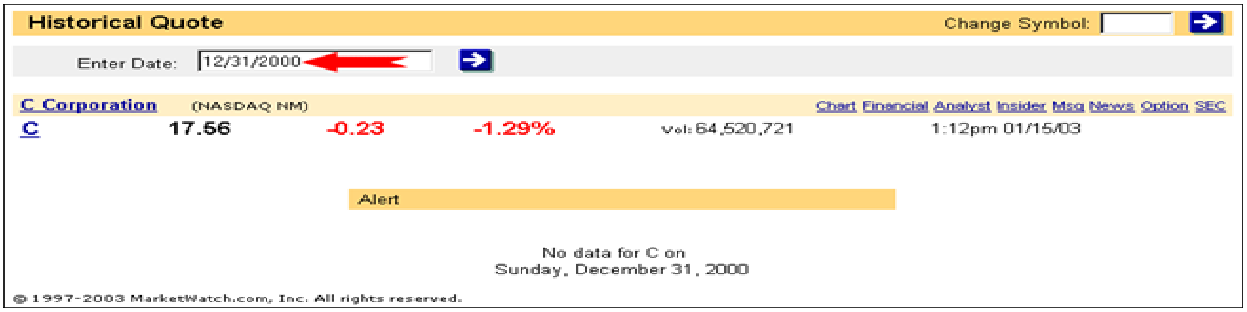
d) Paste the clipboard contents into an open browser’s Address field (Internet Explorer is shown)



e) Click the Go button (or your browser’s equivalent) to access the Market watch web site for the company’s stock price

f) Make sure the ***Split Adjusted Price*** (see red arrow below) is used, if available; otherwise, use the Closing Price

g) If the market was closed on the day supplied by the URL, change the historical quote date (see red arrow below) to the next earlier weekday until data is available.



h) Repeat steps c) through g) for the remaining years **Gross profit-** If gross profit is not listed on the Income statement/Statement of operations review financial data for COGS information and enter a formula to net Sales and COGS. If there is no COGS data, enter the Net Sales amount as the Gross Profit amount. Service companies may not display a Cost of Goods/ Cost of Sales amount.

Cost of Goods/ COGS/ Cost of Sales/ Cost of Revenue are alternative titles for the same data operating Profit-Do not include Interest Expense or Other Income (loss) items in this check figure; otherwise, the check figure will not compare favorably with the Income Statement Operating Profit subtotal. These are non-operating items and should be entered below the operating profit line.

Operating Profit/ Operating income/ Earnings from Operations are alternative titles for the same data

Interest Expense: This line item must be segregated to ensure correct ratio calculations. Interest Expense is sometimes included in the Other Income (Expense/ Loss)' line item. In that situation, look in the 'Notes to consolidated financial statements' section to find the actual amount of Interest Expense that should be entered and use a formula to exclude it from the 'Other Income (Expense/ Loss)' line. If a company has no short-or long term debt, there will generally be no Interest Expense.

Interest Paid and **Income Taxes Paid** (**Refunded**) are generally found at the end of the Cash Flow Statement. If not, look in the 'Notes to consolidated financial statements'

Worksheet supplemental information

To display the underlying formulas related to rations, single click the


button

To redisplay the ratio, single-click the


button

To redisplay the ratios, single-click the Cash flow button


EXCEL IN PROJECT APPRAISAL:

Once you have some understanding of how a spreadsheet works, insert the diskette for Module 3 obtained from the instructor and navigate around a bit:

(1) The elements needed to compute IRR's at private and social prices have been arranged as tables along the diagonal (Figure 3.1). This technique of organizing spreadsheet calculations is sometimes referred to as the "diamondback" method. Its virtue is its flexibility. Once the template has been completed, additional outputs and inputs can be added simply by inserting and deleting rows and columns. For example, when the command *Format, Insert* is used to create space in the spreadsheet, the computer adjusts all of the cells in the template accordingly. A new activity can then be added. Only the values for the formulas in the newly created cells need to be entered. This can done by copying (*Edit, Copy)* the formulas from adjacent cells. Other functions performed over a range, e.g., =SUM(), are unaffected and will include the new cell values without further modification.

(2) The tables are arranged on the spreadsheet in the order they have been discussed in class. The initial tables contain the physical input-output information relevant to the project (WITH_I-O and W/O_I-O). Then come tables that contain the calculations on private import and export parity prices. Following them are tables that calculate the with and without budgets, the investment costs and ultimately, an IRR. Again, once the template is completed, it can be modified for any other project simply by changing the labels and by inserting and deleting rows with the appropriate spreadsheet commands.

(3) To find specific tables, on the diagonal, use the *Formula, GoTo* command. It calls up a table of all the *named ranges* that have been created to identify tables (*Formula, Define Name*). Moving the cursor to a table name and clicking the mouse or pressing "Enter" causes the cursor to move directly to the named cell. With this arrangement, tables are easy to find no matter where they have been placed on the spreadsheet. The result is a system in which the spreadsheet template can be made increasingly complicated as new considerations are added without having to redo the worksheet from scratch.

(4) Cells containing formulas have been protected. This is done by enabling protection for the entire worksheet and then "unprotecting" the data cells. If you want to change formulas or insert and delete rows, you will need to disable protection. Because accidents can happen when cells are unprotected, i.e., formulas can be overwritten, it is a good idea to make a copy of the spreadsheet you have received before you attempt extensive modifications.

Preparing for Homework Exercise 3

The project to be appraised is the project that was designed in Module 2. Without the project, agriculture consists of growing subsistence grains. Assume that the project will (1) improve yields, (2) increase cropping intensities, and (3) introduce a more profitable crop mix by adding a high valued crop (cotton) to the cropping pattern. All agricultural projects derive their benefits from some combination of these three sources. (Positive incremental net revenues can also be generated, of course, by cost saving innovations such as labor saving mechanization.)

Incorporating Costs from Module 2

In the worksheet as it now stands, the private and social IRR's are equal. This is because the values for prices shown in the private and social prices tables are the same. Using the same values in both tables is a useful way to begin the construction of a spreadsheet model because it insures that the formulas have been entered correctly.

The worksheet contains the investment cost obtained from the "feasible" (sequentially linked) spreadsheet from Module 2. (Use *Formula, GoTo* to locate P_INVEST and S_INVEST.) Some numbers were required to check the computations; you may be able to do better.

The first step in carrying out the computer exercises in Module 3 is to incorporate your costs from Module 2. These will vary depending upon the assumptions you made in shortening the duration of the project. Everyone's answer is likely to be different because there is no "correct" answer to the question of how this might be done. Remember to use insert when you add items to the investment tables if you have added new technologies or new resources. Try, as much as possible, to insert rows in the midst of the existing set of items. This will insure the continued validity of formulas that sum over all rows.

Use the same numbers initially in both the private and social investment tables as a check to be sure that the template is computing properly. (Remember, you can *Copy* them.) The private and social IRR's will change as a result of changes in costs. They should, however, remain equal.

Creating an "Analysis Table"

Exploring the results of the appraisal exercise with an extensive sensitivity analysis is standard operating procedure for cost-benefit calculations. It is possible, of course, to enter the relevant data directly into the tables already set up along the diagonal. However, the total amount of time devoted to the exercise can be decreased by organizing an "analysis table."

The outline suggested in Table 3.1 identifies some of the likely candidates for sensitivity analysis. It would be a good idea to look at the questions in Homework Exercise 2 that will be handed out at the same time your receive the diskette to see if other information should be included in the analysis table.

Table 3. 1: Analysis Table					
Assumptions		Assumptions		Assumptions	
Official exchange rate		Yields			
Exchange rate premium		No. of farms			
Tariff Structure (Ad valorem)					
Imports	Wheat	Fertilizer	Fuel	Machinery	Construction Materials

Tax					
Subsidy					
Exports	Sorghum	Peanuts	Cotton		
Tax					
Subsidy					
Factor Disequilibrium (marginal product in Rs/hr)					
Unskilled labor					
Skilled labor					
Results					
			Wheat	Sorghum	Cotton
Private IRR		NPC			
Social IRR		EPC			

Appendix 3: Computing a Private IRR

The following tables provide a hardcopy reference to the private IRR calculations in the Module 3 spreadsheet. They are included here because they will be referred to during the discussion of the IRR computations in class.

W/O_I-O							
		"WITHOUT" PROJECT TECHNICAL COEFFICIENTS					
SEASON		WHEAT	SORGHUM	PEANUTS			
LAND COEFFICIENTS (acres/acre)							
Summer			1	1			
Winter		1					
LABOR COEFFICIENTS (days/acre)							
Summer							
	Irrigation		5	2			
	Plowing		8	6			
	Seedbed		6	3			
	Planting		8	3			
	Harvesting		4	8			
Total Summer			31	22			
Winter							
	Irrigation	3					

	Plowing	2					
	Seedbed	3					
	Planting	3					
	Harvesting	5					
Total Winter		16					
INPUT COEFFICIENTS (Units/acre)							
Fertilizer (bags)		1	2	1.5			
Fuel (gallons)		30	50	20			
Seeds (pounds)		20	20	15			
YIELDS (tons/acre)		2.5	4.75	4			
		"WITHOUT" PROJECT PHYSICAL BUDGET				AVAILABLE	SLACK
					TOTAL	RESOURCES	
LAND USE (acres)						10	6
Summer			2	2	4	10	8
Winter		2			2		
LABOR USE (days)						150	44
Summer			62	44	106	150	118
Winter		32			32		
INPUT USE (units)							
Fertilizer		2	4	3			
Fuel		60	100	40			
Seeds		40	40	30			
OUTPUT (tons)		5	9.5	8			

WITH_I-O		"WITH" PROJECT TECHNICAL COEFFICIENTS						
SEASON		WHEAT	SORGHUM	PEANUTS	COTTON			
LAND COEFFICIENTS (acres/acre)								
Summer			1	1	1			
Winter		1			1			
LABOR COEFFICIENTS (days/acre)								
Summer								
	Irrigation		6	3	3			
	Plowing		8	6	6			
	Seedbed		6	3	3			

	Planting		8	3	5			
	Harvesting		6	10	20			
Total Summer			34	25	37			
Winter								
	Irrigation	4			12			
	Plowing	2						
	Seedbed	3						
	Planting	3						
	Harvesting	8						
Total Winter		20			12			
INPUT COEFFICIENTS (Units/acre)								
Fertilizer (bags)		3	3	2.5	4			
Fuel (gallons)		30	50	20	60			
Seeds (pounds)		30	30	15	10			
YIELDS (tons/acre)		3	5.2	4.3	2.5			
		"WITH" PROJECT PHYSICAL BUDGET						
		WHEAT	SORGHUM	PEANUTS	COTTON	TOTAL	AVAILABLE	SLACK
							RESOURCES	
LAND USE (acres)								
Summer			2	2	3	7	10	3
Winter		2			3	5	10	5
LABOR USE (days)								
Summer			68	50	111	229	150	-79
Winter		40			36	76	150	74
INPUT USE (units)								
Fertilizer (bags)		6	6	5	12			
Fuel (gallons)		60	100	40	180			
Seeds (pounds)		60	60	30	30			
OUTPUT (tons)		6	10.4	8.6	7.5			

PM_PRICES	IMPORT PARTIY PRICES		
	Output	Inputs	
	Wheat	Fertilizer	Fuel
	($/ton)	($/bag)	($/gallon)
F.O.B	116.0	6.3	1.3
Freight	20.0	0.6	0.5
Insurance	5.0	0.1	0.2
Unloading	6.0	0.1	0.3
C.I.F.	147.0	7.1	2.3
Exchange rate	10.0	10.0	10.0
Exchange rate premium	0.0	0.0	0.0
Currency conversion	1,470.0	71.1	23.0
Tariffs/duties	0.0	0.0	0.0
Subsidies (-)	0.0	0.0	0.0
Port charges	22.0	0.2	0.1
Marketing margins	10.0	0.1	0.1
Wholesale price	1,502.0	71.4	23.2
Local transport	14.0	0.1	0.1
Local marketing	27.0	0.3	0.2
Farm gate price	1,543.0	71.8	23.5
(rupees)			

PX_PRICES			
	Sorghum	Peanuts	Cotton
	($/ton)	($/ton)	($/bale)
C.I.F.	390.0	400.0	700.0
Unloading	-39.6	-39.6	-39.6
Freight	-14.7	-14.7	-14.7
Insurance	-10.0	-10.0	-10.0
F.O.B.	325.7	335.7	635.7
Exchange rate	10.0	10.0	10.0
Echange rate premium	0.0	0.0	0.0
Local currency	3,256.7	3,357.0	6,357.0
Taxes/duties	0.0	0.0	0.0
Subsidies	0.0	0.0	0.0
Port charges	-22.0	-22.0	-22.0
Local transport	-14.0	-14.0	-14.0
Local marketing	-27.0	-27.0	-27.0

Local storage	-10.0	-10.0	-10.0
Farm gate price	3,183.7	3,284.0	6,284.0

P_PROFITS	WITHOUT" PROJECT PRIVATE PROFITS					
	Wheat	Sorghum	Peanuts	Cotton	Total	
Output	5.0	9.5	8.0			
Price	1,543.0	3,183.7	3,284.0			
Gross Revenue	7,715.0	30,245.2	26,272.0		64,232.2	
Fertilizer	143.6	287.3	215.5			
Fuel	1,410.0	2,350.0	940.0			
Seed	30.9	63.7	49.3			
Variable Costs	1,584.5	2,701.0	1,204.7	0.0	5,490.2	
Profits	6,130.5	27,544.2	25,067.3	0.0	58,742.0	
	WITH" PROJECT PRIVATE PROFITS					
	Wheat	Sorghum	Peanuts	Cotton	Total	
Output	6.0	10.4	8.6	7.5		
Price	1,543.0	3,183.7	3,284.0	6,284.0		
Gross Revenue	9,258.0	33,110.5	28,242.4	47,130.0	117,740.9	
Fertilizer	430.9	430.9	359.1	861.8		
Fuel	1,410.0	2,350.0	940.0	4,230.0		
Seed	46.3	95.5	49.3	94.3		
Variable Costs	1,887.2	2,876.4	1,348.4	5,186.1	11,298.1	
Profits	7,370.8	30,234.0	26,894.0	41,943.9	106,442.8	

DETERMINING PROJECT VIABILITY:

The best way to find out whether your project is feasible is to complete a Feasibility Study. This process helps you gain confidence that the solution you need to build can be implemented on time and under budget. So here's how to do it in 5 simple steps…

Completing a Feasibility Study

A Feasibility Study needs to be completed as early in the Project Life Cycle as possible. The best time to complete it is when you have identified a range of different alternative solutions and you need to know which solution is the most feasible to implement. Here's how to do it…

Step 1: Research the Business Drivers

In most cases, your project is being driven by a problem in the business. These problems are called "business drivers" and you need to have a clear understanding of what they are, as part of your Feasibility Study.

For instance, the business driver might be that an IT system is outdated and is causing customer complaints, or that two businesses need to merge because of an acquisition. Regardless of the business driver, you need to get to the bottom of it so you fully understand the reasons why the project has been kicked off.

Find out why the business driver is important to the business, and why it's critical that the project delivers a solution to it within a specified timeframe. Then find out what the impact will be to the business, if the project slips.

Step 2: Confirm the Alternative Solutions

Now you have a clear understanding of the business problem that the project addresses, you need to understand the alternative solutions available.

If it's an IT system that is outdated, then your alternative solutions might include redeveloping the existing system, replacing it or merging it with another system.

Only with a clear understanding of the alternative solutions to the business problem, can you progress with the Feasibility Study.

Step 3: Determine the Feasibility

You now need to identify the feasibility of each solution. The question to ask of each alternative solution is "can we deliver it on time and under budget?"

To answer this question, you need to use a variety of methods to assess the feasibility of each solution. Here are some examples of ways you can assess feasibility:

- Research: Perform online research to see if other companies have implemented the same solutions and how they got on.
- Prototyping: Identify the part of the solution that has the highest risk, and then build a sample of it to see if it's possible to create.
- Time-boxing: Complete some of the tasks in your project plan and measure how long it took vs. planned. If you delivered it on time, then you know that your planning is quite accurate.

Step 4: Choose a Preferred Solution

With the feasibility of each alternative solution known, the next step is to select a preferred solution to be delivered by your project. Choose the solution that; is most feasible to implement, has the lowest risk, and you have the highest confidence of delivering.

You've now chosen a solution to a known business problem, and you have a high degree of confidence that you can deliver that solution on time and under budget, as part of the project.

Step 5: Reassess at a lower level
It’s now time to take your chosen solution and reassess its feasibility at a lower level. List all of the tasks that are needed to complete the solution. Then run those tasks by your team to see how long they think it will take to complete them. Add all of the tasks and timeframes to a project plan to see if you can do it all within the project deadline. Then ask your team to identify the highest risk tasks and get them to investigate them further to check that they are achievable. Use the techniques in Step 3 to give you a very high degree of confidence that it’s practically achievable. Then document all of the results in a Feasibility Study report.
After completing these 5 steps, get your Feasibility Study approved by your manager so that everyone in the project team has a high degree of confidence that the project can deliver successfully.
[contentbox width=”630″ borderwidth=”1″ borderstyle=”dashed” bordercolor=”336699″ dropshadow=”0″ backgroundcolor=”F5F5F5″ radius=”0″]About the Author
Jason Westland has been in the project management industry for the past 16 years managing projects of up to 2 billion dollars. If you would like to find out more about Jason or about his new online project management software visit projectmanager.com.[/contentbox]
If you are starting a business, planning an investment, or embarking on a project, it is necessary that you determine whether it is viable or even just feasible for that matter. Knowing the feasibility and viability of an endeavor or business venture will help evaluate its sustainability and the success of the project or business.
What is ‘feasibility,’ and what does it entail to get a feasibility study of a project? Likewise, what is ‘viability,’ and how can one determine if a project is viable or not? Let us define what these words mean and how they can be done.

Feasibility’ is a study that aims at uncovering the strengths and weaknesses of an existing business or a proposed business venture. It takes into consideration the opportunities offered by the environment, its resources, and the subsequent success of the venture. It should include the description of the product or service, its historical background, operational details, financial data and accounting statements, legal and tax requirements, and its policies on management and marketing research.

‘Viability,’ on the other hand, is the study or an investigation of the existing business or proposed venture’s sustainability. It determines whether the proposal should be approved or not. It involves dealing with strategies on how to make the business grow and last. Business growth is an important aspect of viability. How long a business will last is determined by its viability, and it can be seen in the profits that the business has made for a certain period. Good profit means a better chance at success for the business.

There are several types of feasibility:

- Economic feasibility, which uses economic analysis or cost/benefit analysis wherein the benefits are compared with the cost.
- Legal feasibility, which deals with the legal requirements.
- Operational feasibility, which deals with how to solve problems and take advantage of opportunities.
- Schedule feasibility, which deals with the duration of the development and completion of the system and if the schedule or deadline is desirable.

- Market and real estate feasibility, which involves testing of the geographical location of the project.
- Resource feasibility, which involves the amount of time set for the project and the type and amount of resources needed.
- Cultural feasibility, which studies the project's impact on the local culture.
- Financial feasibility, which includes the total cost of the project, its cash flow, and profitability.

Summary:

1. 'Feasibility' is the study of the profitability, strengths, and weaknesses of an existing business or proposed venture while 'viability' is the study of the existing or proposed business's profitability.
2. 'Feasibility' deals with environmental opportunities, historical backgrounds, operational details, legal and tax requirements, financial and accounting statements, managerial and market research policies. 'Viability' deals with strategies on how to make the business grow and succeed.
3. There are many types and aspects of a feasibility study which include financial and cultural feasibility, legal and operational feasibility, and resource feasibility while business growth and sustainability are the main aspects of viability.

RISK ANALYSIS IN PROJECT APPRAISAL:

Analyzing the time to complete a project using project planning tools nearly always underestimates the time to completion. It is not the fault of the software or of the analysts, but of the use of 'best guess' values for task durations, etc. in the project plan. Risk analysis will allow you to avoid systematically underestimating project costs and durations.

The project risk analysis course is designed to help those who wish to apply quantitative risk analysis modeling to project planning problems.

A project is defined as any set of tasks involving resources (human, machine, time, financial) with well-defined goals. Project risk analysis aims at identifying the risks and uncertainties that threaten the achievement of those goals or the efficiency with which the project can be carried out. The techniques are very general and intuitive and require little mathematical knowledge, but reward the project manager with a clear understanding of the risks being faced and efficient ways of managing those risks.

SIMULATION IN PROJECT APPRAISAL:

Risk simulation forms an important part of investment appraisal, not least because it offers a means of examining the impact of uncertainty. Nor is this necessarily confined to managerial economics, many leading texts on strategic management (Johnson and Scholes, 1999) incorporate risk analysis into the evaluation of new or different strategies.

While investment appraisal can easily be conducted using a spreadsheet, risk simulation is more problematic. Risk simulation models are more sophisticated than investment appraisal models. They involve the use of Monte Carlo experiments, which if they are to produce meaningful results have to be undertaken a large number of times. This requires some form of control structure in order to 'automate' and speed up the experimentation process. Because of this, a number of specialist 'add-in' packages have been developed, such as '@Risk' and 'Crystal Ball'. These make risk simulation with a spreadsheet straightforward. A number of articles and texts (Jones and Sheard, 1991; Oakshott, 1997; Vose 1996; Uyeno, 1992; Barlow, 1999) have described the risk simulation applications using @Risk. Unfortunately such packages are not always widely available and students may not have access to them.

While it is possible to undertake risk simulation on a spreadsheet without using a specialist add-in package (Bodily, 1986), to complete a large number of Monte Carlo experiments is slow and time consuming. The macro programming facilities available with more advanced spreadsheets mean that it is possible to set up a risk simulation model that will conduct a large number of experiments or simulations on a non-manual basis. A number of papers (Smith, 1994; Seila and Banks, 1990; Diacogiannis, 1994) have shown how simple models of this type can be developed. The advent of later versions of Excel with facilities for programming in Visual Basic for Applications (VBA) takes the process a stage further and allows the creation of complex control structures that permit the development of sophisticated models.

The purpose of this paper is to show how such models can be developed. The paper also takes the opportunity to explore some of the uses to which students can put risk simulation models in order to make themselves thoroughly conversant with the technique. Hopefully this forms a useful supplement to Judge's (1999) recent paper on Monte Carlo studies.

The Concept of Risk Simulation

Risk simulation is a risk analysis technique that came to prominence in the early 1960s (Hertz, 1964). It involves the use of a probability distribution and random numbers, hence the Monte Carlo element, to estimate net cashflow figures. When discounted these figures sum to an estimated net present value (NPV) for a project. Repeated many times one gets a distribution of project NPV. If the resulting distribution is presented as a graph it is relatively easy to comprehend the uncertainty surrounding a project. This is beneficial for students because it contrasts sharply with the deterministic nature of most investment models.

Building a Risk Simulation Model

The construction and operation of a risk simulation model for an investment appraisal application involves a number of steps.

Step 1: Build an investment appraisal model using discounted cashflow.

Step 2: For each year's net cashflow create a probability distribution and link it to a random number generator.

Step 3: Carry out a simulation by drawing a value from each probability distribution using the random number generator and sum the resulting estimates to provide an overall estimate for project NPV.

Step 4: Repeat the simulation many times (i.e. 500 or more) to provide an estimated distribution for NPV for the project.

Step 5: Decide whether the probability that the project NPV may be negative is, or is not an acceptable risk and proceed accordingly.

Year	Discount Factor	Net Cashflow	Present value
0	1	-85000	-85000
1	0.9091	25000	22727
2	0.8264	25000	20661
3	0.7513	25000	18783
4	0.6830	25000	17075
5	0.6209	25000	15523
		NPV	9770

Table 1: Simple Model

Table 1 shows a simple DCF investment appraisal model that can form the basis of a risk simulation. It utilises cells B2:E11 on the spreadsheet. It is an entirely conventional DCF model. In column one are the years that the project is operational (B4:B9). The third column shows the estimates of net cashflow for each year together with the initial cost of the project (D4:D9). In this instance the initial cost of the project (i.e. purchase of machinery) is �85,000 and the net cashflow is �25,000 each year for five years. In the second column (C4:C9) is the discounting factor. For year 0 the value of the discounting factor is one, because it represents the present time. Thereafter the discounting factor is based on the formula:

$PV = 1/(1 = r)^{n}$

where PV is present value, r is the discount rate and n is the year. In this instance a discount rate of 10% is used and the project has a life of 10 years. The discount rate is located in cell C28. This forms part of the Summary section located in cells B27:E32. Implementing the discounting formula for cell C5 gives the formula:

`+1/(1 + $C$28)^B5`

This formula can be copied into cells C6:C9. Column four (E4:E9) shows the present value of the cashflows, being the result of applying the relevant discount factor to the relevant net cashflow. In cell E11 is the overall NPV for the project represented by the formula:

+Sum(E4:E9).

In order to implement a risk simulation the following additional capabilities are required of a spreadsheet:

> a) a random number generator such as the function RAND () in Excel which generates a random variate every time the spreadsheet is recalculated.
> b) a macro capability to enable the creation of a sub-routine or procedure that will automatically implement the simulation a large number of times.
> c) a statistical function such as FREQUENCY() in Excel which will enable the simulation results to be sorted into a frequency distribution.

All of these capabilities are to be found in most modern spreadsheets, but Excel has the advantage that Visual Basic for Applications provides greater flexibility in creating sub-routines.

To undertake Step 2 the estimated cashflow figures in column two of Table 1 are replaced by a random variate sampled from an appropriate distribution that represents the range and frequency of likely values for this entity. In this instance a normal distribution is used. New values will be generated every time the spreadsheet is recalculated. The probability distribution is represented by a mean value and associated standard deviation. To be consistent with the simple model a mean of �25,000 is used and a standard deviation of �10,000. Identical values are used for every one of the five years of the project. It is the standard deviation that reflects the level of uncertainty. A high value for the standard deviation, as in this case, means a high level of uncertainty and thus a high level of risk. One would expect this to be reflected in the resulting distribution for project NPV.

The probability distribution and random number generator are combined by using the formula: a + b* (RAND() + RAND()...RAND() - 6) where a is the mean (25,000) and b is the standard deviation (10,000) and there are twelve calls to the RAND() function. This is the formula for generating a normally distributed random variate (Seila and Banks, 1990). It is entered into each of the cells representing net cashflows in the model. These are the only changes compared to the simple model. Step 2 is now complete and the model can be used to carry out risk simulations.

Year	Discount factor	Net Cashflow	Present value
0	1	-85000	-85000
1	0.9091	42893	29890
2	0.8264	11596	24092
3	0.7513	26414	21217
4	0.6830	24108	19001
5	0.6209	8164	14137
		NPV	23337

Table 2: Risk Simulation Model

Step 3 involves conducting a simulation manually by pressing the F9 key to recalculate the model. The effect of recalculation is to provide a new value for project NPV (E24). Instead of NPV being fixed, on the basis that all the estimates in the model are certain, it changes to reflect uncertainty. The revised model (table 2) reflects uncertainty by drawing figures for net cashflow at random from a probability distribution. To undertake further simulations (Step 4) one simply re-calculates the model again and again. Successive new values for NPV are generated. Some of them will be negative! Students may like to reflect on the significance of negative values for NPV. Recording the NPV values produced by successive simulations, a distribution can be built up.

The shape of the distribution reflects the mean and standard deviation of the probabilities used to estimate the annual net cashflows. Examining the distribution one can estimate the likelihood of the project NPV being negative. This is the justification for risk simulation. One can gain insights into the prospect that a project may produce an undesirable result.

Unfortunately, building up a distribution using manual recalculation is slow and time consuming. This is where Excel and Visual Basic for Applications enters the picture because to be effective the simulation should be repeated at least 500 times.

Student Task: Record the results of 50 simulations carried out by successively re-calculating the model. What is the probability that the project will produce a negative NPV? Is this an acceptable risk?

Automating the Risk Simulation Model

The essence of the automation of the risk simulation model is the creation of an Excel macro written in VBA. The macro will perform three tasks:

a) re-calculate the model
b) record the results (NPV values) of successive simulations in a list
c) deploy the FREQUENCY () function to analyse the results

The VBA code is simplified if one first uses the 'Name' facility to name ranges of cells:

Name	Range
Bins	I6:I26
Frequencies	J6:J27
NPV	E24
Results	G3:G502

Table 3

The range named Bins houses the values used by the function FREQUENCY() to process the results. The Frequencies range will house the frequencies that are generated. The Results range is where the simulation results (values for NPV) are stored.

Table 4: Simulation Macro

```
Sub Simulation()
'
' Simulation Macro
' Macro recorded 15/01/00 by D.Smith
'

'
    For counter = 3 To 502
      Range("NPV").Select
      Calculate
      Cells(counter, 7).Value = ActiveCell.Value
    Next counter
    Range("frequencies").Select
    Selection.FormulaArray = ("=Frequency(Results, bins)")
    Calculate
End Sub
```

The macro (table 4) is created as a module using the Visual Basic Editor. There are two components to the single subroutine within the macro. The first component is a For..Next loop.

This selects the cell named NPV (E24), recalculates the model and places the resulting value in the NPV cell at the top of the range named Results. On the next circuit of the loop the model is again recalculated and because the counter has been incremented the new value for NPV goes into the next cell in the Results range. This continues until the counter gets to the last cell in the Results range, which in this instance is G502. The counter can be set with different values to undertake more or less simulations.

Results				
Bins	**Frequency**	**Cumulative Frequency**	**Relative Frequency**	**Cumulative Relative Frequency**
-40000	1	1	0.002	0.002
-35000	3	4	0.006	0.008
-30000	3	7	0.006	0.014
-25000	4	11	0.008	0.022
-20000	9	20	0.018	0.040
-15000	22	42	0.044	0.084
-10000	32	74	0.064	0.148
-5000	40	114	0.080	0.228
0	46	160	0.092	0.320
5000	52	212	0.104	0.424
10000	57	269	0.114	0.538
15000	52	321	0.104	0.642
20000	46	367	0.092	0.734
25000	46	413	0.092	0.826
30000	33	446	0.066	0.892
35000	17	463	0.034	0.926
40000	17	480	0.034	0.960
45000	8	488	0.016	0.976
50000	6	494	0.012	0.988
55000	5	499	0.010	0.998
60000	1	500	0.002	1.000

	0	500	0.000	1.000
Total	500		1.000	

Table 5: Results Table

The second part of the macro involves the use of Excel's FREQUENCY() function. To enable this function to sort the simulation results effectively, the values stored in the Results range have to be placed in the cells designated as 'Bins' (I6:I26). This range of cells will form the right hand column (table 5) of the Results Table (I2:M29). To sort the results likely to be obtained with the investment model specified, the values range from + 60,000 to - 40,000 with intervals of 5,000. The frequency produced by executing the FREQUENCY() function appears in the second column of the Results Table (J6:J27). To produce appropriate graphs of the risk simulation results, three further columns need to be designated at this stage for Cumulative Frequency (K6:K27), Relative Frequency (L6:L27) and Cumulative Relative Frequency (M6:M27). For each of these ranges of cells a formula is required. Cumulative Frequency requires the formula +J6 in the first cell followed by +K6+J7 in the next cell down. This formula can then be copied into the remaining cells in the column. The fourth and fifth columns in the Results Table require the number of simulation results as a denominator. This is obtained by placing the formula +SUM (Frequencies) in cell J28. The formula for the relative frequency column is +K6/$J$28. In both instances the formula can be copied down into the remaining cells in the column. As a check to ensure that all the results have been processed cell L28 contains the formula +SUM(L6:L27).

Having set up the Results Table, graphs can be specified based on the figures in the results table. A bar chart will produce a graph of the relative frequency. With probability on the Y axis and the values shown in the Bins range on the X axis, it will show the distribution of project NPVs. A line graph based on the cumulative relative frequency with similar axes will show the cumulative distribution of project NPVs.

The final step is to complete the summary section (B27:E32) on the spreadsheet (Table 6). Using the COUNT() function in C29 will maintain a tally of the number of simulations . The use of MAX(Results) in E28 and MIN(Results) in E29 will capture the highest and lowest observations for project NPV. The function AVERAGE() and STDEV() in E30 and E31 will provide the mean and standard deviation.

Having set up the spreadsheet in this way, lines six to eight of the macro select the range of cells containing the frequencies generated by successive executions of the simulation loop and apply the FREQUENCY() function using the Results and Bins ranges as arguments. Finally the macro recalculates the Results Table in order to generate the relative frequency and cumulative relative frequency figures.

Using the Risk Simulation Model

To run the risk simulation model one simply selects the SIMULATION macro via the TOOLS bar. One of the benefits of the model is that values in the NPV cell (E24) change as the simulations are executed. The simulation results are recorded in the Results range. This facility can be particularly useful if it is necessary to de-bug the model. Upon completion the simulation results are summarised in the Results Table. Selecting the graph tabs should produce figures 1 and 2. Finally the Summary section will provide an overview of results.

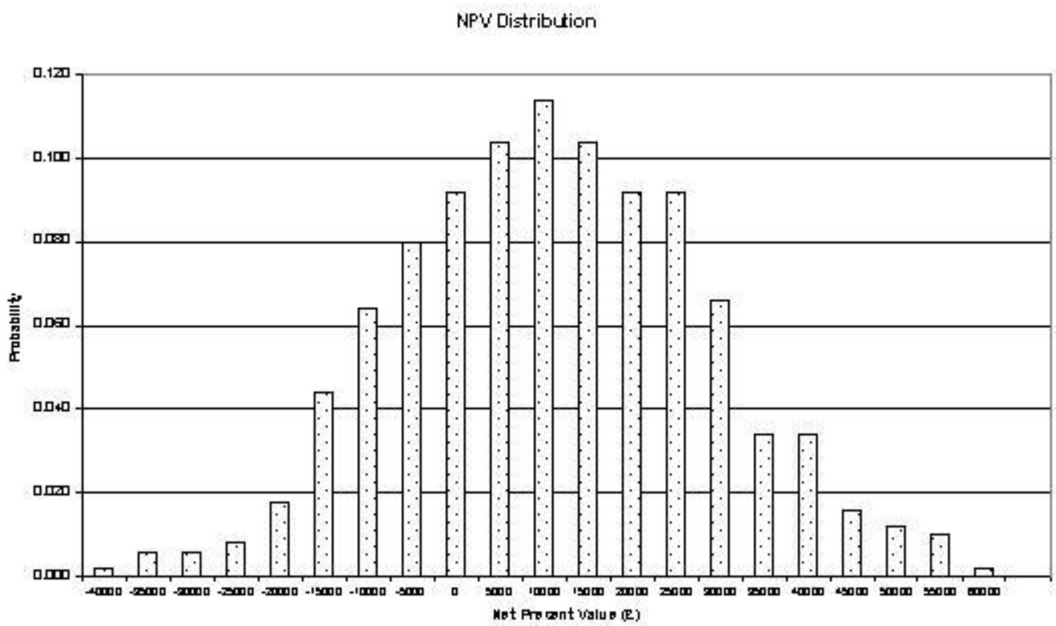


Figure 1

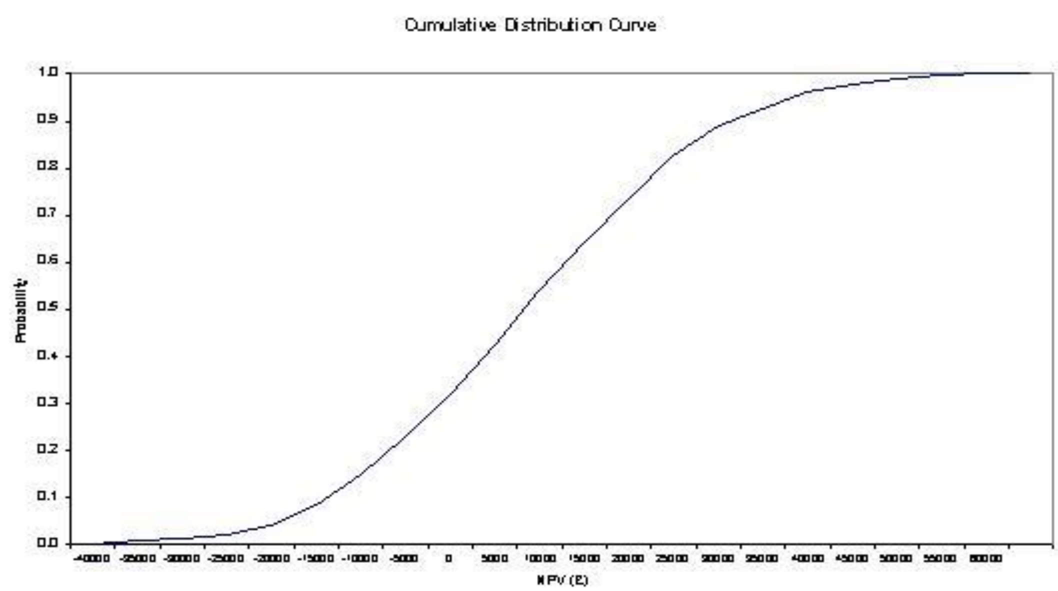


Figure 2

Model Development

Important though it is to get students using the risk simulation model and analysing the results, this is really only the beginning. One of the biggest benefits to be gained from using a risk simulation model without the aid of add-in packages like @Risk is the scope for further model development.

Modifications to the model could take the form of modifications to both the macro and the spreadsheet model. Changes to the macro that could be explored include aspects such as increasing the number of simulations carried out. 500 simulations were used in this instance but it is a simple matter to increase this to 2,000 or 5,000.

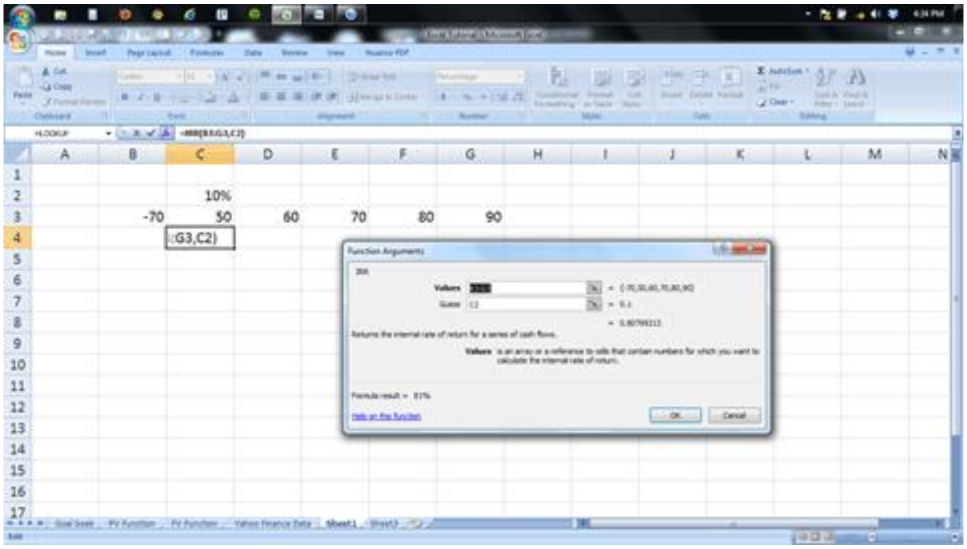
Changes to the model could include the incorporation of some of the following:

- an uncertain discount rate
- distributions other than the normal one used in this case (note: Seila and Banks (1990)provide examples of spreadsheet implementations of these and other distributions)
- net cashflows being non-independent as poor sales in one year link to the next. This sort of correlation could be achieved if the mean of the distribution in years two to five was the value sampled in the previous year
- model each year's net cashflows in terms of revenues and costs where each is drawn from its own probability distribution.

EXCEL IN VALUATION:

There is not a specific function to run a full discounted cash flow model in Excel, but there are a number of tools to make the exercise much more straightforward. As touched upon in the PV and FV functions on a previous page, it is first necessary to estimate either the present or future value of a security, and then also estimate its future cash flows. Discounting these cash flows back by an estimated discount rate will provide a future value. Conversely, starting with a present value and cash flows can allow the user to back into the estimated future value.

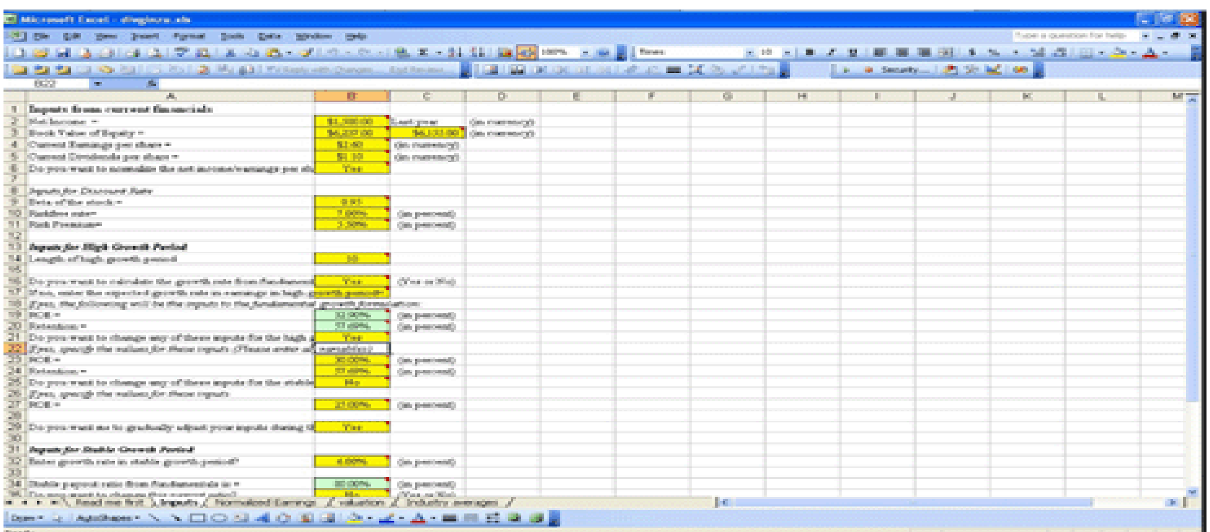
In addition to the above two functions, Microsoft has an IRR function that lets you back into the discount rate, or specifically the internal rate of return, for a series of cash flows. Excel points out that this is very closely related to the PV function, meaning the same inputs are needed, such as an initial present value followed by a string of cash flows.
The below details a specific cash flow stream for an investment, starting with an initial investment of $70.



Dividend Discount Model DDM

The dividend discount model (DDM) represents another approach to estimate the value of a stock or company by discounting back its estimated future dividend rates. It is very similar to a DCF, but uses dividends instead of cash flows. A basic model can be built an only requires knowing the current dividend rate, estimated dividend growth rate, and discount rate, or required rate of return.

However, there are more complicated ways to look to estimate dividends, including at rates that change over time. Below is an example of just how complicated the exercise can become:



Residual Income Model (RIM)

Along with the DDM, the residual income model (RIM) is another specialized version of a DCF used to value a firm. In its most basic form, the RIM has an equity charge that is equal to equity capital multiplied by the cost of equity. This is subtracted from net income to get to a residual income figure, which is used in lieu of cash flow or dividends, as calculated in the DCF and DDM models. Residual income figures can easily be modeled and calculated in Excel, but there are a number of steps to get to these calculations.

Below is an example of a full RIM as created in Excel:

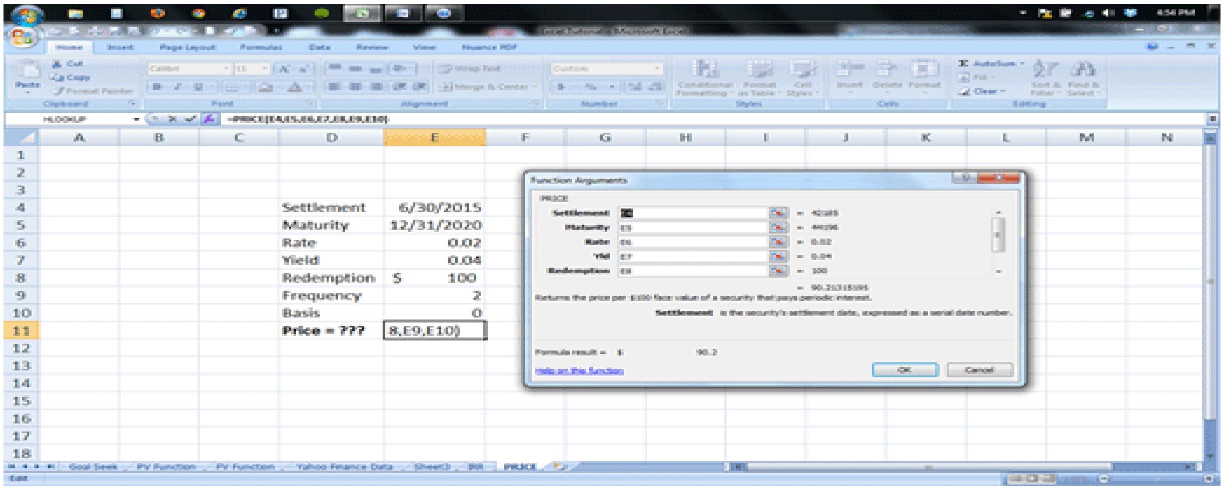
Name of Firm:	**NewCo**
Date of Valuation:	**11/22/10**
($ and shares in millions)	
Growth Rates:	
First 5 years	17.00%
Years 6 – 10	11.00%
After 10 years	4.00%
Capital Retention Rates:	
First 5 years	85.00%
Years 6 – 10	60.00%
After 10 years	20.00%
	$ 3,688
	$ 20,119
Discount Rate	10.00%

And below are the outputs, as calculated by the above RIM:

Book Value		**Present Value of**	
Equity	**Residual Earnings**	**Intrinsic Value**	**IV per Share**
$ 20,119	$66,090	$ 86,209	$ 37

Bond Valuation

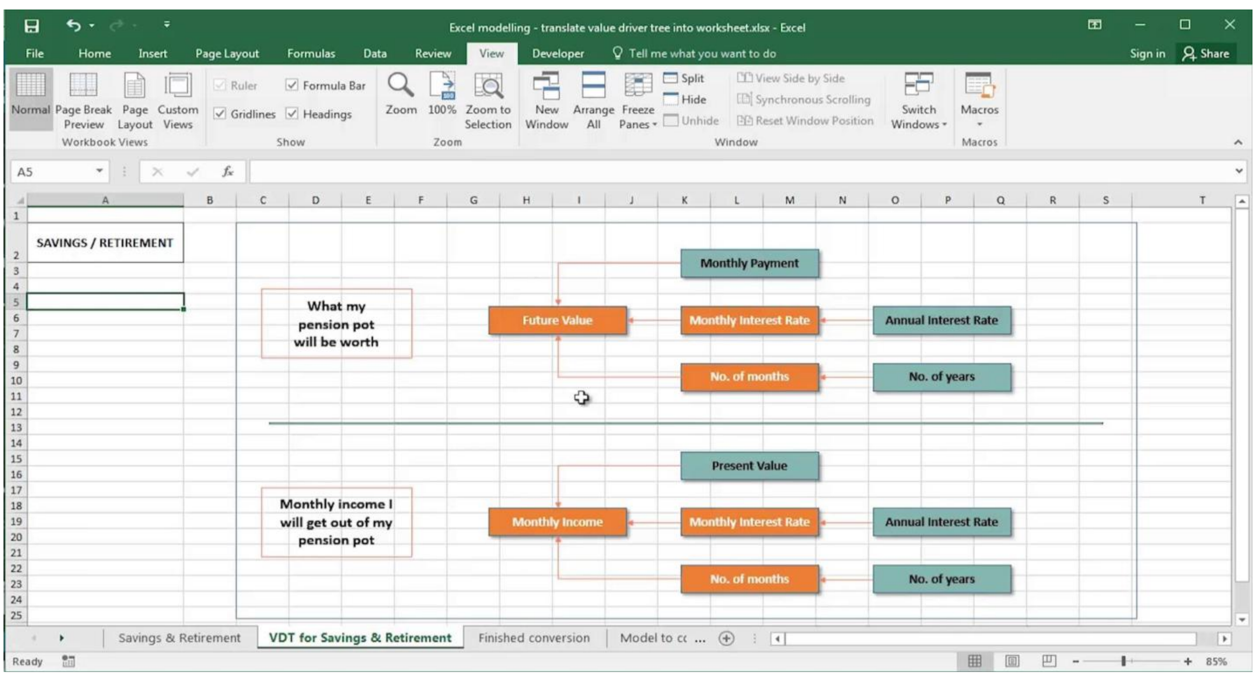
There are a number of bond valuation functions in Excel. The "PRICE" function returns the estimated market value of a bond with a $100 face value. Below are the details of the metrics needed to value such a bond, which happens to be $90.20, based on the inputs provided.



Other bond functions include the ability to calculate a bond's duration, modified duration, yield to maturity, yield, and discount rate Basically, there is the ability to solve for any variable when valuing a bond.

DETERMINATION OF VALUE DRIVERS:

A value driver is an activity or capability that adds worth to a product, service or brand. More specifically, a value driver refers to those activities or capabilities that add profitability, reduce risk, and promote growth in accordance with strategic goals. Such goals can include increasing shareholder value, competitive edge and customer appeal.



Value drivers are the factors that are likely to have the greatest impact on a company's success, and they are specific to different industries and companies.

For example, the value drivers motivating a healthcare company to move certain business processes from on-premises to cloud-based systems would be different than those motivating a manufacturing company seeking to implement digital manufacturing technology and link different data silos and processes of the manufacturing lifecycle. Determining a true value driver requires thinking of long-term gains, and not getting swayed by trendy processes or technologies that don't add tangible value or are only a short-term win.

There are different categories of value drivers, whether types, such as growth drivers, operational drivers or financial drivers, or levels, such as generic or business-unit specific.

When action is required to realize a particular value driver -- for example, managing inventory turns or variables that affect working capital -- the value driver must be defined at an explicit and commensurate level where action can be taken towards its realization. For example, a C-level executive has overarching insight and high-level responsibilities that are very different than that of a front-line manager, yet each can carry out important value-driving actions.

DISCONTINUED CASH FLOW VALUATION:

The discounted cash flow (DCF) formula is equal to the sum of the cash flow in each period divided by one plus the discount rate Weighted Average Cost of Capital (WACC) raised to the power of the period number.

Here is the DCF formula:

DCF = (CF/(1+r)^1) + (CF/(1+r)^2) + (CF/(1+r)^3) + … + (CF/(1+r)^n)

Where:

CF = Cash Flow in the Period
i = the interest rate or discount rate
n = the period number

Steps in the DCF Analysis

The following steps are required to arrive at a DCF valuation:

- Project unlevered FCFs (UFCFs)
- Choose a discount rate
- Calculate the TV
- Calculate the enterprise value (EV) by discounting the projected UFCFs and TV to net present value
- Calculate the equity value by subtracting net debt from EV
- Review the results

What is the DCF formula used for?

The DCF formula is used to determine the value of a business or a security. It represents the value an investor would be willing to pay for an investment, given a required rate of return on their investment (the discount rate).

Examples of uses for the discounted cash flow formula:

- To value an entire business
- To value a project or investment within a company
- To value a bond
- To value shares in a company
- To value an income producing property
- To value the benefit of a cost saving initiative at a company
- To value anything that produces (or has an impact on) cash flow

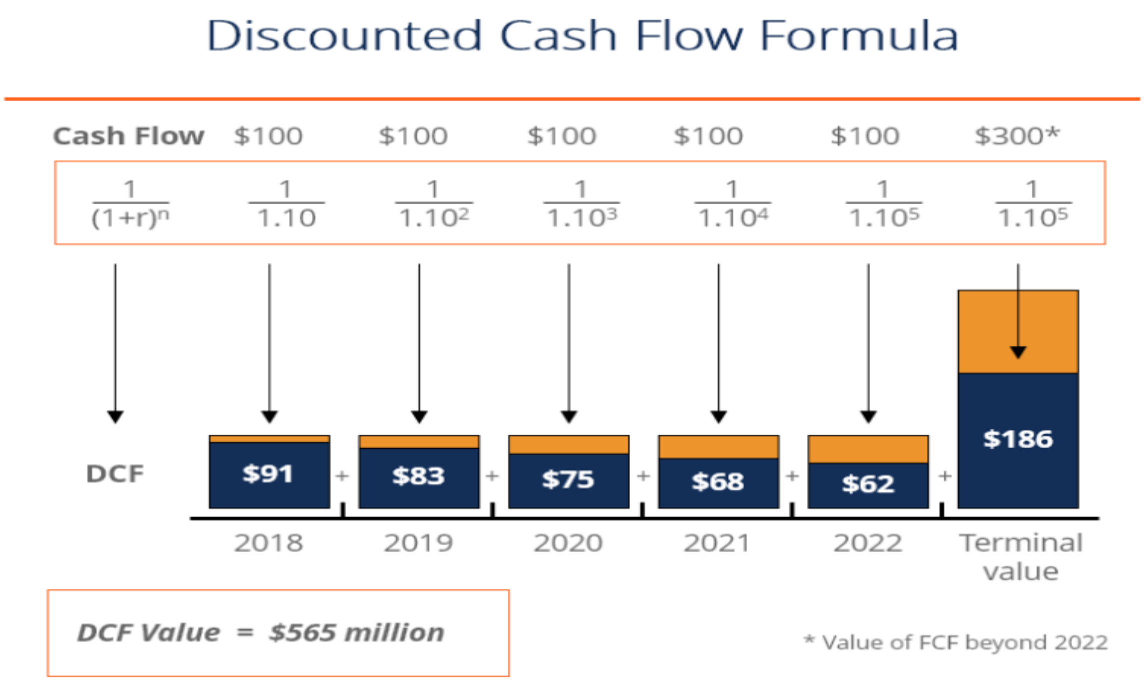
What does the discounted cash flow formula tell you?

When assessing a potential investment, it's important to take into account the time value of money, or the required rate of return that you expect to receive.

The DCF formula takes into account how much return you expect to earn, and the resulting value is how much you would be willing to pay for something, to receive exactly that rate of return.

If you pay less than the DCF value, your rate of return will be higher than the discount rate.

If you pay more than the DCF value, your rate of return will be lower than the discount.



RISK ANALYSIS IN VALUATION:

Using Models for Risk Analysis

A risk analysis model could be a physical scale model, but it is most often a mathematical model. The model can be created by writing code in a programming language, statements in a simulation modeling language, or formulas in a Microsoft Excel spreadsheet. Regardless of how it is expressed, a risk analysis model will include:

- Model *inputs* that are uncertain numbers -- we'll call these uncertain variables
- Intermediate calculations as required
- Model *outputs* that depend on the inputs -- we'll call these uncertain functions

It is essential to realize that model *outputs* that depend on uncertain *inputs* are uncertain themselves -- hence we talk about uncertain variables and uncertain functions. To make use of a risk analysis model, we will test many different numeric values for the uncertain input variables, and we'll obtain many different numeric values for the uncertain output functions. We'll use statistics to analyze and summarize all the values for the uncertain functions (and, if we wish, the uncertain variables).

- Creating the Model
- Model Simplification

Creating the Model

Since a risk analysis model will be subject to intensive computations, you'll generally want to create the model using available risk analysis tools. An Excel spreadsheet can be a simple, yet powerful tool for creating your model -- especially when paired with Monte Carlo simulation software such as Risk Solver. If your model is written in a programming language, Monte Carlo simulation toolkits like the one in Frontline's Solver SDK Platform provide powerful aids.

An example model in Excel might look like this, where cell B6 contains a formula =PsiTriangular(E9,G9,F9) to sample values for the uncertain variable Unit cost, and cell B10 contains a formula =PsiMean(B9) to obtain the mean value of Net Profit across all trials of the simulation.

	A	B	C	D	E	F	G
1							
2	**Financial Results**					**Market Scenarios**	
3					Low Demand	High Demand	Average
4	Sales in units	60,000		Sales units	60,000	100,000	80,000
5	Price per unit	$10.00		Price per unit	$10.00	$8.00	
6	Unit cost	$7.07					
7	Fixed costs	$30,000				**Unit Cost Scenarios**	
8					Low	High	Average
9	Net Profit	$146,070			$6.00	$9.00	$7.50
10	True Average	$69,517					
11							

A portion of an example model in the C# programming language might look like this, where the array Var[ ] receives sample values for the two uncertain variables X and Y, and the uncertain function values are computed and assigned to the Problem's FcnUncertain object Value property:

```
private Engine_Action SimEvaluator_OnEvaluate(Evaluator evaluator)
{
    // First, we ask for the current uncertain variable values
    double[] Var = evaluator.Problem.VarUncertain.Value.Array;

    _textConsole.Write("Evaluation x1 = " + Var[0] + ", x2 = " + Var[1] +
        ", Trial = " + evaluator.Problem.Engine.Stat.FunctionEvals + "\r\n");

    // We compute the function values given the current variable values

    evaluator.Problem.FcnUncertain.Value[0] = Var[0] + Var[1];   // X+Y
    evaluator.Problem.FcnUncertain.Value[1] = Var[0] * Var[1];   // X*Y

    Application.DoEvents();

    return Engine_Action.Continue;
}
```

Model Simplification

Like all models, a risk analysis model is a simplification and approximation of reality. The art of modeling involves choices of what essential factors must be included, and what factors may be ignored or safely excluded from the model. As Albert Einstein suggested, a model should be "as simple as possible, but no simpler."

We must also choose what sample values to test for the uncertain variables. Simulation software such as Risk Solver lets us draw sample values from scores of different probability distributions. While we should do our best to choose the right sample values, we derive a great benefit simply by moving from fixed values to almost any reasonable sample of values for an uncertain quantity.

Dr. Sam Savage likes to use the analogy of shaking a ladder before you use it to climb up on a roof. When you do this, you subject the ladder to a random set of forces, to see how it behaves. Even though the forces when you are shaking are not distributed in the same way as the forces when you are climbing, shaking a ladder is still a good “stress test” in advance.

----ooOoo----

UNIT-IV

EXCEL IN PORTFOLIO THEORY

Determining efficient portfolio, creating dynamic portfolios, portfolio insurance, fixed income portfolio management using excel, excel in derivatives black and schools model in excel, Greeks in excel, real options valuation, building a mega model.

DETERMINING EFFICIENT PORTFOLIO:

As we know, an efficient frontier represents the set of efficient portfolios that will give the highest return at each level of risk or the lowest risk for each level of return. A portfolio is efficient if there is no alternative with:

- Higher expected return with same level of risk
- Same expected return with lower level of risk
- Higher expected return for lower level of risk

Let's take a portfolio of two assets and see how we can build the efficient frontier in excel. Let's say we have two securities, A and B, with the following risk-return data.

	A	B	C
1		**Security A**	**Security B**
2	**Expected Returns**	12%	20%
3	**Standard Deviation**	20%	40%
4			
5	**Correlation**	**-0.2**	

We can combine these two assets to form a portfolio. In the portfolio, we can combine the two assets with different weights for each asset to create an infinite number of portfolios having different risk-return profiles. For example, if we take 50% of each asset, the expected return and risk of the portfolio will be as follows:

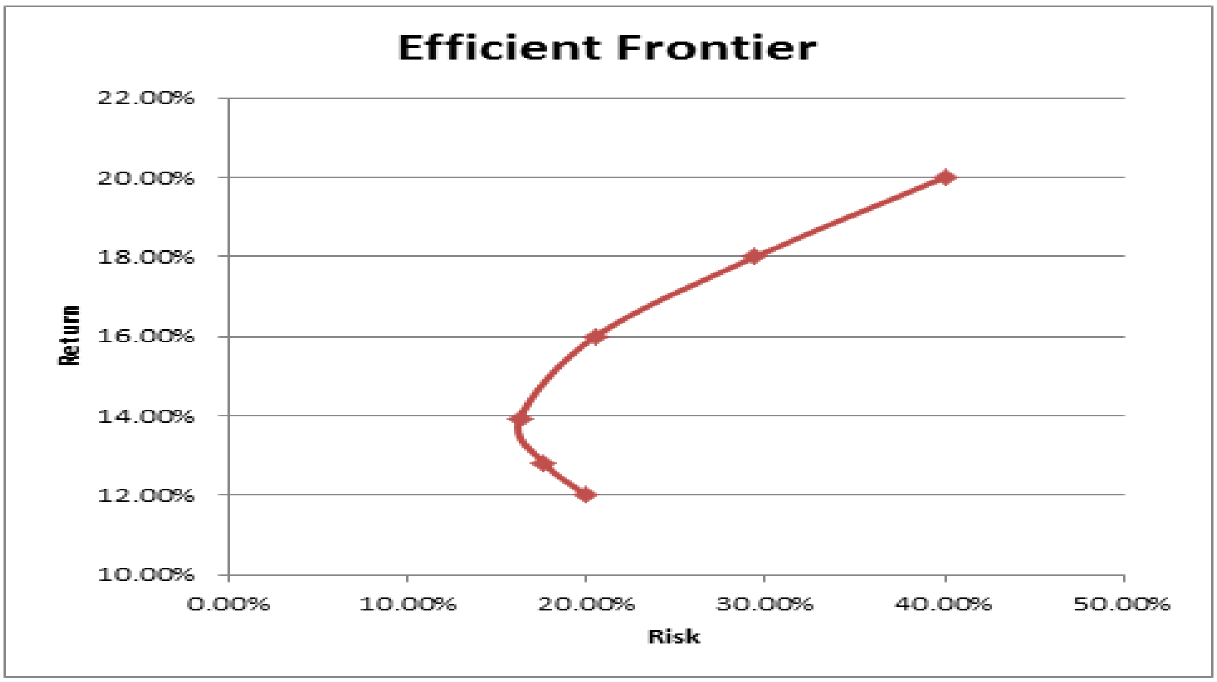
E(R) = 0.50*12% + 0.50*20% = 16%

σ = Sqrt(0.20^2*0.5^2+0.40^2*0.5^2+2*(-0.2)*0.5*0.5*0.2*0.4) = 20.49%

The following table shows the risk-return profile for different portfolios created by combining the two assets in different weights.

Portfolio	A Proportion	B Proportion	Expected Return	Standard Deviation
1	1	0	12.00%	20.00%
2	0.9	0.1	12.80%	17.64%
3	0.76	0.24	13.92%	16.27%
4	0.5	0.5	16.00%	20.49%
5	0.25	0.75	18.00%	29.41%
6	0	1	20.00%	40.00%

The risk and return of these portfolios can be plotted on the XY scatter graph with risk on x-axis and return on Y axis. The graph looks as follows and is called the efficient frontier.



Note that this graph was created with just two assets in the portfolio. The efficient frontier can be created using multiple assets. This frontier represents all the feasible portfolio combinations that one can create. There is also a minimum variance portfolio (MVP) for which there is minimum risk. An investor will not want to purchase a portfolio below the MVP. The curve bends backwards which indicates the benefits of diversification due to negative correlation.

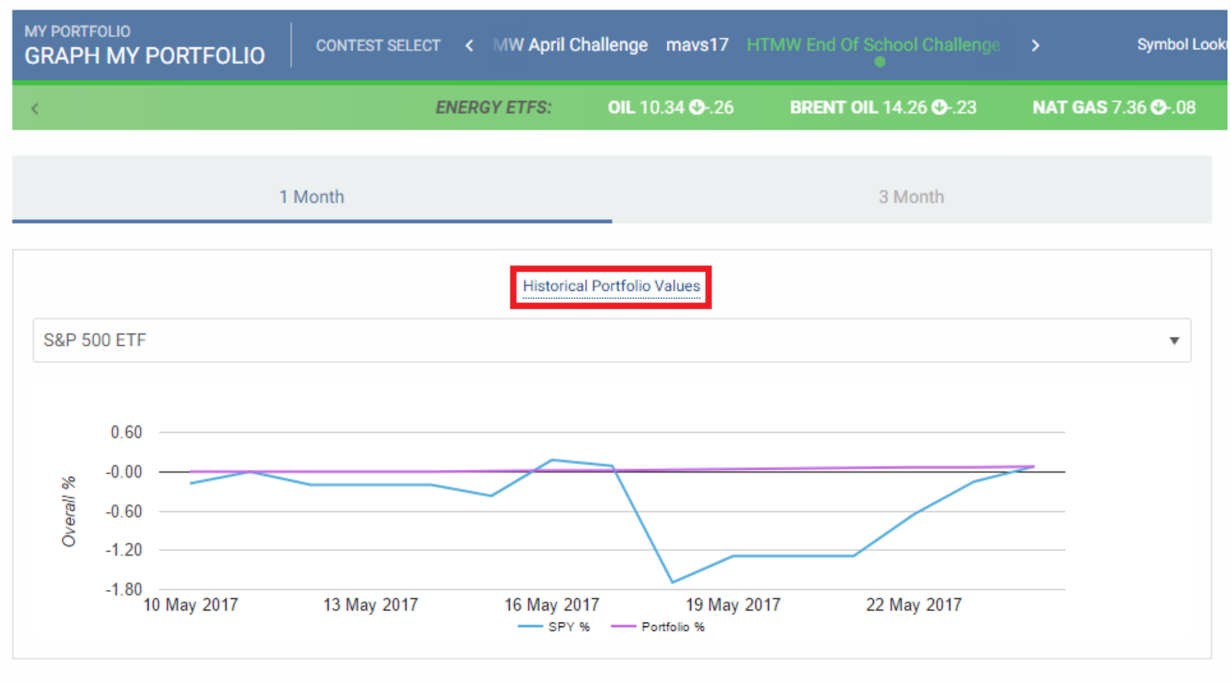
CREATING DYNAMIC PORTFOLIOS:

Before we can do anything with Excel, we need to get some numbers! The information you use in excel is called "Data". Some of it we will need to write down, some can be copied and pasted, and some we can download directly as an excel file.

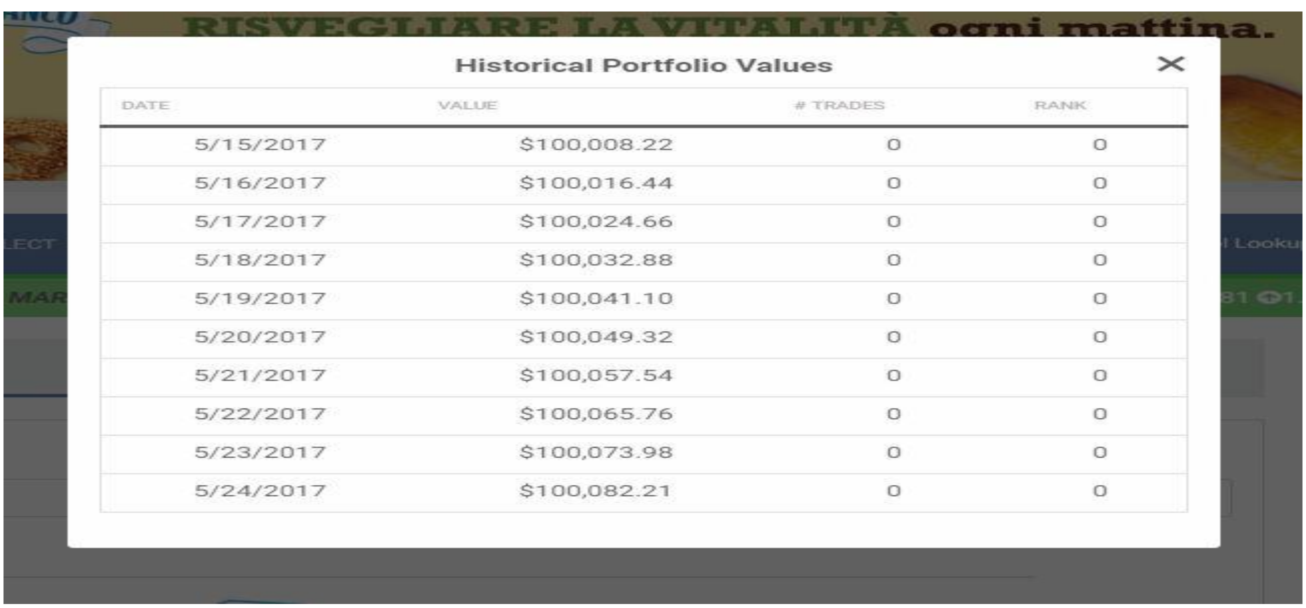
Getting Your Historical Portfolio Values

To get your old portfolio values, you can copy and paste them out of the HTMW website..

First, you will need to get your historical portfolio values from the HTMW website. You can find these on the “Graph My Portfolio” page.



This will open up a small window showing what your portfolio value was for every day of the contest. Highlight the information you want, then right click and “Copy”.



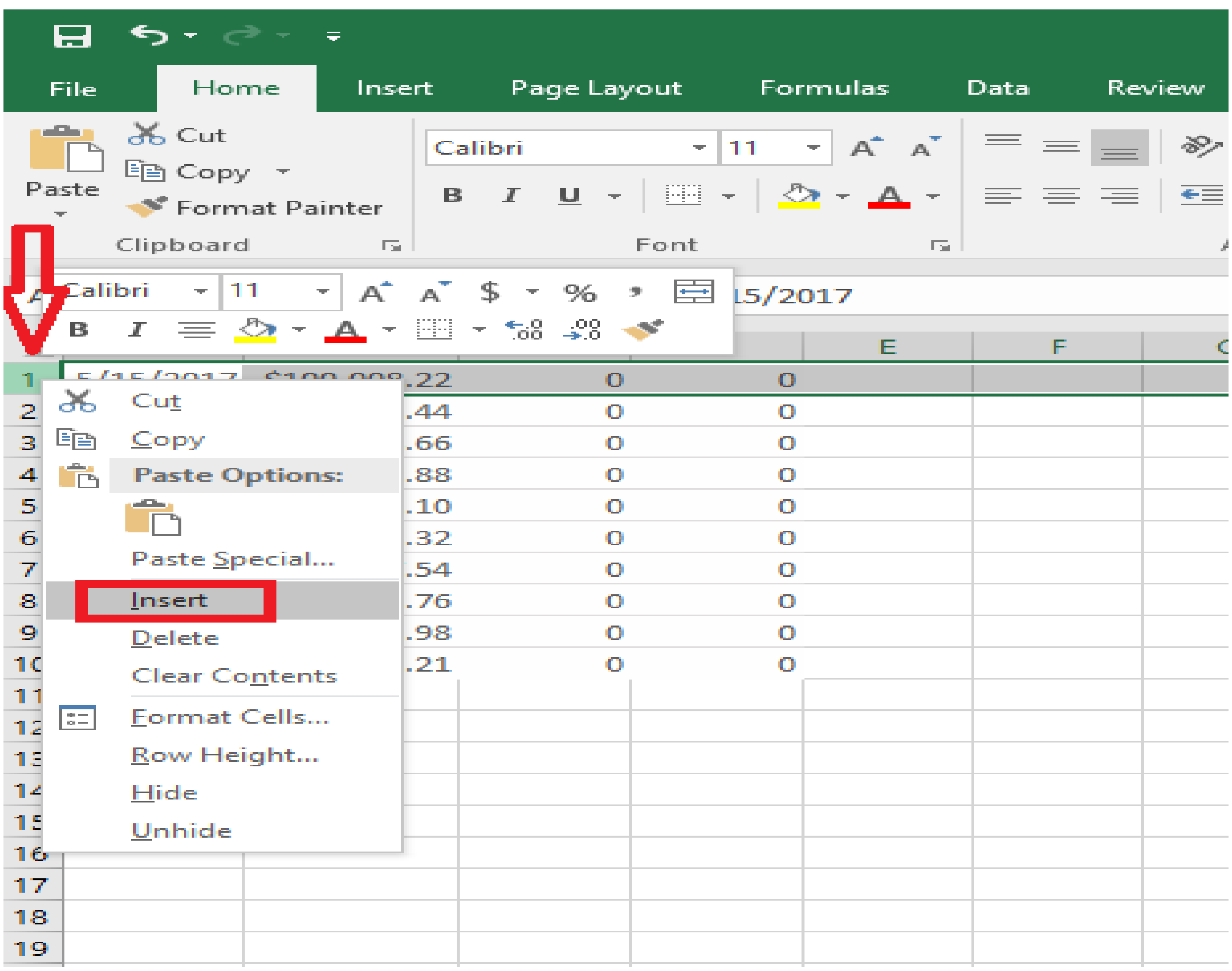
Historical Portfolio Values

DATE	VALUE	# TRADES	RANK
5/15/2017	$100,008.22	0	0
5/16/2017	$100,016.44	0	0
5/17/2017	$100,024.66	0	0
5/18/2017	$100,032.88	0	0
5/19/2017	$100,041.10	0	0
5/20/2017	$100,049.32	0	0
5/21/2017	$100,057.54	0	0
5/22/2017	$100,065.76	0	0
5/23/2017	$100,073.98	0	0
5/24/2017	$100,082.21	0	0

Next, open up a new blank spreadsheet and click cell A1. You can then right-click and "Paste" the data in. The column headings should be included too.

	A	B	C	D	E
1	DATE	VALUE	# TRADES	RANK	
2	5/15/2017	$100,008.22	0	0	
3	5/16/2017	$100,016.44	0	0	
4	5/17/2017	$100,024.66	0	0	
5	5/18/2017	$100,032.88	0	0	
6	5/19/2017	$100,041.10	0	0	
7	5/20/2017	$100,049.32	0	0	
8	5/21/2017	$100,057.54	0	0	
9	5/22/2017	$100,065.76	0	0	
10	5/23/2017	$100,073.98	0	0	
11	5/24/2017	$100,082.21	0	0	
12					

If the column headings are not included, right-click the first row and select "Insert Row". This will add a new row to the top of the spreadsheet where you can type in the column names.

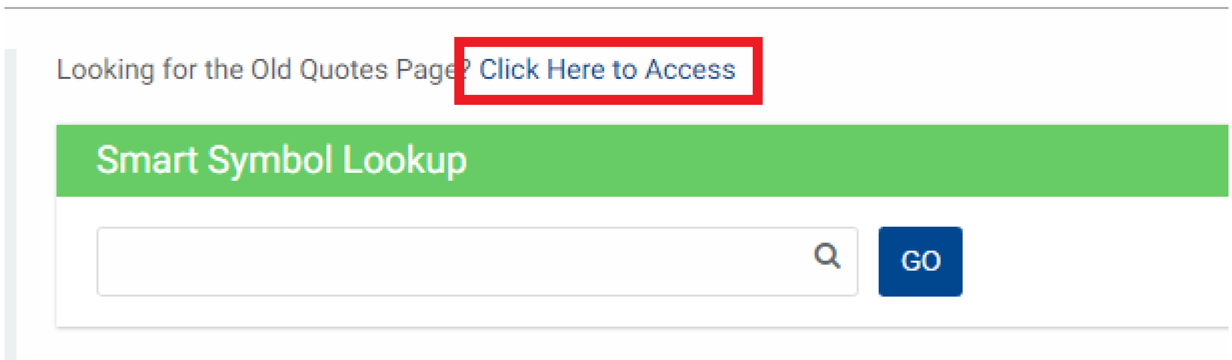


Now “Save” your file somewhere you can easily find it later, you’ve got some data!

Getting Historical Prices For Stocks (Copy And Pasting Data In To A Spreadsheet)

For this example, we want to get the historical prices for a stock so we can look at how the price has been moving over time. First, a new blank spreadsheet in Excel.

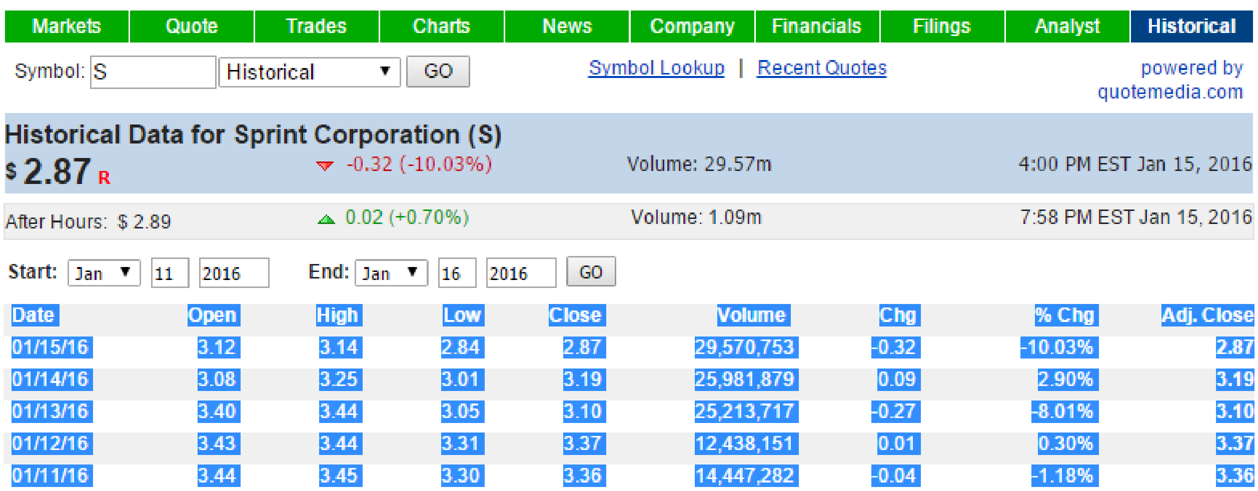
We will use Sprint stock (symbol: S). Go to the quotes page and search for S using the old quotes tool (the newest version does not yet have historical prices):



Next, click the “Historical” tab at the top right of the quote:

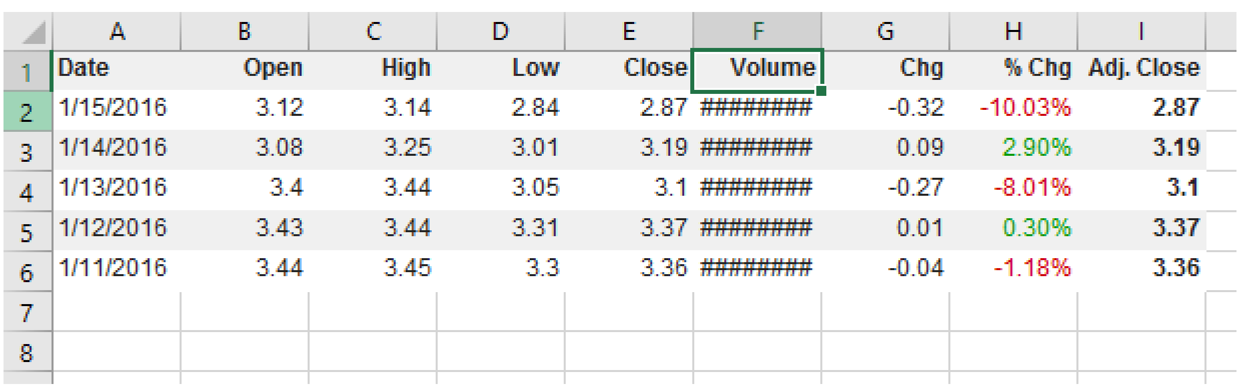
Next, change the "Start" and "End" dates to the time you want to look at. For this example, we will use the same dates that we saved for our portfolio values, January 11 through January 15, 2016.

Once you load the historical prices, highlight everything from "Date" to the last number under "Adj. Close" (it should look like this):



Date	Open	High	Low	Close	Volume	Chg	% Chg	Adj. Close
01/15/16	3.12	3.14	2.84	2.87	29,570,753	-0.32	-10.03%	2.87
01/14/16	3.08	3.25	3.01	3.19	25,981,879	0.09	2.90%	3.19
01/13/16	3.40	3.44	3.05	3.10	25,213,717	-0.27	-8.01%	3.10
01/12/16	3.43	3.44	3.31	3.37	12,438,151	0.01	0.30%	3.37
01/11/16	3.44	3.45	3.30	3.36	14,447,282	-0.04	-1.18%	3.36

Now copy the data, select cell A1 in your blank excel spreadsheet, and paste.



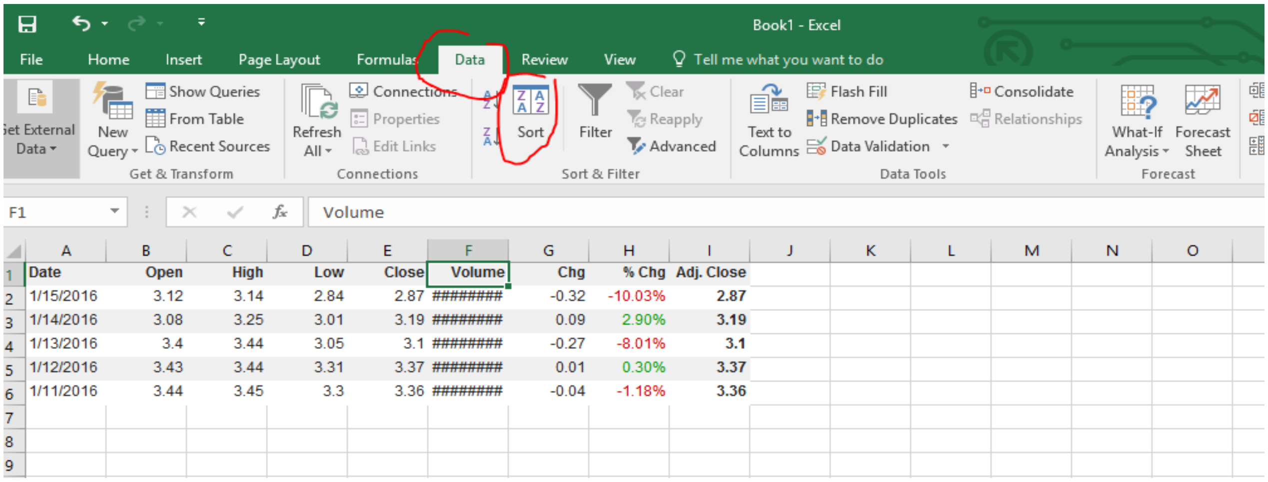
	A	B	C	D	E	F	G	H	I
1	Date	Open	High	Low	Close	Volume	Chg	% Chg	Adj. Close
2	1/15/2016	3.12	3.14	2.84	2.87	#########	-0.32	-10.03%	2.87
3	1/14/2016	3.08	3.25	3.01	3.19	#########	0.09	2.90%	3.19
4	1/13/2016	3.4	3.44	3.05	3.1	#########	-0.27	-8.01%	3.1
5	1/12/2016	3.43	3.44	3.31	3.37	#########	0.01	0.30%	3.37
6	1/11/2016	3.44	3.45	3.3	3.36	#########	-0.04	-1.18%	3.36
7									
8									

Congratulations, we have now imported some data into excel! Notice that your column headings are already detected – this will be important later.

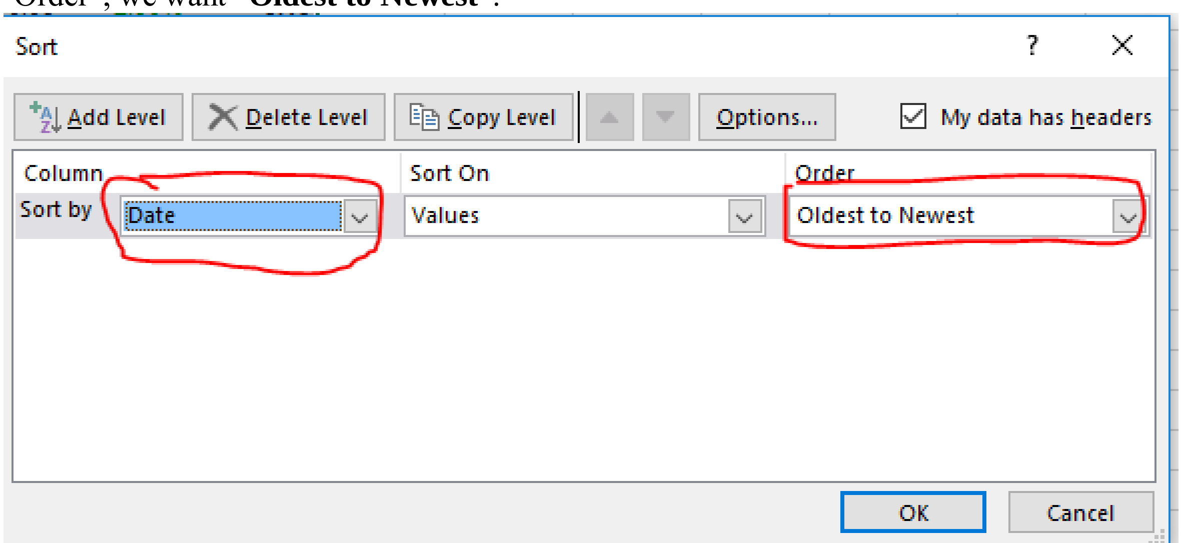
From there, there are few things we would like to change.

Changing The Order Of Your Data

First, this data is in the opposite order as our portfolio values. To get it in the same order, we want to sort this table by date, from oldest to newest. At the top menu, click on "**Data**", then click "**Sort**":



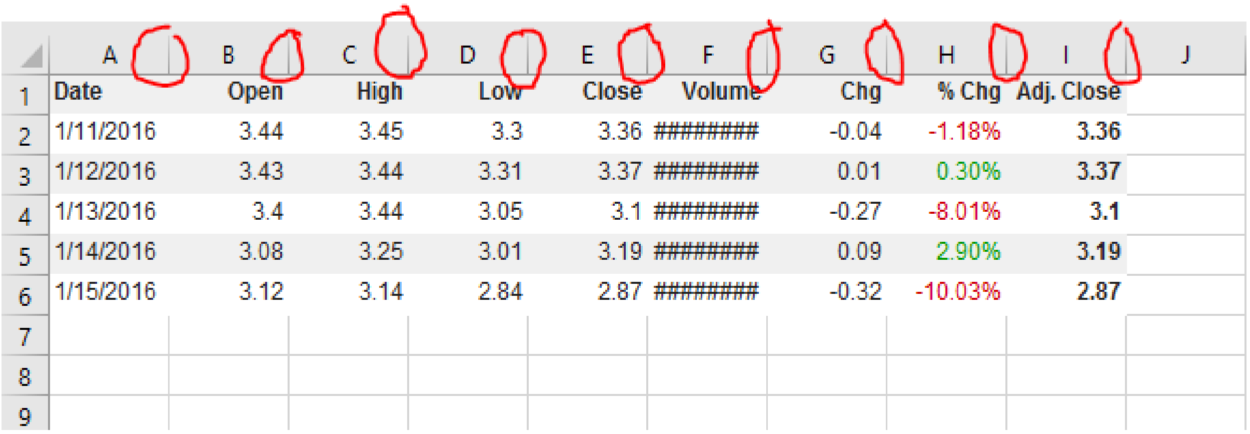
You can now choose what we want to sort by, and how to sort it. If you click the drop-down menu under "Sort By", excel lists all the column headings it detects (select "**Date**"). Next, under "Order", we want "**Oldest to Newest**":



Now your data should be in the same order as your portfolio values from earlier.

Changing Column Width

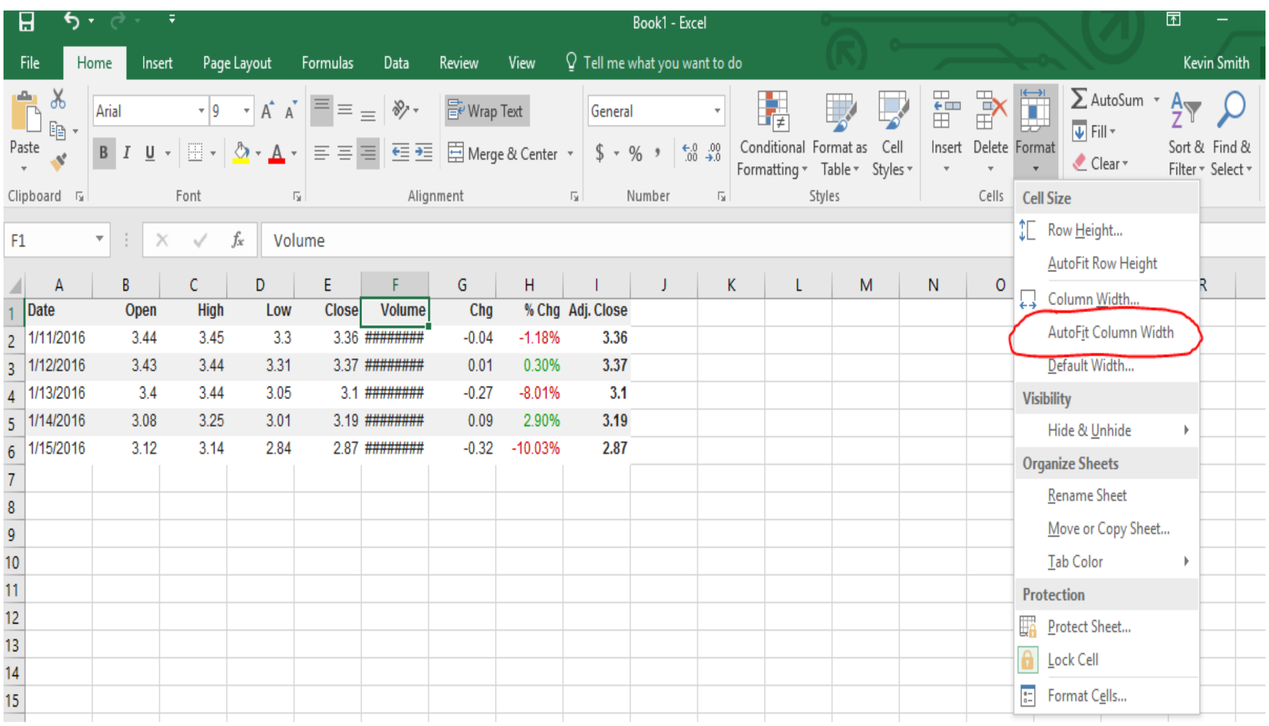
Next, you'll notice that "Volume" appears just as "########". This is not because there is an error, the number is just too big to fit in the width of our cell. To fix this, we can increase and decrease the widths of our cells by dragging the boundaries between the rows and columns:



	A	B	C	D	E	F	G	H	I	J
1	Date	Open	High	Low	Close	Volume	Chg	% Chg	Adj. Close	
2	1/11/2016	3.44	3.45	3.3	3.36	########	-0.04	-1.18%	3.36	
3	1/12/2016	3.43	3.44	3.31	3.37	########	0.01	0.30%	3.37	
4	1/13/2016	3.4	3.44	3.05	3.1	########	-0.27	-8.01%	3.1	
5	1/14/2016	3.08	3.25	3.01	3.19	########	0.09	2.90%	3.19	
6	1/15/2016	3.12	3.14	2.84	2.87	########	-0.32	-10.03%	2.87	
7										
8										
9										

Tip: if you double click these borders, the cell to the left will automatically adjust its width to fit the data in it.

If you want to automatically adjust all your cells at once, at the top menu click "Format", and "Auto Fit Column Width":

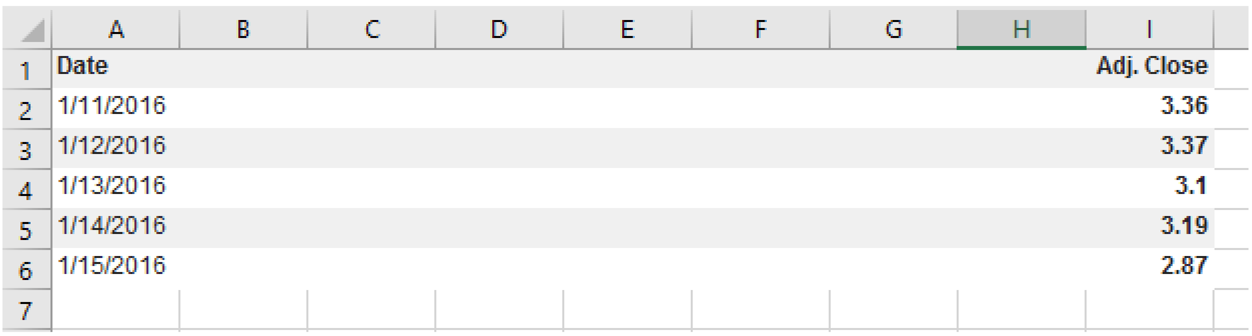


Once you've adjusted your volume column, everything should be visible!

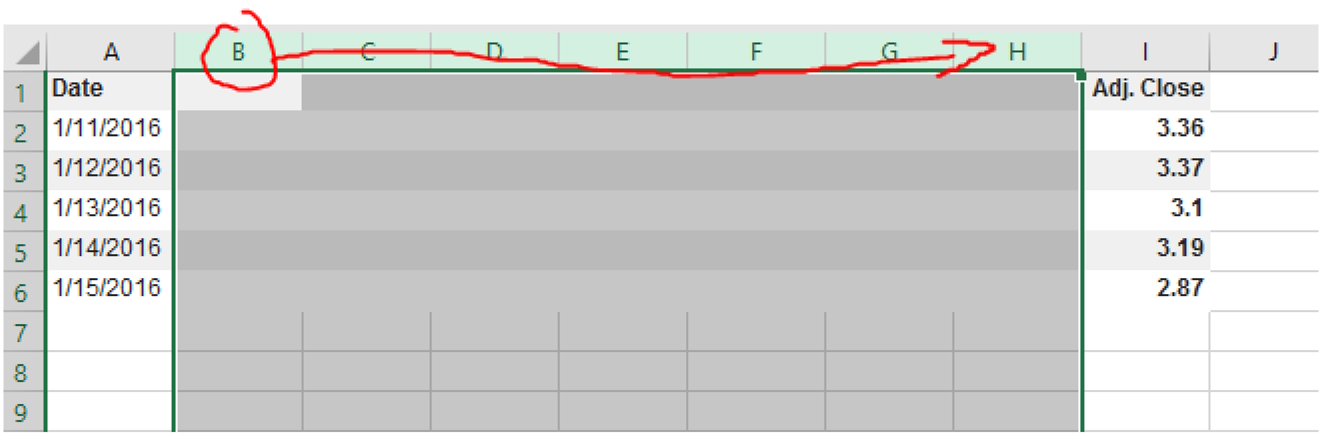
Removing Columns You Don't Need

I think that we will only want to use the Adj. Close price in the calculations we will be doing later (the "Adj. Close" price is the closing price adjusted for any splits or dividends that happened since that day). This means I want to keep the "Date" and "Adj. Close" columns, but delete the rest.

If you try to just select the data and delete it, you'll end up with a big empty space:



Instead, click on "B" and drag all the way to "H" to select the full columns:

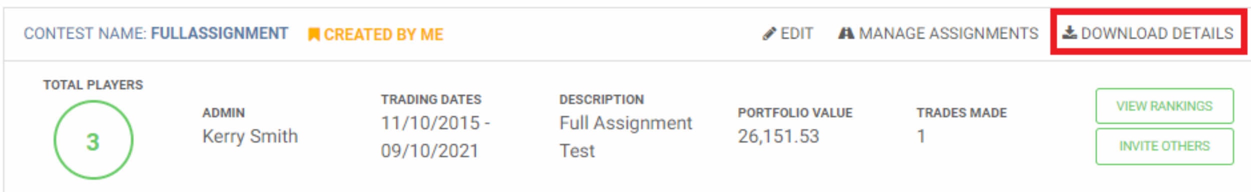


Now right-click and click "Delete", and the entire rows will disappear. Now the Adj. Close will be your new column B, with no more empty space. You now have your historical price data, so save this excel file so we can come back to it later.

Getting Your Transaction History And Open Positions (Copying data from another spreadsheet)

If you want a copy of your open positions or transaction history in Excel, you can download it directly from How The Market Works.

First, go to your Contests page and find the contest you want the information for. Then click "Download Details".



This will download a spreadsheet showing your transaction history, open positions, and your current cash balance with portfolio value. You might get a warning when opening the file, this is normal.

	A	B	C	D	E	F	G	H	I	J
1	How The Market Works									
2	ACCOUNT STATEMENT									
3										
4	Date			1/17/2016						
5	Student's Username			ksmith						
6	Student's Name			Kerry Smith						
7	Class Code			January Trading Contest		Transaction History				
8	DATE	TRANS	SHARES	TICKER		PRICE	COMMISSION		TOTAL AMOUNT	
9							Beginning Cash			100000
10				Account Activity						
11	1/12/2016	Cash Transaction	127	SPY		191.95		-10		-24377.65
12	1/12/2016	Cash Transaction	7222	S		3.35		-10		-24193.7
13	1/12/2016	Short Proceeds	-67	DWTI		349.23		0		23398.41
14	1/12/2016	Cash Transaction	11620	UWTI		2.1		-10		-24402
15										
16							Interest Earned			17.1
17							Interest Charged			0
18							Ending Cash			26986.65
19				Open Positions		Open Positions				
20			11620	UWTI		1.969				22879.78
21			-67	DWTI		365.27				24473.09
22			7222	S		2.87				20727.14
23			127	SPY		187.81				23851.87
24						Market Value of Open Positions				67458.79
25							Total Portfolio Value			93387.86
26			Your portfolio return for the trading period was -6.61%; the S&P500 return was -2.25%.							
27			Your sharpe ratio for the trading period was 0.00							
28										
29										

The spreadsheet should look similar to the one above. The top red square is your transaction history, the bottom red square is your Open Positions.

To actually use this data, you will need to open a new blank spreadsheet and copy these boxes (just like we did above).

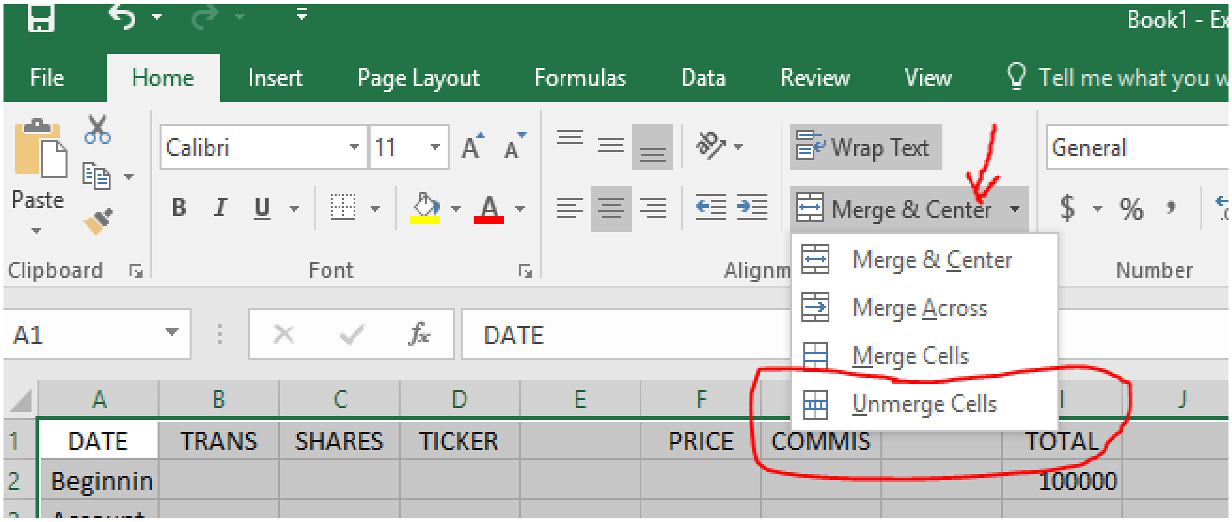
Transaction History

First, let's copy our transaction history. Select the information in the box above, and then paste it in to your blank sheet:

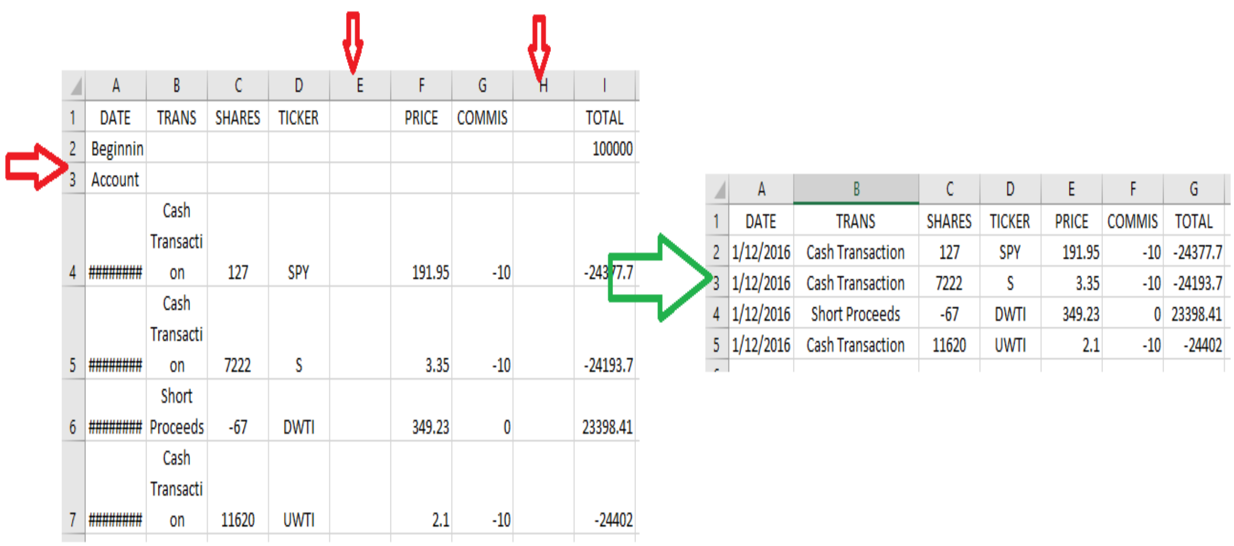
	A	B	C	D	E	F	G	H	I	J
1	DATE	TRANS	SHARES	TICKER		PRICE	COMMISSION		TOTAL AMOUNT	
2								Beginning Cash		100000
3	Account Activity									
4	#########	Cash Transacti on	127	SPY		191.95		-10		-24377.65
5	#########	Cash Transacti on	7222	S		3.35		-10		-24193.7
6	#########	Short Proceeds	-67	DWTI		349.23		0		23398.41
7	#########	Cash Transacti on	11620	UWTI		2.1		-10		-24402

Before we can use this data, notice that there are some "**Merged Cells**" – places where the data is spread across two cells. This is the case with the Ticker, Commission, and Total Amount cells. We need to "unmerge" these cells to make our data usable.

To do this, select all your data, then on the main menu bar click on "**Merge and Center**". Under this, click "**Unmerge Cells**"



Now that we have our data all in their own cells, we can start deleting the rows and columns we don't need. For example, rows 2 and 3 have our beginning cash, which we don't need in our transaction history. Columns E and H are now blank, so we can get rid of those too. Once you delete the rows and columns you don't need, you can also autofit the row width to make the "date" visible.



	A	B	C	D	E	F	G	H	I
1	DATE	TRANS	SHARES	TICKER		PRICE	COMMIS		TOTAL
2	Beginnin								100000
3	Account								
4	########	Cash Transaction	127	SPY		191.95	-10		-24377.7
5	########	Cash Transaction	7222	S		3.35	-10		-24193.7
6	########	Short Proceeds	-67	DWTI		349.23	0		23398.41
7	########	Cash Transaction	11620	UWTI		2.1	-10		-24402

	A	B	C	D	E	F	G
1	DATE	TRANS	SHARES	TICKER	PRICE	COMMIS	TOTAL
2	1/12/2016	Cash Transaction	127	SPY	191.95	-10	-24377.7
3	1/12/2016	Cash Transaction	7222	S	3.35	-10	-24193.7
4	1/12/2016	Short Proceeds	-67	DWTI	349.23	0	23398.41
5	1/12/2016	Cash Transaction	11620	UWTI	2.1	-10	-24402

You can now save this sheet and close it.

Open Positions

Getting your open positions will be very similar, but we need to enter the Column Headings in Row 1 ourselves. Open a new blank spreadsheet, and paste in the second box from the file you downloaded from How The Market Works. It should look something like this:

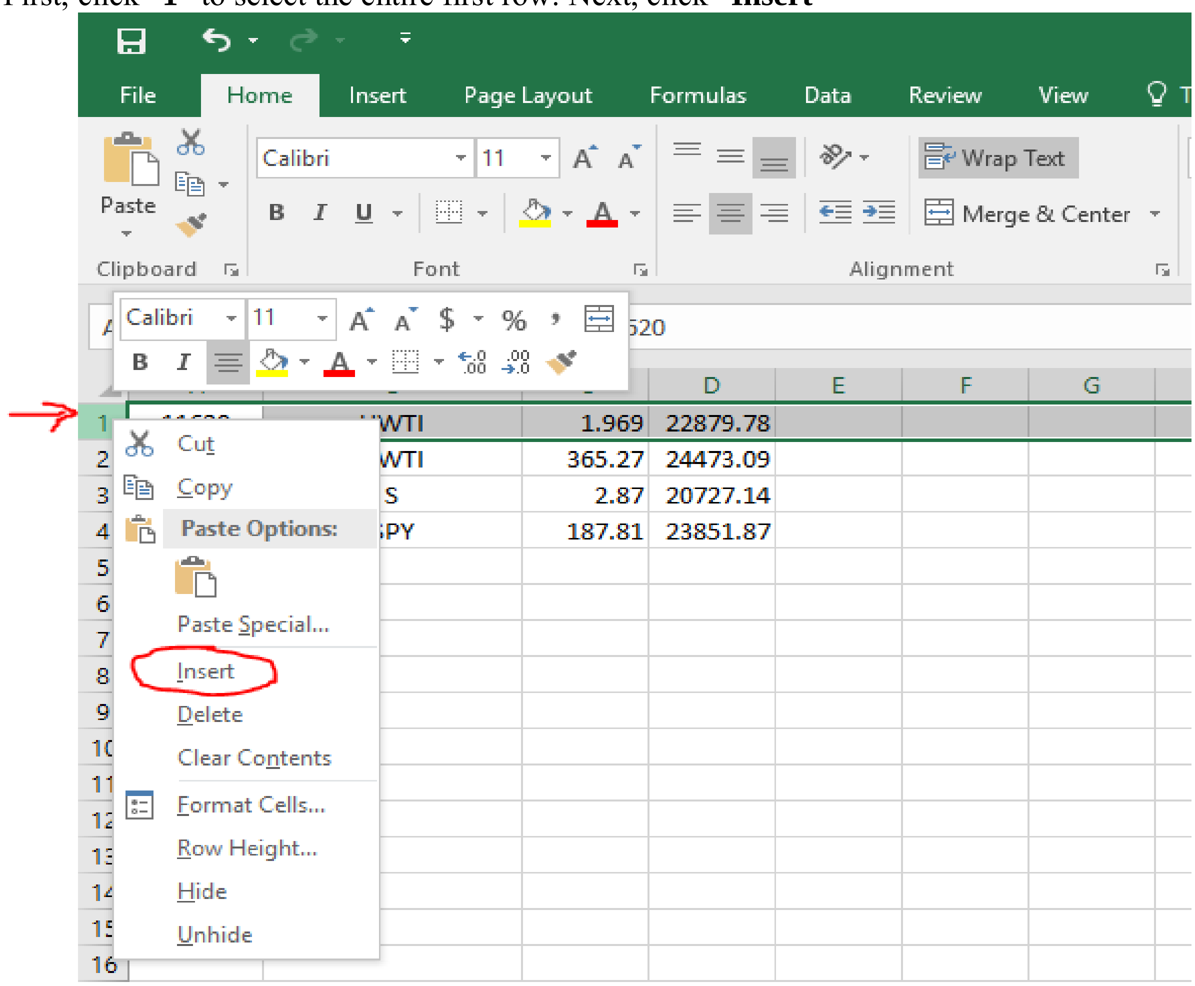
	A	B	C	D	E	F	G	H
1	11620	UWTI		1.969				22879.78
2	-67	DWTI		365.27				24473.09
3	7222	S		2.87				20727.14
4	127	SPY		187.81				23851.87

Just like with the Transaction History, first unmerge all your cells, then delete the blank columns:

	A	B	C	D
1	11620	UWTI	1.969	22879.78
2	-67	DWTI	365.27	24473.09
3	7222	S	2.87	20727.14
4	127	SPY	187.81	23851.87

Now we need to add our column headers. To do this, we need to insert a new row.

First, click “**1**” to select the entire first row. Next, click “**Insert**”



Now everything should move down, and your first row should be blank. Enter these as your column headers:

"Quantity" "Symbol" "Price" "Total Cost"

It should look like this when finished:

	A	B	C	D
1	Quantity	Symbol	Price	Total Cost
2	11620	UWTI	1.969	22879.78
3	-67	DWTI	365.27	24473.09
4	7222	S	2.87	20727.14
5	127	SPY	187.81	23851.87

And thats it! Now save your spreadsheet for later.

Using Excel To Track Your Stock Portfolio – Graphing

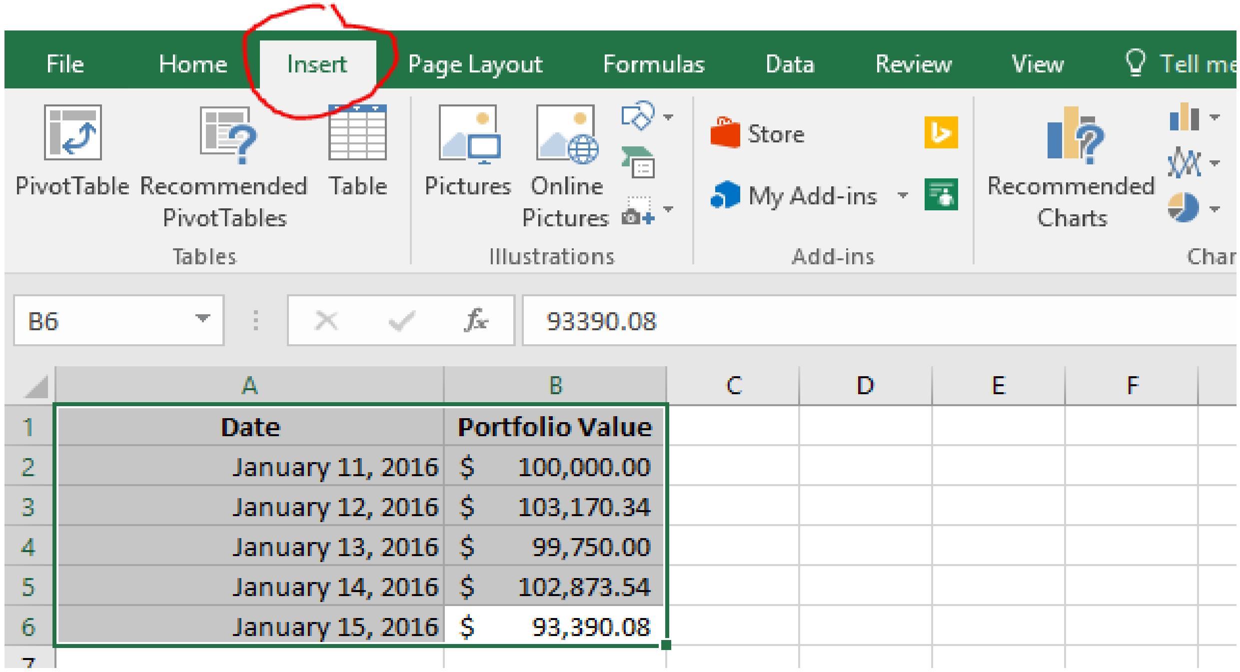
Now that we have some data, let's make some graphs with it! We will go over how to make line graphs of your daily portfolio value and your portfolio percentage change, plus a bar chart showing your open positions. This is usually the most fun part of using excel to track your stock portfolio.

Line Graph – Your Daily Portfolio Value

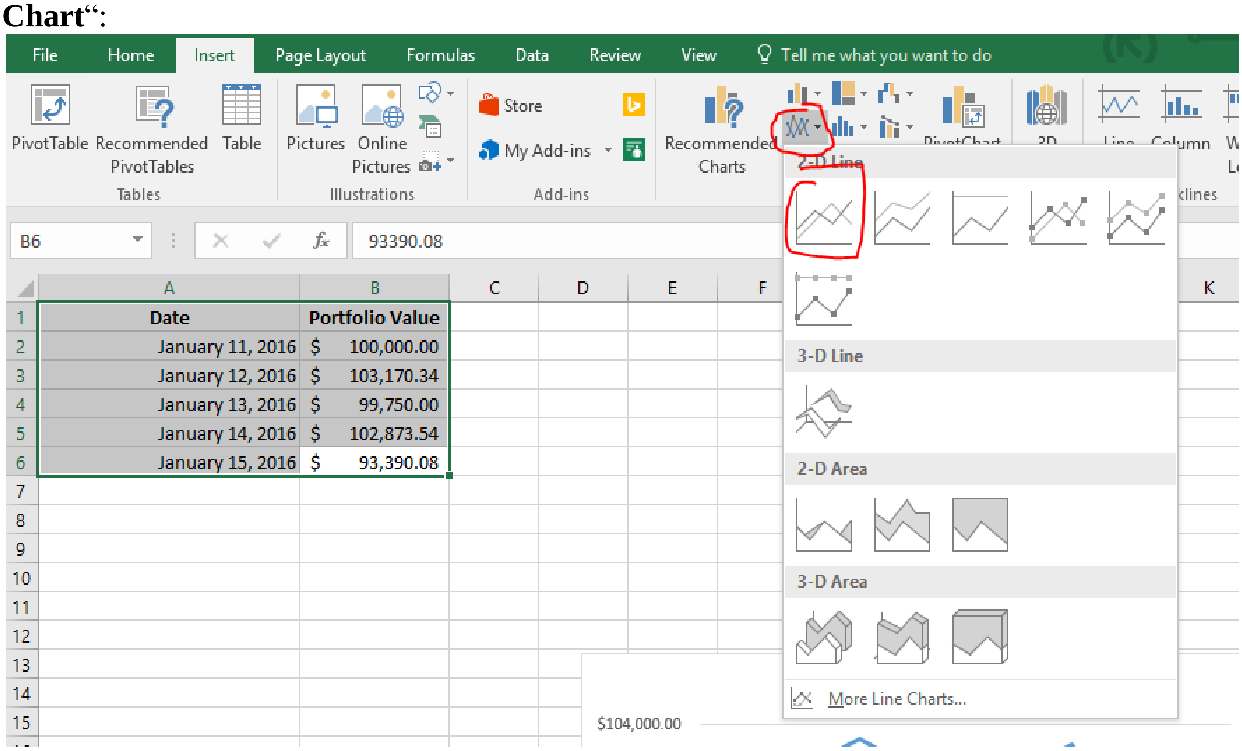
First, we want to make a line graph showing our daily portfolio value. First, open your spreadsheet that has your daily portfolio values:

	A	B
1	Date	Portfolio Value
2	January 11, 2016	$ 100,000.00
3	January 12, 2016	$ 103,170.34
4	January 13, 2016	$ 99,750.00
5	January 14, 2016	$ 102,873.54
6	January 15, 2016	$ 93,390.08
7		
8		
9		
10		

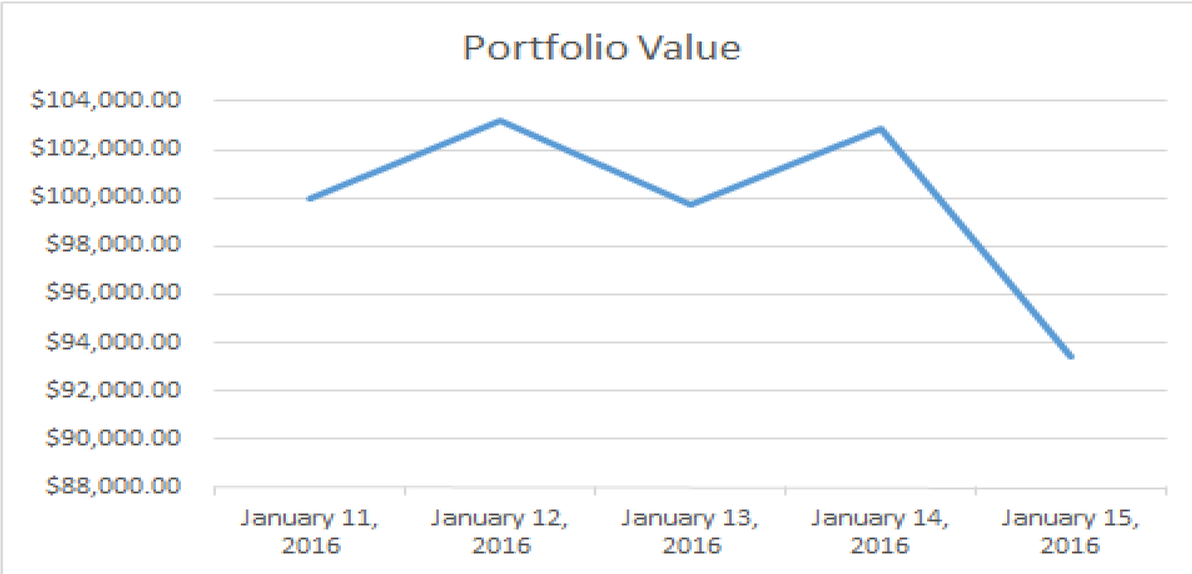
Next, highlight your data, and click "**Insert**" on the top tab:



Here, under the "**Charts**" section, click on the one with lines, and choose the first "**2d Line Chart**":



And that is it! Your new chart is ready for display. You can even copy the chart and paste it in to Microsoft Word to make it part of a document, or paste it into an image editor to save it as an image.



Line Graph – Portfolio Percentage Changes

Next, we want to make a graph showing how much our portfolio has changed every day. To do this, first we need to actually calculate it.

Doing calculations in Excel

In the next column we will calculate our daily portfolio percentage change. First, in the next column, add the header "% Change"

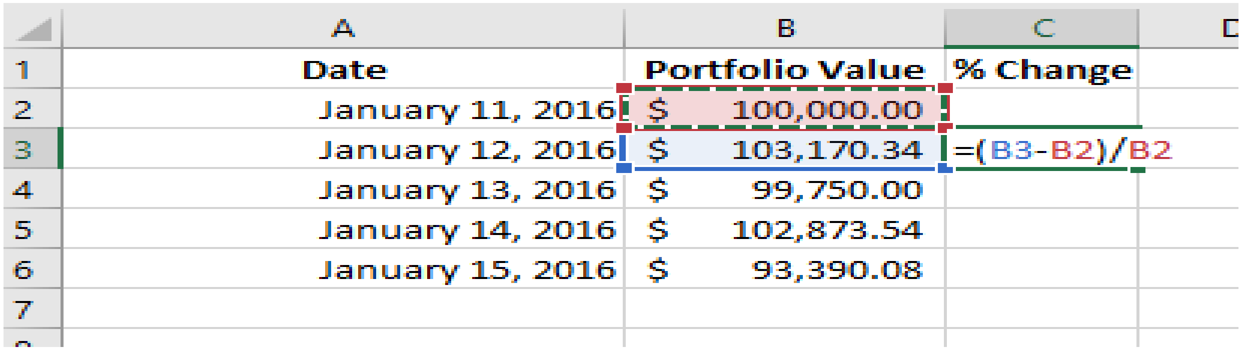
	A	B	C
1	Date	Portfolio Value	% Change
2	January 11, 2016	$ 100,000.00	
3	January 12, 2016	$ 103,170.34	
4	January 13, 2016	$ 99,750.00	
5	January 14, 2016	$ 102,873.54	
6	January 15, 2016	$ 93,390.08	
7			
8			

Now we need to make our calculation. To calculate the percentage change each day, we want to take the difference between the most recent day's value minus the day before, then divide that by the value of the day before:

Percentage Change = (Day 2's Value – Day 1's Value) / Day 1's Value

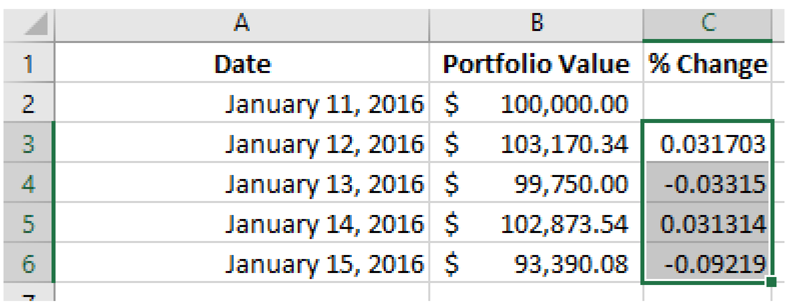
To do this, in cell C3 we can do some operations to make the calculation for percentage change. To enter a formula, start by typing “=”. You can use the same symbols you use when writing on paper to write your formulas, but instead of writing each number, you can just select the cells.

To calculate the percentage change we saw between day 1 and day 2, use the formula above in the C3 cell. It should look like this:



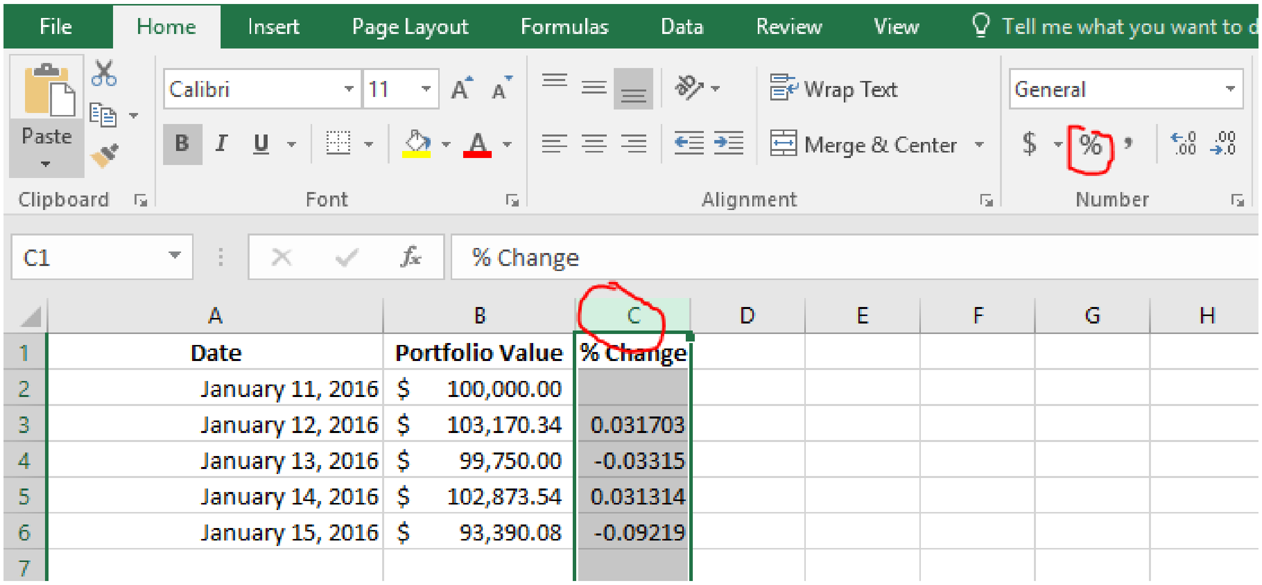
	A	B	C
1	Date	Portfolio Value	% Change
2	January 11, 2016	$ 100,000.00	
3	January 12, 2016	$ 103,170.34	=(B3-B2)/B2
4	January 13, 2016	$ 99,750.00	
5	January 14, 2016	$ 102,873.54	
6	January 15, 2016	$ 93,390.08	
7			

Now click on the bottom right corner of that cell and drag it to your last row with data, Excel will automatically copy the formula for each cell:



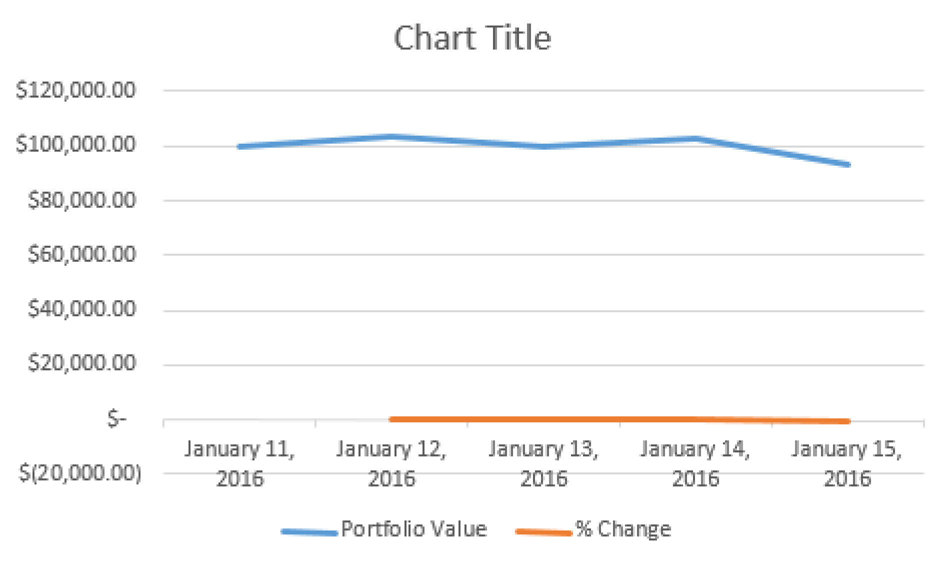
	A	B	C
1	Date	Portfolio Value	% Change
2	January 11, 2016	$ 100,000.00	
3	January 12, 2016	$ 103,170.34	0.031703
4	January 13, 2016	$ 99,750.00	-0.03315
5	January 14, 2016	$ 102,873.54	0.031314
6	January 15, 2016	$ 93,390.08	-0.09219

You now have your percentages! If you want them to display as percentages instead of whole numbers, click on “C” to select the entire column, then click the small percentage sign in the tools at the top of the page:



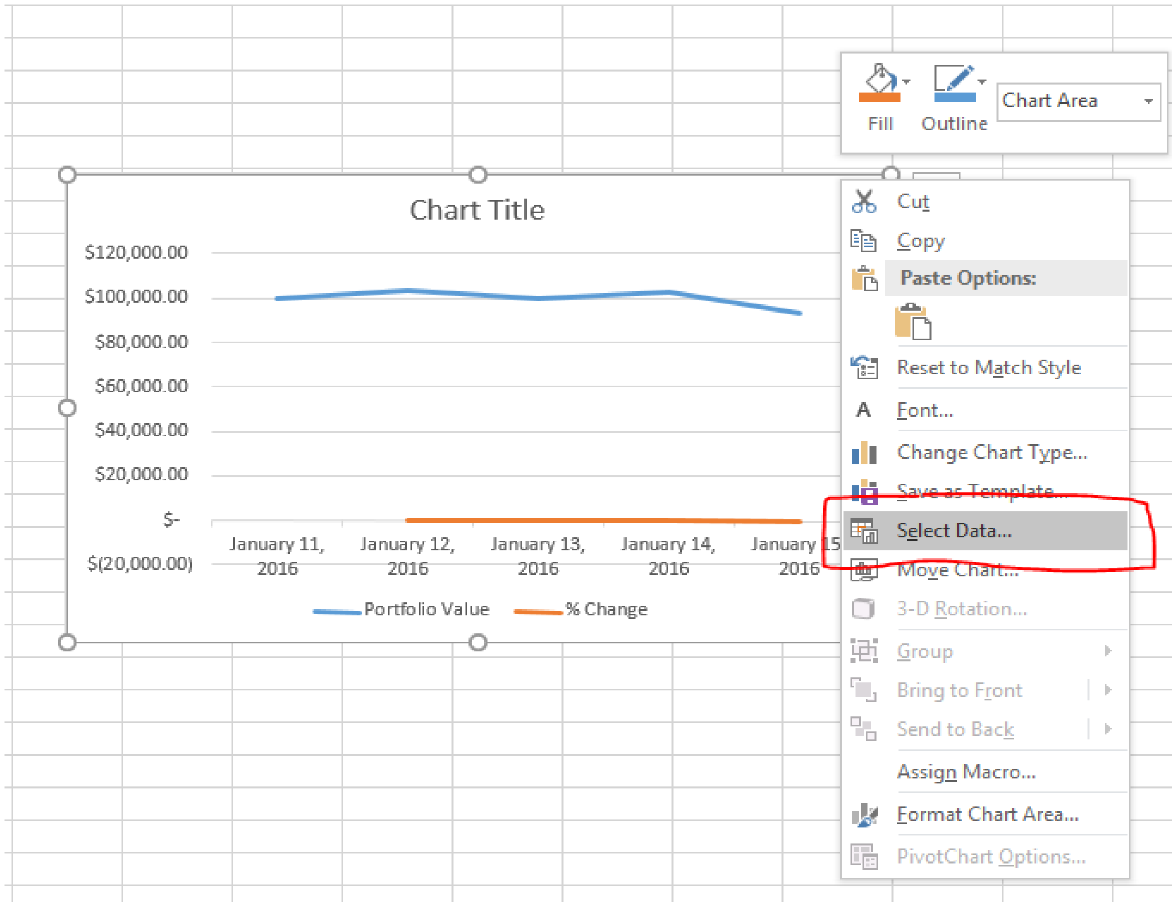
Making Your Graph With Only Certain Columns

Now we want to make a graph showing how our portfolio was changing each day, but if we try to do the same thing as before (selecting all the data and inserting a "Line Chart", the graph doesn't tell us very much:



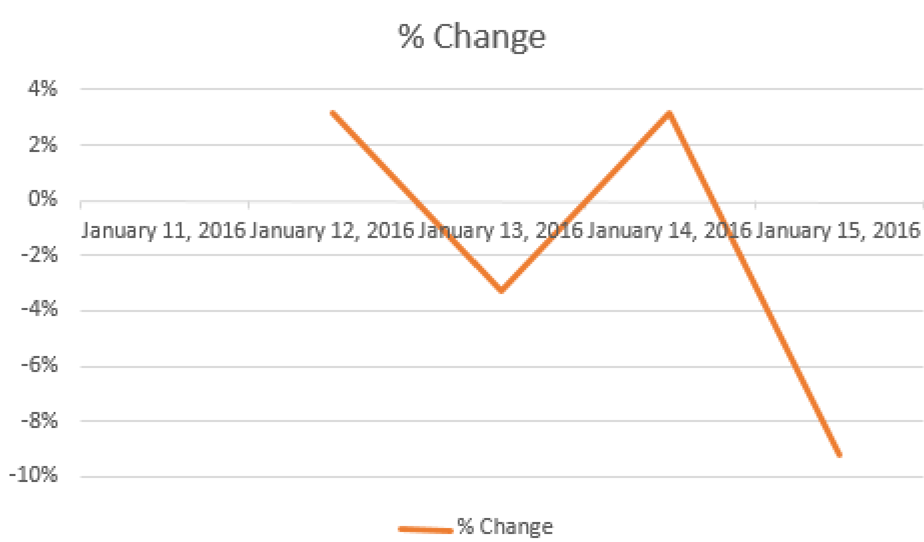
This is because it is trying to show both the total portfolio value and the percentage change at the same time, but they are on a completely different scale!

To correct this, we need to change what data is showing. Right click on your graph and click "Select Data":



This is how we decide what data is showing in the graph. Items on the left side will make our lines, items on the right will make up the items that appear on the X axis (in this case, our Dates).

Uncheck "Portfolio Value", then click OK to update your graph:

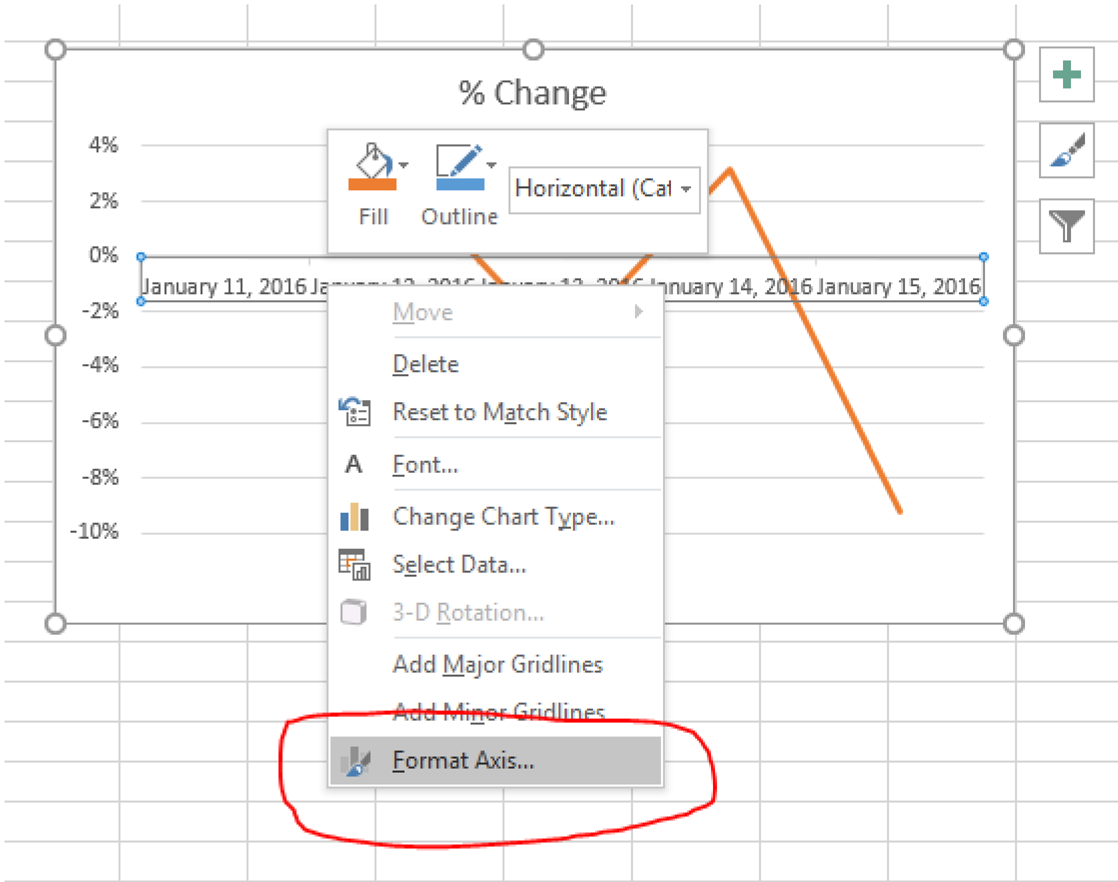


Tip: Since we don't

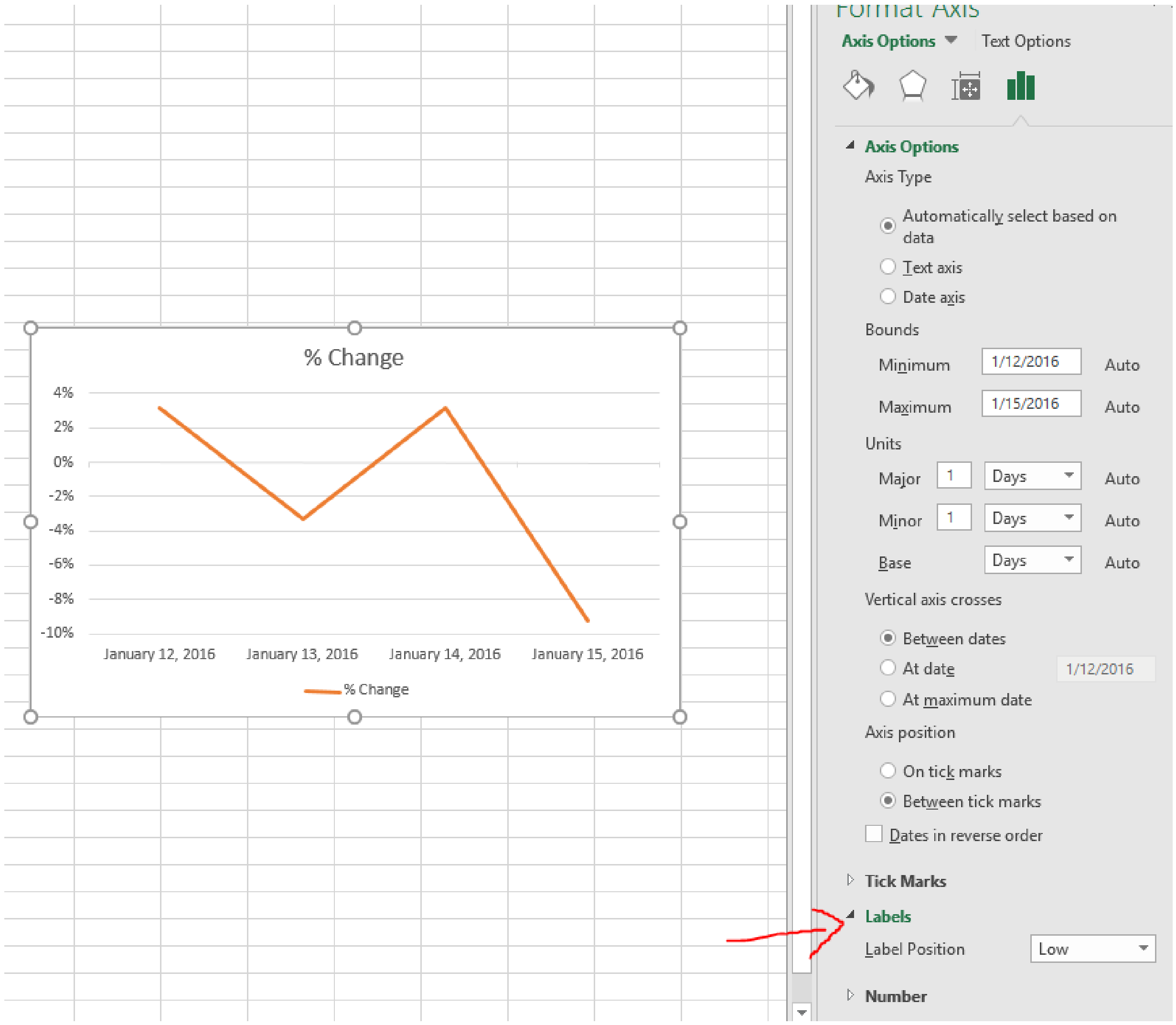
have any data for January 11th here, we can also uncheck that on the right side to not show that date.

This is closer, but now we want to move the dates back to the bottom of the graph (here they are along the “0” point of the Y axis).

To do this, right-click on the dates and select “Format Axis”:



A new menu will appear on the right side of the screen. Here, click “Labels”, then set the Label Position to “Low”.

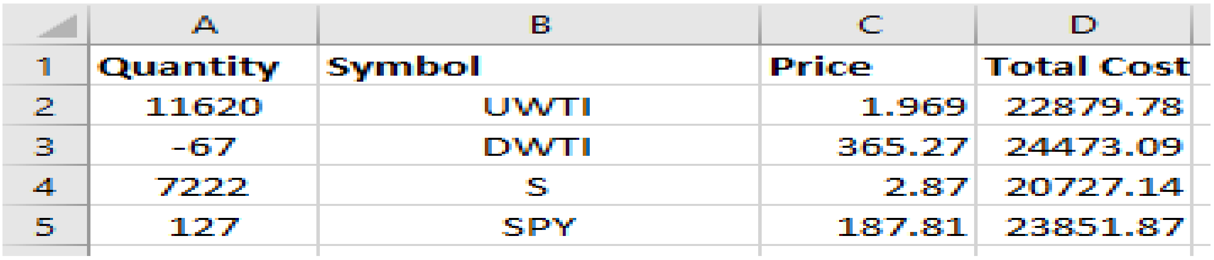


Congratulations, your graph is now finished! You can now easily see which days your portfolio was doing great, and which days you made your losses.

Bar Chart – Seeing Your Open Positions

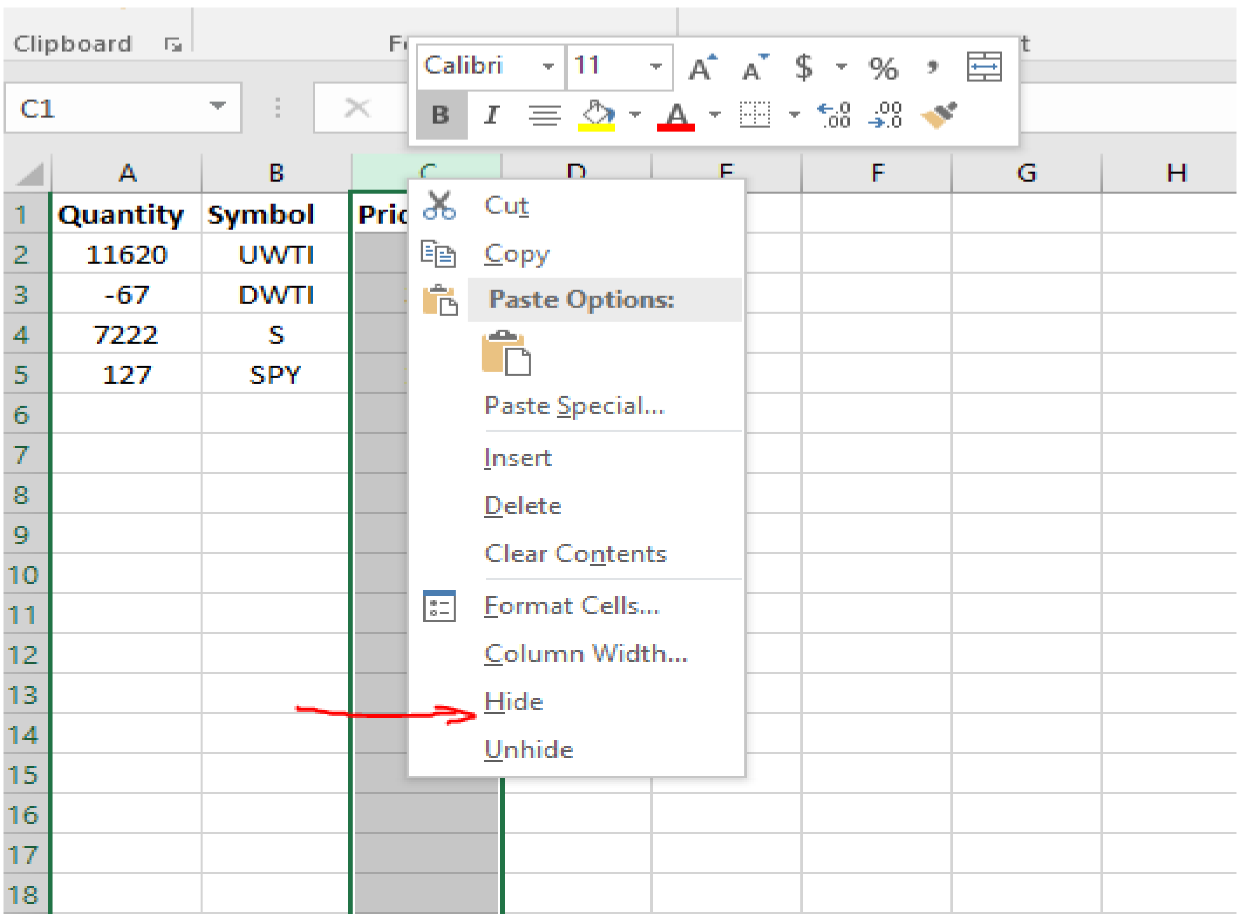
Next we would like to make a bar chart showing how much of our current open positions is in each stock, ETF, or Mutual Fund.

First, open your spreadsheet with your Open Positions. It should look something like this:

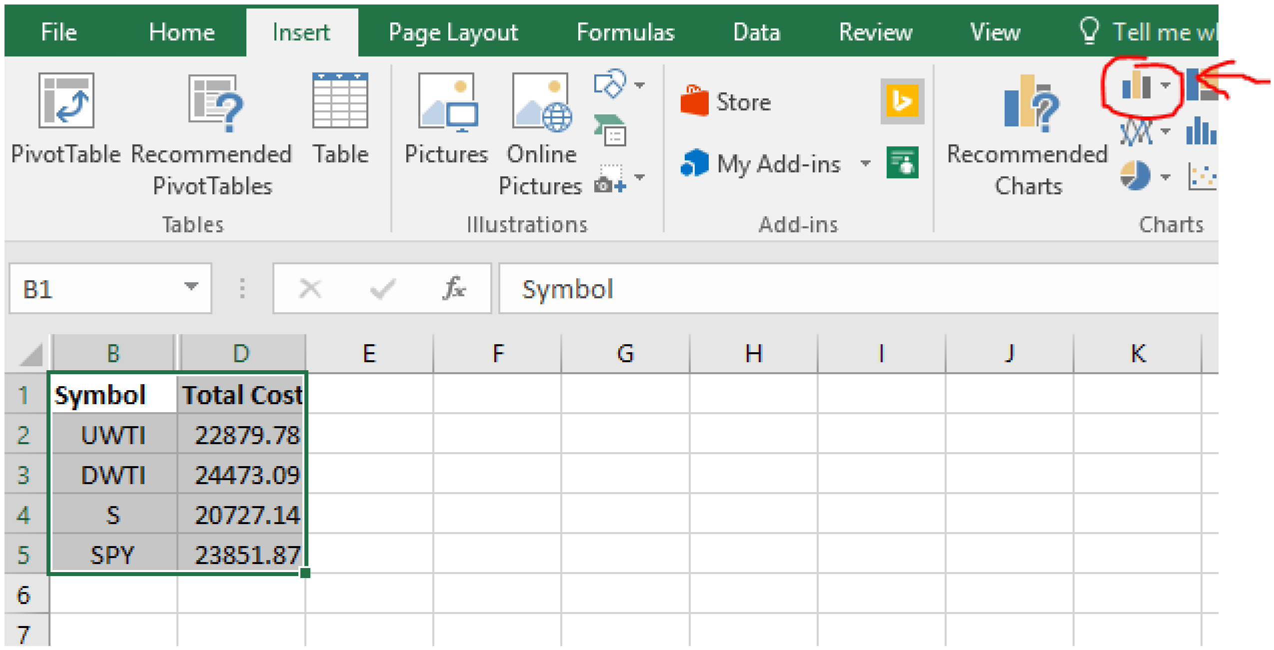


	A	B	C	D
1	Quantity	Symbol	Price	Total Cost
2	11620	UWTI	1.969	22879.78
3	-67	DWTI	365.27	24473.09
4	7222	S	2.87	20727.14
5	127	SPY	187.81	23851.87

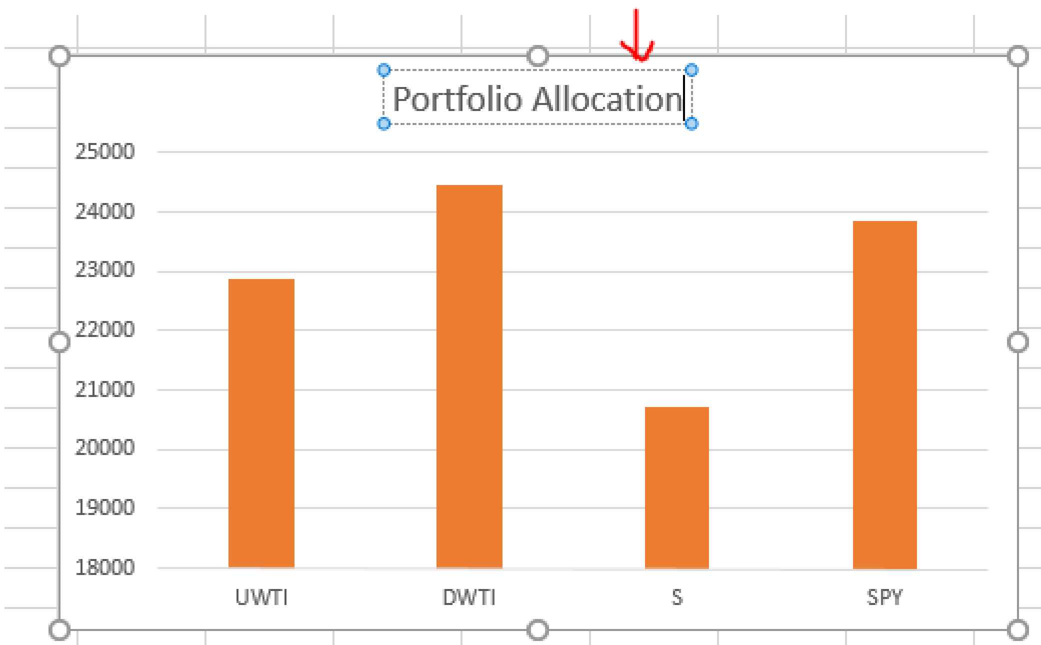
Since we want to make a bar chart, we can only have two columns of data. We want one column showing the symbol, and a second column showing how much it is worth. The “Total Cost” column is the current market value of these stocks, so that is the one we want to keep. However, we don’t want to delete the quantity and price, since we might want it later. Instead, select the columns you don’t want, and right-click their letter (A and C in this case). Then, select “Hide”:



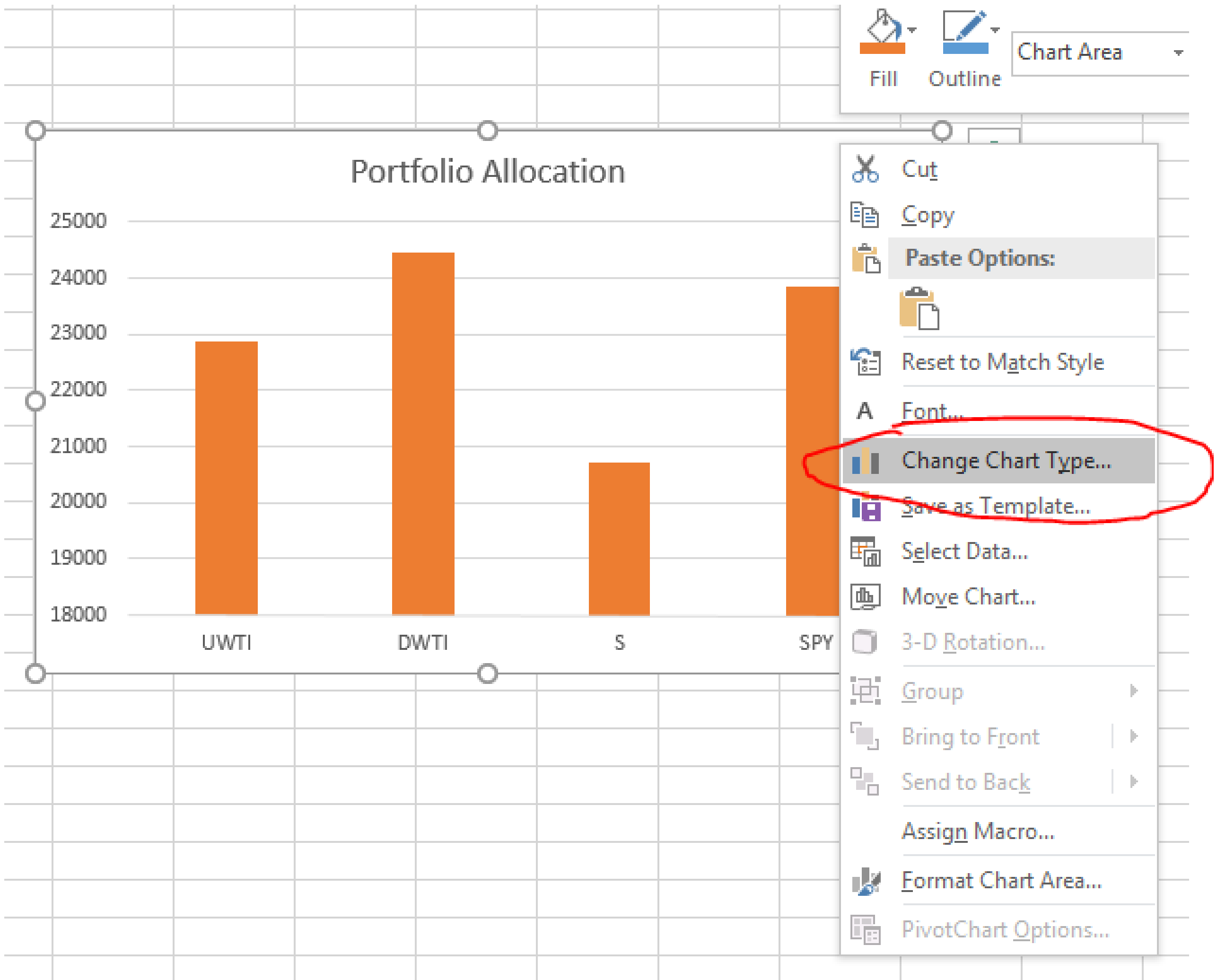
Now the columns that we don’t want in our chart are hidden. We can always get them back later by going to “Format” -> “Visiblity” -> “Unhide Columns”. Now select your data and insert a “Bar Chart” instead of a “Line Chart”:



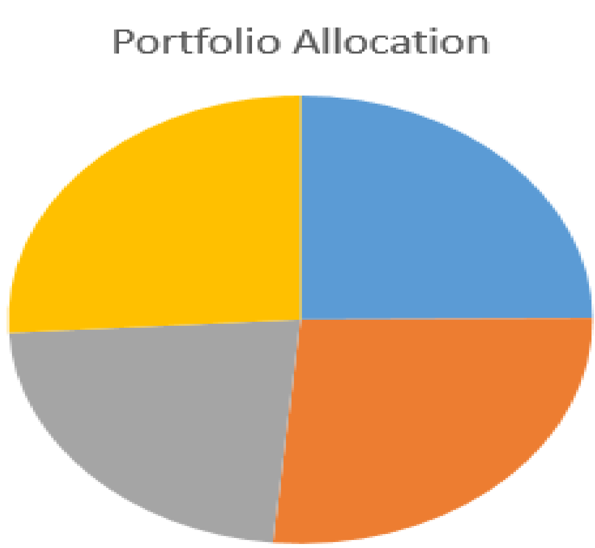
Before you're finished, your chart will say "Total Cost". You can change this by clicking on "Total Cost" and editing to say whatever you would like (like "Portfolio Allocation"):



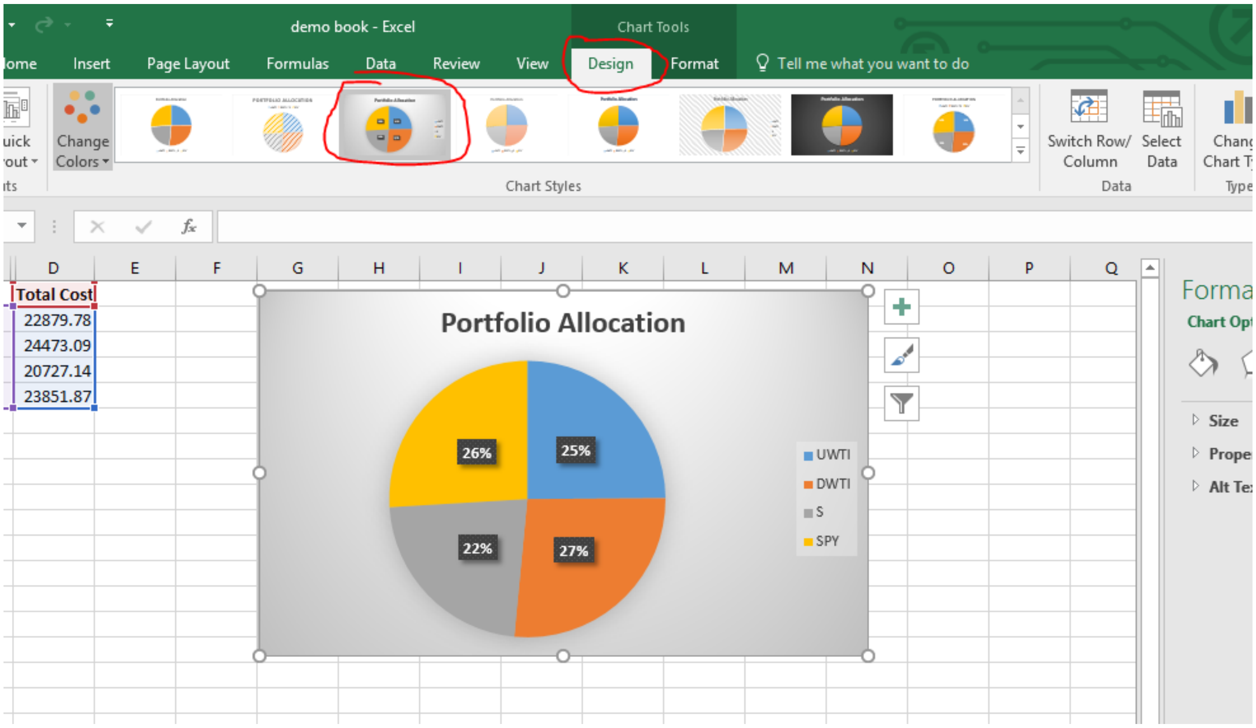
This graph is now finished, but you can also try changing the Chart Type to try to get a Pie Chart. First, right click your graph and select "Change Chart Type":



Next, find the “Pie” charts, and pick whichever chart you like the best.



Last, now we don't know which piece of the pie represents which stock. To add this information, click your pie chart, then at the top of the page click "Design". Then select any of the options to change how your pie chart looks.



Congratulations, you've converted your bar chart into a pie chart! This one should look almost the same as the one you have on the right side of your Open Positions page.

Using Excel To Track Your Stock Portfolio – Calculating The Profit And Loss Of Your Trades

The most important reason you would want to use excel to track your stock portfolio is trying to calculate your profit and loss from each trade. To do this, open the spreadsheet with your transaction history. It should look something like this:

	A	B	C	D	E	F	G
1	DATE	TRANS	SHARES	TICKER	PRICE	COMMISSION	TOTAL AMOUNT
2	1/12/2016	Cash Transaction	127	SPY	192	-10	-24377.65
3	1/12/2016	Cash Transaction	7222	S	3.35	-10	-24193.7
4	1/12/2016	Short Proceeds	-67	DWTI	349.2	0	23398.41
5	1/12/2016	Cash Transaction	11620	UWTI	2.1	-10	-24402
6	1/19/2016	Cash Transaction	-7222	S	3.5	-10	25277
7	1/19/2016	Cash Transaction	-5000	UWTI	1.9	-10	9500
8							

Tip: If you have not bought and then sold a stock, you can't calculate how much profit you've made on the trade.

First, we want to change how the data is sorted so we can group all the trades of the same symbol together. Use the "Sort" tool to sort first by "Ticker", next by "Date" (oldest to newest).

	A	B	C	D	E	F	G
1	DATE	TRANS	SHARES	TICKER	PRICE	COMMISSION	TOTAL AMOUNT
2	1/12/2016	Short Proceeds	-67	DWTI	349.2	0	23398.41
3	1/12/2016	Cash Transaction	7222	S	3.35	-10	-24193.7
4	1/19/2016	Cash Transaction	-7222	S	3.5	-10	25277
5	1/12/2016	Cash Transaction	127	SPY	192	-10	-24377.65
6	1/12/2016	Cash Transaction	11620	UWTI	2.1	-10	-24402
7	1/19/2016	Cash Transaction	-5000	UWTI	1.9	-10	9500

For DWTI and SPY, we haven't ever "closed" our positions (selling a stock you bought, or covering a stock you short), so we cannot calculate a profit or loss. For now, hide those rows.

	A	B	C	D	E	F	G
1	DATE	TRANS	SHARES	TICKER	PRICE	COMMISSION	TOTAL AMOUNT
3	1/12/2016	Cash Transaction	7222	S	3.35	-10	-24193.7
4	1/19/2016	Cash Transaction	-7222	S	3.5	-10	25277
6	1/12/2016	Cash Transaction	11620	UWTI	2.1	-10	-24402
7	1/19/2016	Cash Transaction	-5000	UWTI	1.9	-10	9500

Now we're ready to calculate! Lets start with the trade for S. This one is easy because the shares I sold equal the shares I bought. This means if we just add the "Total Amount", it will tell us the exact profit or loss we made on the trade.

=G4+G3

C	D	E	F	G	H
SHARES	TICKER	PRICE	COMMISSION	TOTAL AMOUNT	
7222	S	3.35	-10	-24193.7	
-7222	S	3.5	-10	25277	1083.3
11620	UWTI	2.1	-10	-24402	
-5000	UWTI	1.9	-10	9500	

You can see the calculation we used at the top

This does not work for UWTI, because I sold a different number of shares than I bought. This means that I need to first calculate the total cost of the shares I sold, then I can use that to determine my profit.

First: multiply your purchase price times the number of shares you sold:

	A	B	C	D	E	F	G
1	DATE	TRANS	SHARES	TICKER	PRICE	COMMISSION	TOTAL AMOUNT
3	1/12/2016	Cash Transaction	7222	S	3.35	-10	-24193.7
4	1/19/2016	Cash Transaction	-7222	S	3.5	-10	25277
6	1/12/2016	Cash Transaction	11620	UWTI	2.1	-10	-24402
7	1/19/2016	Cash Transaction	-5000	UWTI	1.9	-10	9500
8							
9							Cost Of Purchase
10							=C7*E6

Second: add this number to the "Total Amount" from when you sold your shares.

	A	B	C	D	E	F	G
1	DATE	TRANS	SHARES	TICKER	PRICE	COMMISSION	TOTAL AMOUNT
3	1/12/2016	Cash Transaction	7222	S	3.35	-10	-24193.7
4	1/19/2016	Cash Transaction	-7222	S	3.5	-10	25277
6	1/12/2016	Cash Transaction	11620	UWTI	2.1	-10	-24402
7	1/19/2016	Cash Transaction	-5000	UWTI	1.9	-10	9500
8							
9							Cost Of Purchase
10							-10500
11							Profit or Loss
12							=G10+G7

Now you have your profit or loss for this trade. Note: this is the method for if you bought more shares than you sold – if you bought shares at different prices, then sell them later, you'll need to calculate your Average Cost to use in your calculation.

PORTFOLIO INSURANCE:

Table 13.3 : Portfolio Insurance ('Stock + Futures' Replication Portfolio)

Version May 2001 (KCDN)

This spreadsheet calculates the value of a 'stock + futures' replication portfolio, used for portfolio insurance.
The spreadsheet is set up for a 10 period horizon (t = 0 to t = 0.1).

User Inputs : These are in red. CHANGE ONLY RED CELLS

Initial Share price, S	280	(index value)
Step size for change in S	0.5	(arbitrarily chosen here, for pedagogic reasons - ie. Non-stochastic and gives 'easy calculations for verification)
Strike Price, K	280	(index value)
Initial Put Premium, P	2.9701	(index units)
Initial Futures Price,F	282.8140	(index units)
Interest rate, r	0.1	(annual, decimal)
Volatility(=standard devn)	0.12	annual, decimal)
Drift rate for stock	0.15	(Not used here: Only use if you require a stock price following a GBM, instead of assuming S changes by 0.5 per period)
δ ("Dividend" rate)	0	(contin. Compounded,p.a., decimal)
Time to maturity(years)	0.1	(time to maturity of the futures and the options contracts, years or fraction of a year)
Timesteps, dt	0.01	
V0(stocks)	560000	(Initial dollar value of Stock Portfolio)
zf	500	(Futures multiple on stock index futures contract - here $500)
M	100	(maturity/face value of T-Bill/bond)

HEDGE POSITIONS

N0(star)	2000	Number of stocks in "stock+futures" replication portfolio -(index units)
N0	1979.0078	Number of stocks in "stock+put" portfolio -(index units)

Time t	Time left T-t	Asset Price S	d1	d2	Delta of Call	Delta of Put	Call Option Premium C	Put Option Premium P
0	0.1	280.0000	0.2825	0.2445	0.6112	-0.3888	5.7561	2.9701
0.01	0.1	279.5000	0.2354	0.1974	0.5930	-0.4070	5.4550	3.1690
0.02	0.1	279.0000	0.1882	0.1503	0.5746	-0.4254	5.1631	3.3771
0.03	0.1	278.5000	0.1409	0.1030	0.5560	-0.4440	4.8804	3.5944
0.04	0.1	278.0000	0.0936	0.0556	0.5373	-0.4627	4.6071	3.8211
0.05	0.1	277.5000	0.0462	0.0082	0.5184	-0.4816	4.3432	4.0571
0.06	0.1	277.0000	-0.0014	-0.0393	0.4995	-0.5005	4.0887	4.3027
0.07	0.1	276.5000	-0.0490	-0.0869	0.4805	-0.5195	3.8437	4.5577
0.08	0.1	276.0000	-0.0967	-0.1346	0.4615	-0.5385	3.6082	4.8222
0.09	0.1	275.5000	-0.1445	-0.1824	0.4426	-0.5574	3.3822	5.0962
0.1	0.1	275.0000	-0.1923	-0.2303	0.4237	-0.5763	3.1657	5.3796

Time t	STOCK + PUT PORTFOLIO "Delta" Change in Value of ... Stocks dV(S)	 Puts dV(P)	 Stock + Put dV(S+P)	STOCK + PUT PORTFOLIO TRUE Value V(S+P)	 TRUE Change in value dV(S+P)	STOCK + FUTURES PORTFOLIO Number of Futures Contracts Nf	 Futures Price F	 Change in Futures Price dF	 Value of Stocks ONLY N0(star)xS	 Change in Value of Stocks ONLY	 Delta Change in Value of Stock+ Futures dV(S+F)
0				560000		-1.5650577	282.814		560000		
0.01	-989.504	384.7006	-604.803	559404.2	-595.835	-1.6362553	282.309	-0.5050251	559000	-1000	-604.8033
0.02	-989.504	402.6789	-586.825	558826.4	-577.737	-1.7083761	281.804	-0.5050251	558000	-1000	-586.825
0.03	-989.504	420.8903	-568.614	558267	-559.425	-1.7812711	281.299	-0.5050251	557000	-1000	-568.61361
0.04	-989.504	439.2972	-550.207	557726.1	-540.936	-1.8547854	280.7939	-0.5050251	556000	-1000	-550.20671
0.05	-989.504	457.8605	-531.643	557203.8	-522.312	-1.9287594	280.2889	-0.5050251	555000	-1000	-531.64341
0.06	-989.504	476.5398	-512.964	556700.2	-503.592	-2.0030292	279.7839	-0.5050251	554000	-1000	-512.96406
0.07	-989.504	495.2939	-494.21	556215.3	-484.818	-2.0774282	279.2789	-0.5050251	553000	-1000	-494.21001
0.08	-989.504	514.0806	-475.423	555749.3	-466.032	-2.1517881	278.7738	-0.5050251	552000	-1000	-475.42332
0.09	-989.504	532.8574	-456.647	555302	-447.278	-2.2259397	278.2688	-0.5050251	551000	-1000	-456.64653
0.1	-989.504	551.5816	-437.922	554873.4	-428.598	-2.2997145	277.7638	-0.5050251	550000	-1000	-437.92232

Note : in this spreadsheet, the 'Time left is keep constant. The user can easily change this.

The entries above for 'dV(S+P)' should exactly match those of the 'replication portfolio' of dV(S+P) ,'stock+futures', in the final column of this sheet

The entries in the column 'TRUE change in value' are the actual changes in the 'stock+put' portfolio and these will not exactly match those of the 'replication portfolio' in the final column, since the latter uses the 'put-delta' which is an approximation.

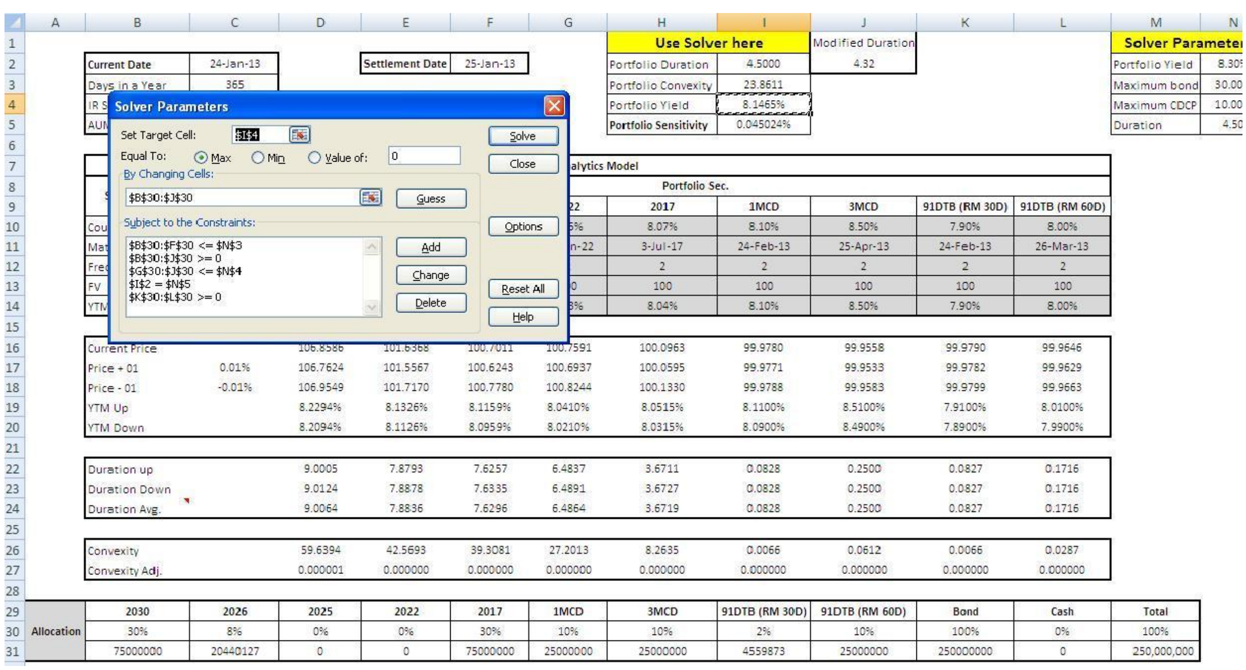
FIXED INCOME PORTFOLIO MANAGEMENT USING EXCEL:

There are income funds which have a mandate to keep the maturity profile of the fund limited to some number. For E.g. Birla Dynamic normally keeps the duration near to 3. So how does one keep constant watch on it? How does one optimize return with respective duration? How should one allocate his funds to enjoy maximum convexity other things (i.e. duration, yield) remaining constant. How can one optimize returns of the portfolio following risk mandates like maximum allocation to one security should not be more than 30%, maximum in G sec should not be more than 50%, etc. Yes excel solves every above mentioned aspect, "SOLVER" is an optimizer tool which helps you generate better results with in hand parameters.

In the attached sheet I have highlighted two tables i.e. "USE SOLVER HERE" and "SOLVER PARAMETERS". One will have to work on the above tables once bonds/NCDs/other papers information is entered in the brown cells. Let's try out one case which will help you understand in a better way.

Now using solver tool we are asking excel to return us the best portfolio allocation to get maximum yield keeping some parameters in mind. Just to understand one conditions we have specified is that $B:$30:$F$30<=$N$3 i.e. Any gilt paper should not exceed 30% of the portfolio value.

If I was not using Solver than probably would randomly allocated money to papers available keeping mandate in mind.



Current Date	24-Jan-13
Days in a Year	365
IR Shift (in bps)	1
AUM	250000000

Settlement Date	25-Jan-13

Use Solver here		Modified Duration
Portfolio Duration	4.5034	4.33
Portfolio Convexity	24.4345	
Portfolio Yield	8.1218%	
Portfolio Sensitivity	0.045059%	

Solver Paramet	
Portfolio Yield	8.3
Maximum bond	30.
Maximum CDCP	10.
Duration	4.

Analytics Model										
Security Title	Price Change	Portfolio Sec.								
		2030	2026	2025	2022	2017	1MCD	3MCD	91DTB (RM 30D)	91DTB (RM 60D)
Coupon		8.97%	8.33%	8.20%	8.15%	8.07%	8.10%	8.50%	7.90%	8.00%
Maturity Date		5-Jun-30	9-Jan-26	24-Mar-25	11-Jun-22	3-Jul-17	24-Feb-13	25-Apr-13	24-Feb-13	26-Mar-13
Frequency		2	2	2	2	2	2	2	2	2
FV		100	100	100	100	100	100	100	100	100
YTM		8.22%	8.12%	8.11%	8.03%	8.04%	8.10%	8.50%	7.90%	8.00%

Current Price		106.8586	101.6368	100.7011	100.7591	100.0963	99.9780	99.9558	99.9790	99.9646
Price + 01	0.01%	106.7624	101.5567	100.6243	100.6937	100.0595	99.9771	99.9533	99.9782	99.9629
Price - 01	-0.01%	106.9549	101.7170	100.7780	100.8244	100.1330	99.9788	99.9583	99.9799	99.9663
YTM Up		8.2294%	8.1326%	8.1159%	8.0410%	8.0515%	8.1100%	8.5100%	7.9100%	8.0100%
YTM Down		8.2094%	8.1126%	8.0959%	8.0210%	8.0315%	8.0900%	8.4900%	7.8900%	7.9900%

Duration up		9.0005	7.8793	7.6257	6.4837	3.6711	0.0828	0.2500	0.0827	0.1716
Duration Down		9.0124	7.8878	7.6335	6.4891	3.6727	0.0828	0.2500	0.0827	0.1716
Duration Avg.		9.0064	7.8836	7.6296	6.4864	3.6719	0.0828	0.2500	0.0827	0.1716

Convexity		59.6394	42.5693	39.3081	27.2013	8.2635	0.0066	0.0612	0.0066	0.0287
Convexity Adj.		0.000001	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

	2030	2026	2025	2022	2017	1MCD	3MCD	91DTB (RM 30D)	91DTB (RM 60D)	Bond	Cash	Total
Allocation	15%	15%	16%	10%	1%	10%	10%	10%	13%	100%	0%	100%
	37500000	37500000	40000000	25000000	2500000	25000000	25000000	25000000	32500000	250000000	0	250,000,000

This could have been one of the results. Yield here is tad low than optimum yield possible. Hence one performs optimum adhering to mandates of the scheme using solver.

EXCEL IN DERIVATIVES BLACK AND SCHOOLS MODEL IN EXCEL:

The Black-Scholes formula (also called Black-Scholes-Merton) was the first widely used model for option pricing. It's used to calculate the theoretical value of European-style options using current stock prices, expected dividends, the option's strike price, expected interest rates, time to expiration and expected volatility.

The formula, developed by three economists – Fischer Black, Myron Scholes and Robert Merton – is perhaps the world's most well-known options pricing model. It was introduced in their 1973 paper, "The Pricing of Options and Corporate Liabilities," published in the *Journal of Political Economy*. Black passed away two years before Scholes and Merton were awarded the 1997 Nobel Prize in Economics for their work in finding a new method to determine the value of derivatives (the Nobel Prize is not given posthumously; however, the Nobel committee acknowledged Black's role in the Black-Scholes model).

The Black-Scholes model makes certain assumptions:

- The option is European and can only be exercised at expiration.
- No dividends are paid out during the life of the option.
- Markets are efficient (i.e., market movements cannot be predicted).
- There are no transaction costs in buying the option.
- The risk-free rate and volatility of the underlying are known and constant.
- The returns on the underlying are normally distributed.

Note: While the original Black-Scholes model didn't consider the effects of dividends paid during the life of the option, the model is frequently adapted to account for dividends by determining the ex-dividend date value of the underlying stock.

Black-Scholes Formula

The formula, shown in Figure 4, takes the following variables into consideration:

- current underlying price
- options strike price
- time until expiration, expressed as a percent of a year
- implied volatility
- risk-free interest rates

$$\boldsymbol{C} = SN(d_1) - N(d_2)Ke^{-rt}$$

C = Call premium
S = Current stock price
t = Time until option exercise
K = Option striking price
r = Risk-free interest rate
N = Cumulative standard normal distribution
e = Exponential term

s = St. Deviation
ln = Natural Log

$$\boldsymbol{d_1} = \frac{\ln\left(S/_K\right) + \left(r + s^2/_2\right)t}{s \cdot \sqrt{t}}$$

$$\boldsymbol{d_2} = d_1 - s \cdot \sqrt{t}$$

Figure 4: The Black-Scholes pricing formula for call options.

The model is essentially divided into two parts: the first part, *SN(d1)*, multiplies the price by the change in the call premium in relation to a change in the underlying price. This part of the formula shows the expected benefit of purchasing the underlying outright. The second part, $N(d2)Ke^{-rt}$, provides the current value of paying the exercise price upon expiration (remember, the Black-Scholes model applies to European options that can be exercised only on expiration day). The value of the option is calculated by taking the difference between the two parts, as shown in the equation.

The mathematics involved in the formula are complicated and can be intimidating. Fortunately, you don't need to know or even understand the math to use Black-Scholes modeling in your own strategies. As mentioned previously, options traders have access to a variety of online options calculators, and many of today's trading platforms boast robust options analysis tools, including indicators and spreadsheets that perform the calculations and output the options pricing values. An example of an online Black-Scholes calculator is shown in Figure 5. The user inputs all five variables (strike price, stock price, time (days), volatility and risk free interest rate) and clicks "get quote" to display results.

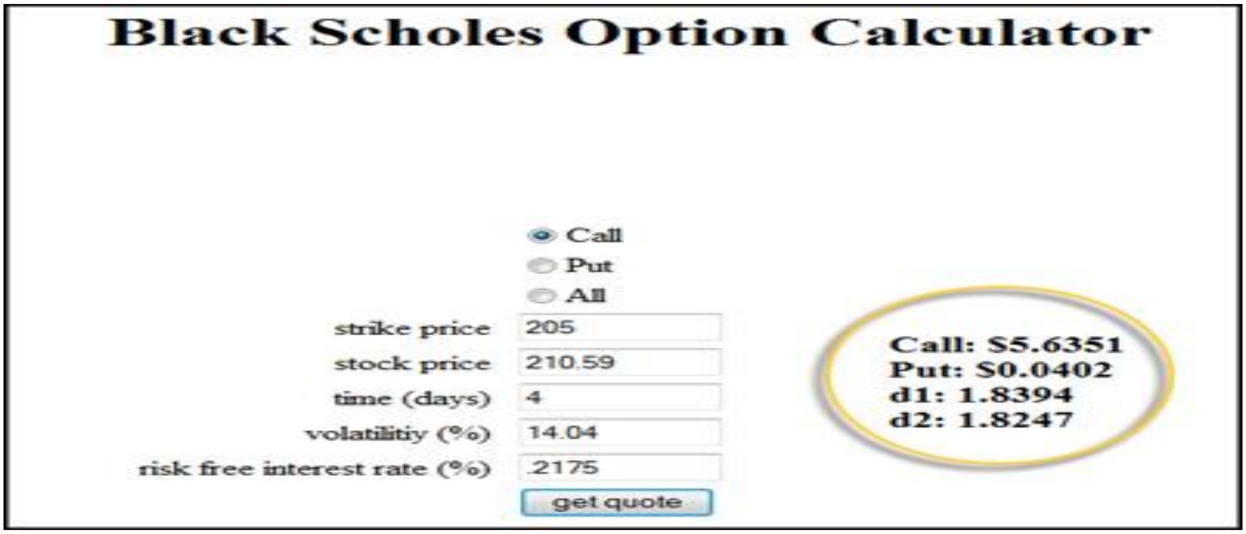


Figure 5: An online Black-Scholes calculator can be used to get values for both calls and puts. Users enter the required fields and the calculator does the rest. Calculator courtesy

Option Value based on the Black-Scholes Model:

Black-Scholes Option Pricing Model	
Inputs:	
Stock Price (S)	$10.00
Strike Price (X)	$10.00
Volatility (σ)	40.00%
Risk-free Rate	4.27%
Time to expiration (T)	10 yrs
Dividend Yield	0.00%
# of Options (000)	10,000
# Shares Outstanding (000)	100,000
Tax Rate	40.00%
Output:	
D1	0.97003
D2	-0.29488
N(D1)	0.83398
N(D2)	0.38404
Call Price	**$5.83411**
Put Price	**$2.35874**
Value of Call Options (000	**$58,341**
After-tax Option Value (00	**$35,005**

Black-Scholes Option Pricing Model (with dilution)	
Inputs (with dilution effects):	
Stock Price (S)	$10.00
Strike Price (X)	$10.00
Volatility (σ)	40.00%
Risk-free Rate	4.27%
Time to expiration (T)	10 yrs
Dividend Yield	0.00%
# of Options (000)	10,000
# Shares Outstanding (000)	100,000
Tax Rate	40.00%
\	
Adjusted S (dilution)	$9.59
D1	0.93696
D2	-0.32795
N(D1)	0.82561
N(D2)	0.37148
Call Price	**$5.49418**
Put Price	**$2.42844**
Value of Call Options (000	**$54,942**
After-tax Option Value (00	**$32,965**

*Note: This spreadsheet requires iterative calculations which may result in circular references.
To correct this problem, go to "Tools" - "Options" - Calculation and check the "iteration" box.

GREEKS IN EXCEL:

This Excel spreadsheet implements the Black-Scholes pricing model to value European Options (both Calls and Puts). The spreadsheet allows for dividends and also gives you the Greeks

These are sample parameters and results

Black Scholes and Greeks in VBA

http://investexcel.net

The VBA is open and can be used in your own projects

Parameters	
Stock Price	50
Strike Price	65
Time To Expiry	1
Volatility	15%
Risk Free Rate	3.00%
Dividend Yield	2.00%

Results	Call	Put
Option Price	0.1588	14.2279
Delta	0.0540	-0.9460
Gamma	0.0146	0.0146
Theta	-0.0009	-0.0061
Vega	0.0548	0.0548
Rho	0.0249	-0.6059

OPTION GREEKS (see macro for source code) — by Alex Matulich, alex■unicorn.us.com — Updated 1/24/2002 to fix theta and results for put options.

Inputs are yellow boxes. Outputs are blue text. — http://unicorn.us.com/trading/ — Updated 4/16/2005 to fix math error involving risk free rate.

		using option price	using implied volatility
INPUTS	Today's date	4/16/2005	4/16/2005
	Option expiration month	5	5
	Option expiration year	2005	2005
	Underlying stock or futures price	100	100
	Option strike price	90	90
	Option price	10.905065	#NAME?
	Call option? (TRUE or FALSE)	TRUE	FALSE
	annual risk-free interest rate	2%	2%
	Implied volatility	#NAME?	33.0%
OUTPUTS	Days to expiration	#NAME?	#NAME?
Greeks:	delta	#NAME?	#NAME?
	gamma	#NAME?	#NAME?
	theta	#NAME?	#NAME?
	vega	#NAME?	#NAME?
	rho	#NAME?	#NAME?

Black-Scholes Greeks Excel Formulas

This is the second part of the Black-Scholes Excel guide covering Excel calculations of option Greeks (delta, gamma, theta, vega, and rho) under the Black-Scholes model. I will continue in the example from the first part to demonstrate the exact Excel formulas. See the first part for details on parameters and Excel formulas for d1, d2, call price, and put price.
Here you can find detailed explanations of all the Black-Scholes formulas.
Here you can see how everything works together in Excel in the Black-Scholes Calculator.

	Price	Delta	Gamma	Theta	Vega	Rho
Call option	1.87	0.7263	0.1303	-0.0219	0.0284	0.0135
Put option	0.45	-0.2737	0.1303	-0.0210	0.0284	-0.0057

Delta in Excel

Delta is different for call and put options. The formulas for delta are relatively simple and so is the calculation in Excel.

$$Call\ delta = e^{-qt} * N(d_1) \quad Put\ delta = e^{-qt} * (N(d_1) - 1)$$

I calculate call delta in cell V44, continuing in the example from the first part, where I have already calculated the two individual terms in cells M44 and S44:

=M44*S44

	M	N	O	P	Q	R	S	T	U	V
43	$N(d_1)$	$N(-d_1)$	$N(d_2)$	$N(-d_2)$	e^{-rt}	$X e^{-rt}$	e^{-qt}	$S_0 e^{-qt}$	Call price	Call delta
44	0.6194	0.3806	0.5695	0.4305	0.9993	34.98	1.0000	36.07	2.42	=M44*S44

The calculation of put delta is almost the same, using the same cells. Just add minus one and don't forget the brackets:

=S44*(M44-1)

	M	N	O	P	Q	R	S	T	AA	AB
43	$N(d_1)$	$N(-d_1)$	$N(d_2)$	$N(-d_2)$	e^{-rt}	$X e^{-rt}$	e^{-qt}	$S_0 e^{-qt}$	Put price	Put delta
44	0.6194	0.3806	0.5695	0.4305	0.9993	34.98	1.0000	36.07	1.33	=S44*(M44-1)

Gamma in Excel

The formula for gamma is the same for calls and puts. It is slightly more complicated than the delta formulas above:

$$Gamma = \frac{e^{-qt}}{S_0\,\sigma\,\sqrt{t}} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}$$

Notice especially the second part of the formula:

$$\frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}$$

You will find this term in the calculation of theta and vega too. It is the standard normal probability density function for -d1. In Excel the formula looks like this:

=EXP(-1*POWER(K44,2)/2)/SQRT(2*PI())

… where K44 is the cell where you have calculated d1 (see first part).

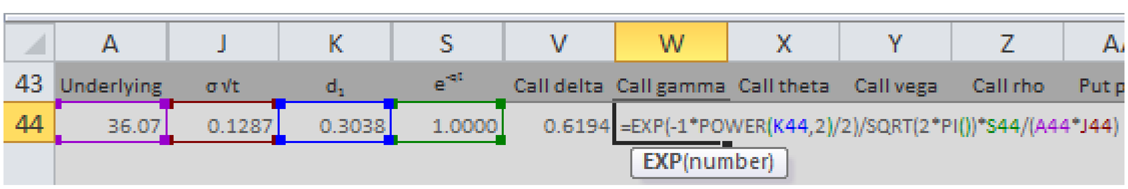
Alternatively, you can use the NORM.DIST Excel function, which I have also explained in the first part. The only difference from the first part is that the last parameter (cumulative) is now FALSE. Don't forget the minus sign before K44:

=NORM.DIST(-K44,0,1,FALSE)

These two formulas must return the same result.

In the example from the Black-Scholes Calculator I use the first formula. The whole formula for gamma (same for calls and puts) is:

=EXP(-1*POWER(K44,2)/2)/SQRT(2*PI())*S44/(A44*J44)



	A	J	K	S	V	W	X	Y	Z	A
43	Underlying	σ√t	d_1	e^{-qt}	Call delta	Call gamma	Call theta	Call vega	Call rho	Put p
44	36.07	0.1287	0.3038	1.0000	0.6194	=EXP(-1*POWER(K44,2)/2)/SQRT(2*PI())*S44/(A44*J44)				

Theta in Excel

Theta has the longest formulas of all the five most common option Greeks. It is different for calls and puts, but the differences are again just a few minus signs here and there and you must be very careful. Theta is very small for many options, which makes it often hard to detect a possible error in your calculations.

$$Call\ theta =$$
$$= \frac{1}{T}\left(-\left(\frac{S_0\ \sigma\ e^{-qt}}{2\sqrt{t}} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}\right) - r\ X\ e^{-rt}\ N(d_2) + q\ S_0\ e^{-qt}\ N(d_1)\right)$$

$$Put\ theta =$$
$$= \frac{1}{T}\left(-\left(\frac{S_0\ \sigma\ e^{-qt}}{2\sqrt{t}} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}\right) + r\ X\ e^{-rt}\ N(-d_2) - q\ S_0\ e^{-qt}\ N(-d_1)\right)$$

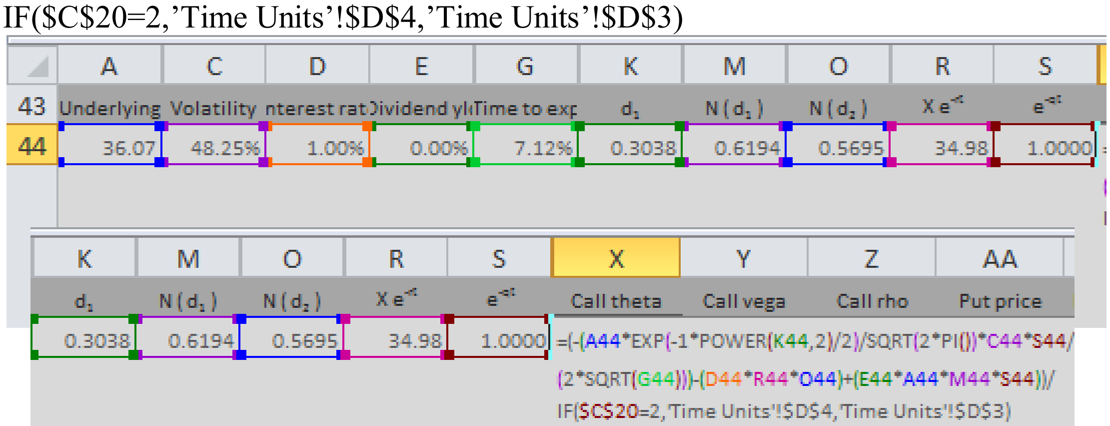
Although it looks complicated, all the symbols and terms in the formulas should be already familiar from the calculations of option prices and delta and gamma above. One exception is the T at the beginning of the formulas.

T is the number of days per year. You can choose either calendar days (T=365 or 365.25) or trading days (T=252 or something similar, depending on where you trade). Based on your selection, the interpretation of theta will then be either option price change in one calendar day or option price change in one trading day.

Call Option Theta

The whole formula for call theta in our example is in cell X44. It is long and uses several (10) other cells, but there is no high mathematics:

=(-(A44*EXP(-1*POWER(K44,2)/2)/SQRT(2*PI())*C44*S44/
(2*SQRT(G44)))-(D44*R44*O44)+(E44*A44*M44*S44))/
IF($C$20=2,'Time Units'!$D$4,'Time Units'!$D$3)



	A	C	D	E	G	K	M	O	R	S
43	Underlying	Volatility	nterest rat	Dividend yi	Time to exp	d_1	$N(d_1)$	$N(d_2)$	$X e^{-rt}$	e^{-qt}
44	36.07	48.25%	1.00%	0.00%	7.12%	0.3038	0.6194	0.5695	34.98	1.0000

K	M	O	R	S	X	Y	Z	AA
d_1	$N(d_1)$	$N(d_2)$	$X e^{-rt}$	e^{-qt}	Call theta	Call vega	Call rho	Put price
0.3038	0.6194	0.5695	34.98	1.0000	=(-(A44*EXP(-1*POWER(K44,2)/2)/SQRT(2*PI())*C44*S44/ (2*SQRT(G44)))-(D44*R44*O44)+(E44*A44*M44*S44))/ IF($C$20=2,'Time Units'!$D$4,'Time Units'!$D$3)			

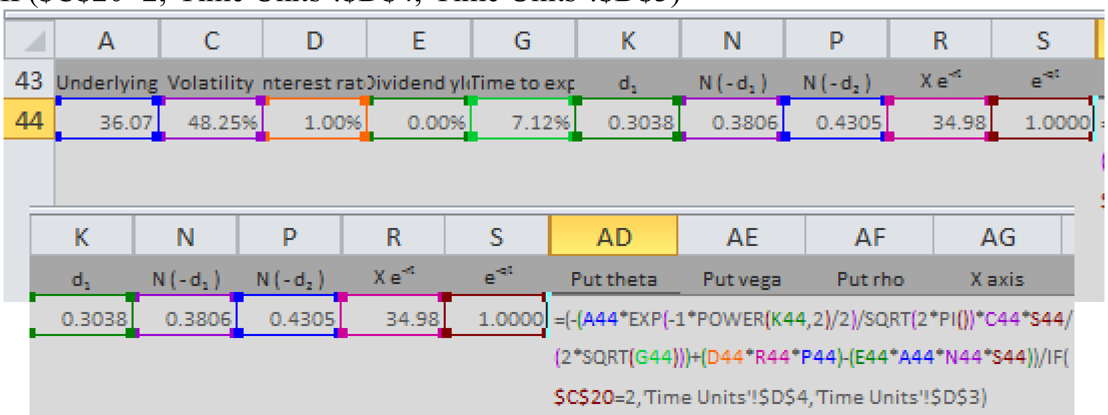
The last line of the formula in the screenshot above is the T. Cell C20 in the calculator contains a combo where users select calendar days or trading days. Cells D3 and D4 in the sheet Time Units contain the number of calendar and trading days per year. If you want to keep it simple, you can replace the whole last line of the formula with a fixed number, such as 365.

You can again find the explanation of all the individual cells in the first part or see all these Excel calculations directly in the calculator.

Put Option Theta

Analogically to call theta, the formula for put theta in cell AD44 is:

=(-(A44*EXP(-1*POWER(K44,2)/2)/SQRT(2*PI())*C44*S44/(2*SQRT(G44)))+(D44*R44*P44)-(E44*A44*N44*S44))/IF($C$20=2,'Time Units'!$D$4,'Time Units'!$D$3)



Vega in Excel

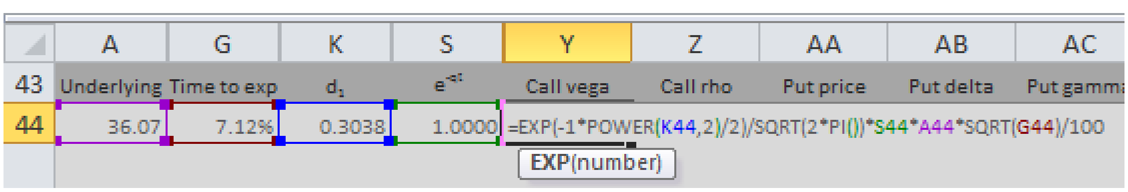
The formula for vega is the same for calls and puts:

$$Vega = \frac{1}{100}\, S_0\, e^{-qt}\, \sqrt{t} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}$$

There is nothing new. You can again see the familiar term at the end.

In the calculator example I calculate vega in cell Y44:

=EXP(-1*POWER(K44,2)/2)/SQRT(2*PI())*S44*A44*SQRT(G44)/100



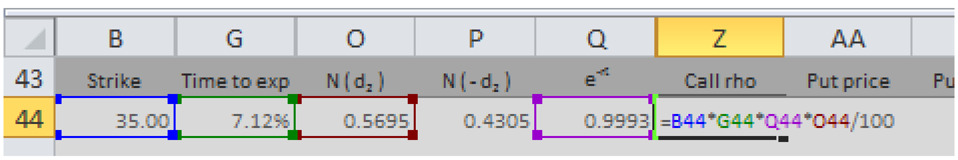
Rho in Excel

Rho is again different for calls and puts. There are two more minus signs in the put rho formula.

$$Call\ rho = \frac{1}{100} X\ t\ e^{-rt} * N(d_2) \quad Put\ rho = -\frac{1}{100} X\ t\ e^{-rt} * N(-d_2)$$

In the calculator example I calculate call rho in cell Z44. It is simply a product of two parameters (strike price and time to expiration) and cells that I have already calculated in previous steps:

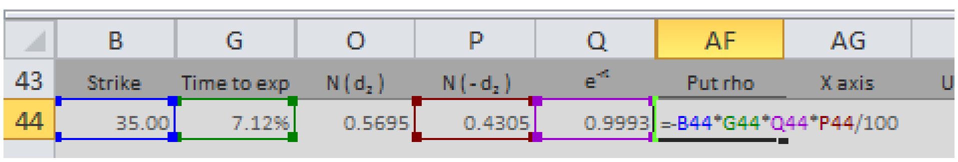
=B44*G44*Q44*O44/100



	B	G	O	P	Q	Z	AA	
43	Strike	Time to exp	$N(d_2)$	$N(-d_2)$	e^{-rt}	Call rho	Put price	Pu
44	35.00	7.12%	0.5695	0.4305	0.9993	=B44*G44*Q44*O44/100		

I calculate put rho in cell AF44, again as product of 4 other cells, divided by 100. Make sure to put the minus sign to the beginning:

=-B44*G44*Q44*P44/100



	B	G	O	P	Q	AF	AG	
43	Strike	Time to exp	$N(d_2)$	$N(-d_2)$	e^{-rt}	Put rho	X axis	U
44	35.00	7.12%	0.5695	0.4305	0.9993	=-B44*G44*Q44*P44/100		

More about Option Greeks in Excel

You can also use Excel and the calculations above (with some modifications and improvements) to model behaviour of individual option Greeks and option prices in different market situations (changes in the Black-Scholes model parameters). That is beyond the scope of this guide, but you can find it in the Black-Scholes Calculator and PDF Guide.

REAL OPTIONS VALUATION:

The Real Options Valuation model encompasses a suite of option pricing tools to quantify the embedded strategic value for a range of financial analysis and investment scenarios. Traditional discounted cash flow investment analysis will only accept an investment if the returns on the project exceed the hurdle rate. While this is a worthwhile exercise, it fails to consider the myriad of strategic options that are associated with many investments. This model provides the ability to identify what options might exist in your proposal and the tools to estimate the quantification of them. The key features of this model include:

- Ease and flexibility of input, with embedded help prompts.
- Informative 'Quick Start' menu for choosing the correct tool for the situation.
- Modified Black Scholes options model to value the options to delay, expand, or abandon investments.
- Automatic binomial 'tree' builder model to evaluate complex strategic options with multiple stages.
- Nash equilibrium Game Theory model to evaluate market entry strategies in a competitive environment.
- Ability to predefine historical investment and/or industry risk profiles to utilize across real options models.
- Compatible with all versions of Excel for Windows as well as Excel for Mac as a cross platform analytical business solution.
-

The **Excel Real Options Valuation Template** brings together a collection of option valuation tools geared to quantify strategic value from uncertainty and risks in investment timing and economic environment dynamics. Real options valuation differs from the traditional discounted cash flow approach to valuation by quantifying assumptions based on the volatility of underlying cash flows of an investment or business. The Excel Real Options Valuation template provides analytical tools based on modified option pricing theory to evaluate investment strategy alternatives and estimate the value of undertaking them.

Key features of the Excel Real Options Valuation template include:

- Input flow is assisted with information on each Real Options Valuation theory and detailed explanations for ease of interpretation.
- The 'Quick Start' menu provides information for choosing the correct Real Options Valuation tool for the investment decision and associated opportunity to be analyzed and quantified.
- The modified Black Scholes option pricing model is available to value the options to delay, expand, or abandon investment projects. Modifications to the traditional Black Scholes model include the accounting of dividends or cash flows from the underlying asset and the ability to exercise the option before the time in which the opportunity is expected to expire.
- The Binomial tree option valuation model allows the creation of unlimited binomial option branches to evaluate complex strategic options with multiple critical decision stages. New binomial branch values flow back through the entire to the starting node.
- The Game Theory model based on the Nash equilibrium theory is provided to determine the optimal strategy as a leader, follower or entering the market simultaneously in a competitive environment. Game theory analysis is suitable for evaluating market entry timing for new products or businesses.
- Categorized investment and/or industry risk profiles are provided and can be modified to utilize across Real Options Valuation models as a proxy for risk assumptions. Applying standardized risk assumptions across multiple option valuations not only accelerates the analytical process but also provides a common benchmark for comparing business strategies.

BUILDING A MEGA MODEL:

When it comes to building Excel models, there really are no widely accepted guidelines that Excel users follow. Because of this, Excel model building is more of an art than a science. Every single model you encounter tends to have its own nuances and quirks. Even if they come from the same user, as no standard processes exist, Excel models often show a lack consistency.

The reason this problem exists is pretty apparent: most Excel users just don't invest time in thinking about how they should structure their models. When designing a new model, we get so focused on building calculations and writing formulas that the context and structure of the model rarely prioritized. In other situations, we start building an Excel model and underestimate how often we'll need use it. Over time, as we add more and more components to the model without regard to structure, it soon becomes unwieldy.

During my tenure as a management consultant, I worked with many different clients on several quantitative projects. Having built and worked on so many models before, I've seen this potential improvement area countless times. The concept of model building is still a gray, ambiguous subject matter. The purpose of this post is to document what I've learned in my experience and begin to establish a standard Excel model building framework.

To review the essential skills of Excel model building, I will review key principles, propose a basic tab structure, and walk through specific steps that should be taken. I will use an attached dummy model to illustrate the principles I've recommended. Obviously my opinion is just one of several Excel experts, so I expect that this post will evolve as I receive feedback.

Key Principles

The secret to building good Excel models is all about having a user focus. For every model that you build:

Assume that someone else will need to use your model in the future.

People always underestimate how many different users an Excel model will pass through. Having a user focus is important even if you know you'll be the only one using it. Take the example of a financial model used to prepare for monthly close. Every single month, either you or whoever owns that role will have to repeat the process with new data. There have been several times in my career where I've had to go back to a model that I hadn't touched in several months and stressed out trying to figure out my original thinking.

Please keep in mind that there is a difference between **a calculation** and **a model**. We've all opened up Excel before just to perform some quick math that would've been difficult without a calculator. In these situations, the principles of model building principles are probably not a priority. However, if you're building something that's complex enough to be considered a model, there's a very high likelihood that the process will either need to be repeated or, at the very least, explained to someone else in the future.

Taking a user perspective prepares you for this inevitable transition. It encourages you to provide documentation, remove extraneous elements, and not take shortcuts that might cause confusion. Every time you build a new Excel model, there are three key principles you should focus on:

Logic

As you are finalizing the model you build, you should always try to take the perspective of someone who is completely new to the model you're building. This is where stepping away from the model for a few hours would be helpful, assuming you have the leeway to do so. When building a model, it's easy to focus on the specific outputs you need to produce and forget the big picture of what the model is supposed to do. Key questions you should ask yourself include:

- **Would your model make sense to a new user?**
- **Have the most obvious issues been either built into the model or addressed in documentation?**
- **Have you made any non-intuitive assumptions?**
- **Is the end purpose of your model apparent and understandable?**

Efficiency

Over the course of building a model, new information and requirements will often change how the model is structured. When this happens, we rarely go back and rebuild the entire model in a more efficient fashion. Because of this, models can become fragmented and inefficient. The key here is to think about your Excel model holistically: with everything you've added thus far, think about the most efficient way to get to the answer. Based on the time you have left, you should then make adjustments to the model to reflect this ideal. Key questions include:

- **Do you get to your final outputs in the most efficient manner?**
- **Are there any tabs or data points you are no longer using?**
- **Have you used your space efficiently?**
- **Are your tabs formatted consistently in terms of structure and arrangement?**

Transparency

Over the course of my career, I've rarely come across an Excel model with adequate documentation. People are either too busy or too lazy to invest time in this important characteristic. There are two key things you should realize about adding transparency to your Excel model. First, documentation doesn't have to be a 20 page document that explains your file; it can literally be comments on cells, additional tabs with notes, or even small descriptions within formulas. Secondly, any bit of documentation you add is beneficial; even if you don't have time to provide context for your entire file, add notes and comments where they would be most helpful to the user. Key questions for transparency are:

- **Is there adequate documentation?**
- **Are each of the tabs and their purpose in the model apparent?**
- **Is it obvious where the inputs and outputs of the model are?**
- **Did you hide any tabs or cells?**

Index Tab

For every complex model I build, I always try to include and an index which is a tab that **describes all the other tabs and provides the user the full scope of functionality** within the model. Once you've completed building the model, it's useful to add links from the index tab to every tab you've described, to facilitate ease of navigation. Ideally, the Index tab will not have any complex model calculations; it should mainly provide documentation and increase the transparency of your model.

Input Tabs

It's extremely important to keep all of your inputs in as few tabs and cells as possible. Working with Excel files where user inputs are expected in several different tabs is one of the most cumbersome issues we deal with. You should keep all of your input tabs in one section of the workbook and highlight them to signal inputs are required. Also keep in mind that you should never have a single input being entered in two different locations – if you need the variable in two different locations just link both locations to the same cell.

Drivers

Drivers are the **input variables within your model that you expect to adjust**. Having drivers is what allows you to perform sensitivity and scenario analysis. The way you setup your driver inputs will be key to how you perform scenario analysis.

Static Inputs

Your static assumptions are the variables that you **don't expect to change**and don't need to perform sensitivity or scenario analysis on. Having a separate tab just for static inputs isn't always a necessity, as some people just incorporate them with other inputs. The main reason for doing so is just to keep them separate from the true drivers of your model.

Data Tables

Your data tables essentially represent **the database of your model**. Any form of data that's complex enough to have rows and columns should be put in a table. When creating your tables, be sure to follow proper database theory. For large tables, it's best to have only one table per tab.

Calculation Tabs

The calculation tabs are the **engine of your model**. They should take your drivers, static assumptions, and data tables and perform all the calculations necessary to turn them into outputs values. Traditionally, this is where the majority of the work in model building will occur, in terms of formula writing. Do your best not to mix calculation tabs with either inputs or outputs.

Output Tabs

The output tabs are **what you plan to present externally** to the end customer of the model. For example, if you're building a financial model, you'll likely have a balance sheet, income statement, and statement of cash flows as output tabs. Keep these tabs clean of any inputs or calculations and use the Page Setup menu in Excel to format these for printing.

Documentation Tabs

Assuming you've already created an Index tab, having additional documentation tabs may not be necessary. However, if this additional information does not fit will in any of the other categories above, it's best to create these tabs to ensure transparency for the user.

Now that we've learned the key principles of model building, as well as a general tab structure, this final part of the Excel model building tutorial will review a step by step example of building a model from the ground up. The direction is still somewhat high level, but I've included a sample model that follows the prescribed guidelines. The model has already been built to completion, but it can be used to help you follow along and provide context for the high level steps referenced.

Step 1: Build Output Tabs Shell – Understand Your Requirements

Most people who've implemented software will tell you that the majority of errors occur during the requirements gathering phase of the project. (For those of you who haven't done an implementation, this is the phase of the project where you figure out what your software actually needs to do) Excel model building faces the exact same issue. Before you start building, you should figure out what outputs your model needs to generate. These requirements will greatly influence every subsequent step you take. For example, if you need to build multiple scenarios, you may need to leave space to input different scenario assumptions. If you need to conduct sensitivity analysis, then you may need to use Excel Data Table or build a sensitivity tornado chart.

Understanding your exact requirements first is not always possible, but you should always try to be as definitive as you can. The worst case scenario is investing several hours into building a model that can't generate the type of outputs you actually need.

In this adjusted snapshot of the sample model, you can see here that the requirements are to build a five your P&L forecast. In the model download, you'll note that I've also included a "Sales Revenue by City" report as an additional requirement.

Company P&L Forecast

all values in thousands

	2013	2014	2015	2016	2017	2018
	Actual	*Fcst*	*Fcst*	*Fcst*	*Fcst*	*Fcst*
Revenue	**$ 16,698.4**					
Nitro	$ 4,624.5					
Infinity	$ 5,278.8					
Durango	$ 6,795.1					
COGS	**$ 10,004.8**					
Nitro	$ 2,081.0					
Infinity	$ 3,167.3					
Durango	$ 4,756.5					
Gross Margin	**$ 6,693.5**					
SG&A	**$ 5,180.0**					
Salaries	$ 2,553.0					
Rent & Utilities	$ 1,346.0					

Step 2: Build Calculations on Paper – Determine Inputs Required

It's always tempting to jump right into Excel to start building your model immediately. But whenever you're dealing with a really complex model, it's always useful to step back with just a pen and paper to sketch out your intended plan. While not everyone uses this step, it can definitely help you gain perspective on your work and prevent you from missing critical ideas.

Step 3: Build Input Tabs and Gather the Required Values

Once you've sketched out your calculations, you should have a pretty good idea of what inputs you need to build your model. As mentioned in the tab structure post, you can have three kinds of inputs: **drivers**, **static inputs**, and **data tables**. As a best practice, you should try to **ensure that all of your inputs are in as few tabs as possible**, with the minor exception of breaking them up into different tabs between these three categories. This is critical because one of the biggest transparency complaints people have when dealing with second hand models is that they can't find out where they're supposed to input values.

On many occasions, you won't have the actual input value you need when you begin building your model. In this situation, it's best to input a dummy figure, or some rough historical average, so you can continue the model building process. Just make sure to add a notation so you remember to come back and update it.

The example below shows the Drivers tab within the sample model.

Drivers

	2013	2014	2015	2016	2017	2018
Total Annual Sales Growth		3.0%	3.0%	4.0%	4.0%	5.0%
Product Share Allocation						
Nitro	28%	30.0%	35.0%	40.0%	40.0%	50.0%
Infinity	32%	30.0%	25.0%	25.0%	25.0%	20.0%
Durango	41%	40.0%	40.0%	35.0%	35.0%	30.0%
Total	100%	100%	100%	100%	100%	100%
Annual COGS Changes						
Nitro		2.0%	3.0%	3.0%	3.0%	4.0%
Infinity		2.0%	2.0%	1.0%	1.0%	0.0%
Durango		-5.0%	-4.0%	-3.0%	-2.0%	-2.0%
SG&A Increases						
Salaries		2.0%				
Rent & Utilities		5.0%				
Legal & Insurance		3.0%				
Other		2.0%				

Step 4: Load Data Tables

Data tables represent a slightly more complex input than drivers or static inputs. As a general rule, **any table that has more rows and / or columns that you can fit and view on your laptop screen deserves its own tab**. Make sure that you use proper database formatting for these tables, as it is very possible that someone will take the table and load it into another file in the future.

In the sample model, we have a data table representing Total Product Sales by Territory in 2013.

Step 5: Build Calculations off of Inputs, Drivers, and Data Tables

At this point we've finished most of the setup tasks for model building and are ready to get into the heart of the exercise. Your knowledge of database theory and Excel formulas will definitely come in handy here. The calculation tabs are probably the least uniform aspect of Excel models. This is because, for any given goal, there are several ways to get to your solution. While it would be ideal to build your model in the most efficient way possible during your first try, this is rarely possible. The fact is good model building requires trial and error.

Only by going through different iterations of your model can you create the best possible outcome.

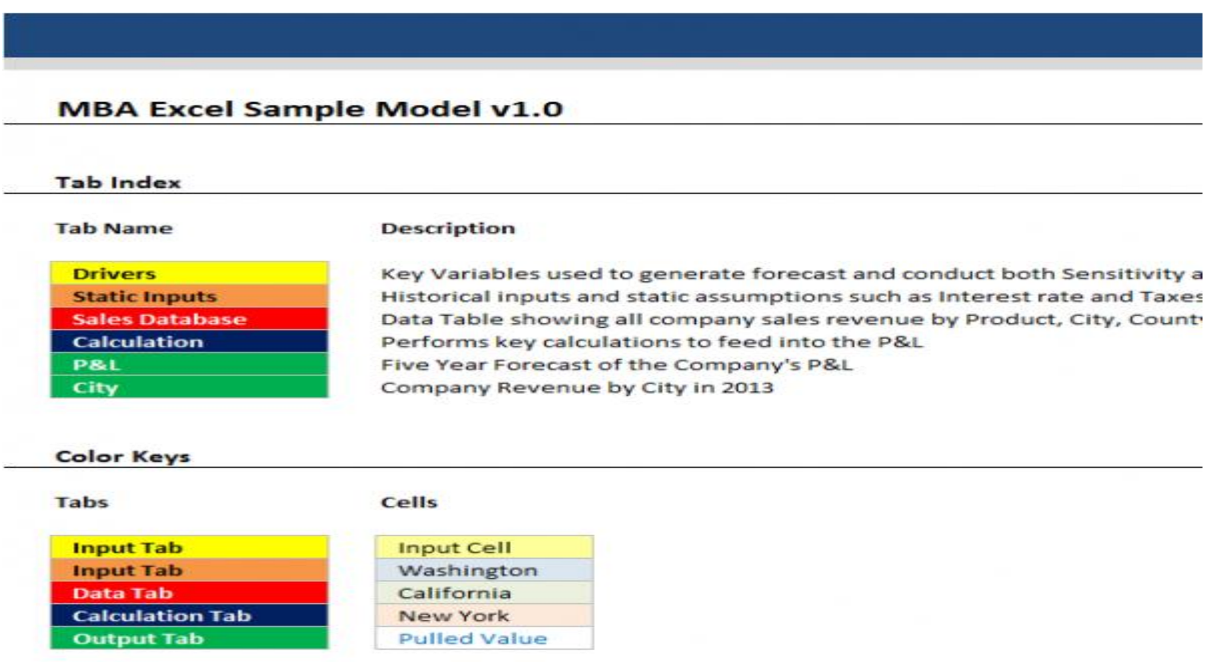
One best practice to keep in mind is that you should try to **do most of your calculations in your calculation tabs and not in your output tabs**. While it can definitely be faster to do calculations in the output tabs, it may make it harder for someone to audit your file in the future. By keeping all calculations in a defined area, you'll significantly increase both the consistency and the transparency of your file. The major exception to this rule is if you're just doing a sum, count, or lookup. Since these formulas summarize your data, they are appropriate for the output section.

Step 6: Link Calculated values to Output Tabs and Finalize Formatting of Output Tabs

By now the data you've run your calculations and should be very close to the exact values you need in your output tabs. You may still need to use some summary formulas to arrange your data based on your initial requirements. Since the output tabs are primarily for display, take time to format these for printing and apply Visual Design techniques. Additionally, make them as transparent as possibly by including sources, unit values, and any other beneficial documentation.

Step 7: Build Your Index Tab

At this point, you should have the majority of your tabs in place for your model. Building your Index Tab will significantly help summarize the scope and functionality of your model. Make sure that every tab you've created is documented and described. If you realize that any tabs are unnecessary, remove them. You will probably need to update this tab periodically if any aspect of your model changes.



Step 8: Link Key Output Values to Drivers Tab to Perform Scenario and Sensitivity Analysis

As you get towards the end of the model building process, it's very likely that you'll want to conduct some form of scenario or sensitivity analysis. To prepare for this step, you should determine what output values are the most important to your analysis and link them back to your drivers tab. The process for doing so is relatively simple and shouldn't take much more than using the equals sign to write a simple linking formula.

Additionally, you'll obviously need to understand which of your drivers are most likely to change and have a reasonable range of possible values for these variables. These factors will be completely dependent on the specific type of model you are building.
Another potential option for sensitivity analysis is to use Excel's Watch Window feature. While this is a great tool for sensitivity specifically, linking your output values to the drivers tab is the best way to create defined scenarios.

SG&A Increases	
Salaries	2.0%
Rent & Utilities	5.0%
Legal & Insurance	3.0%
Other	2.0%

Output KPIs

	2014	2015	2016	2017	2018
Revenue	$ 17,199.3	$ 17,715.3	$ 18,423.9	$ 19,160.9	$ 20,118.9
COGS	$ 10,096.0	$ 10,398.9	$ 10,667.4	$ 11,161.2	$ 11,447.7
Net Income	$ 977.7	$ 1,174.0	$ 1,233.3	$ 1,446.2	$ 1,531.8

Step 9: Create Documentation and Finish Index Tab

Excel models ever have adequate documentation. This additional step adds to your workload and no one really enjoys doing it. However, having documentation can make a huge difference to whomever you might hand your off work to. I like to think of documentation as an insurance policy; put in a little work now, and you'll significantly reduce the need to answer questions in the future. You'll also be much less likely to forget your own methodology if you ever need to come back to your file.

Documentation doesn't have to be a long winded user guide that takes several hours to write. It can take the form of comment boxes in cells, notes in formulas, or just a separate tab in the Excel document explaining your assumptions. All of these things further the transparency of your model and should be included if possible.

Step 10: Add Cell & Workbook Protection Where Appropriate

This last step is important if you plan to either widely distribute your file or solicit inputs from your colleagues. This is especially important in the latter scenario because before you save a new version of your file, you want cell protection in areas that should not be adjusted as well as a clear understanding of what sections your colleagues had the ability to change. The process of protecting your file is fairly simple: you just need to choose which cells will be editable by other users and then assign a password to your workbook.

You'll notice in the sample model, I've protected the Index Tab where the link to the documentation exists. That way, it reduces the likelihood that this sample model will be sent out without the accompanying documentation.

----oooOooo---

UNIT-V

UNDERSTANDING SUBROUTINES AND FUNCTIONS AND BUILDING SIMPLE FINANCIAL MODELS USING SUBROUTINES AND FUNCTION

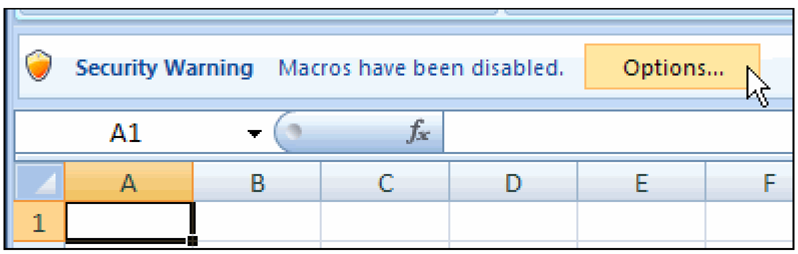
Recording and editing macros, subroutines and functions, decision rules, message box and input box, debugging, designing advanced financial models using visual basic application user forms, other advanced features, actual model building.

RECORDING AND EDITING MACROS:

Open the Macro Workbook:

When you recorded the macro, you selected a workbook to store the macro. We'll open that workbook, and find the Excel VBA code.

1. In Excel, open the workbook where you stored the Excel VBA code. If you stored the macro in the Personal Macro workbook, it should already be open, and hidden from view.
2. If a security warning appears at the top of the worksheet, click the Options button.
3.

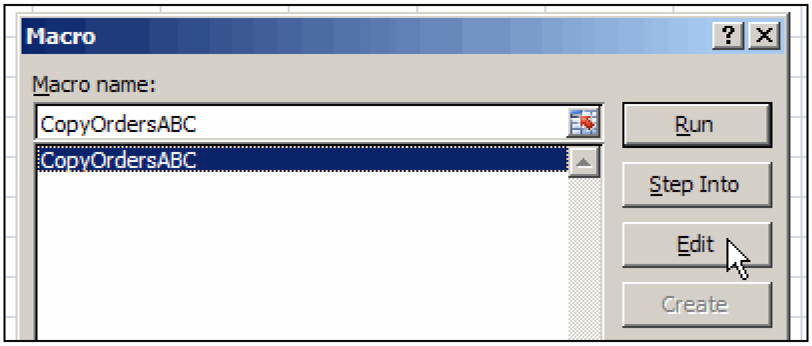


Then click Enable This Content, to allow the workbook's macros to run.

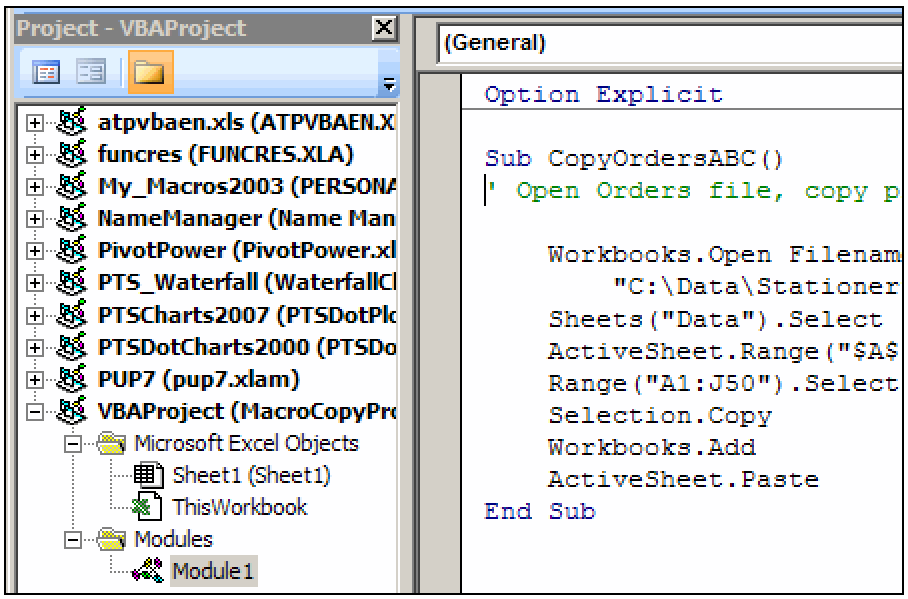
Find the Excel VBA Code

Next, we'll go to the recorded code.

1. On the Ribbon, click the Developer tab, then click Macros.
2. In the Macro dialog box, click on the name of your macro.
3. At the right of the dialog box, click Edit.



The Excel Visual Basic Editor (VBE) opens, showing the code that you recorded. Your code might look different from the sample shown below.



The Excel Visual Basic Editor

- At the right in the VBE is the **Code Window**. The cursor is flashing near the top of the code for your recorded macro.
- At the left, you should see a list of files, in the **Project Explorer Window**.

In the Code Window, you can edit the text, just as you would in Microsoft Word, or Notepad.

In the Project Explorer Window, you can select an object and see any code that it contains. In the screen shot above, Module 1 is highlighted, in the VBA Project for our workbook, named MacroCopyProduct.xlsm.

Check the Recorded Code

The Excel Macro Recorder created some code, while we performed the steps in our process. In my example, these were the steps:

1. Open the orders file, named StationeryShort2007.xlsx

2. Filter the list on the Data sheet, to show only the Binder orders
3. Copy the Binder orders
4. Create a new workbook
5. Paste the Binder orders into the new workbook.

Here's how those steps look, when written in Excel VBA by the Macro Recorder.

```
Sub CopyOrdersABC()
' Open Orders file, copy Binders to new workbook

    Workbooks.Open Filename:= _
        "C:\Data\StationeryShort2007.xlsx"
    Sheets("Data").Select
    ActiveSheet.Range("$A$1:$J$50").AutoFilter _
        Field:=7, Criteria1:="Binder"
    Range("A1:J50").Select
    Selection.Copy
    Workbooks.Add
    ActiveSheet.Paste
End Sub
```

Change the Recorded Code

The Excel Macro Recorder is a great tool for getting started with Excel VBA. Sometimes you can leave the code exactly as is, and it will run fine every time you need it. Most times though, the recorded code needs to be modified, and we'll start with a simple change.

When recording the code, I selected a specific range, "A1:J50", which is used in two lines of the code. If new rows of data are added, the code won't include them.

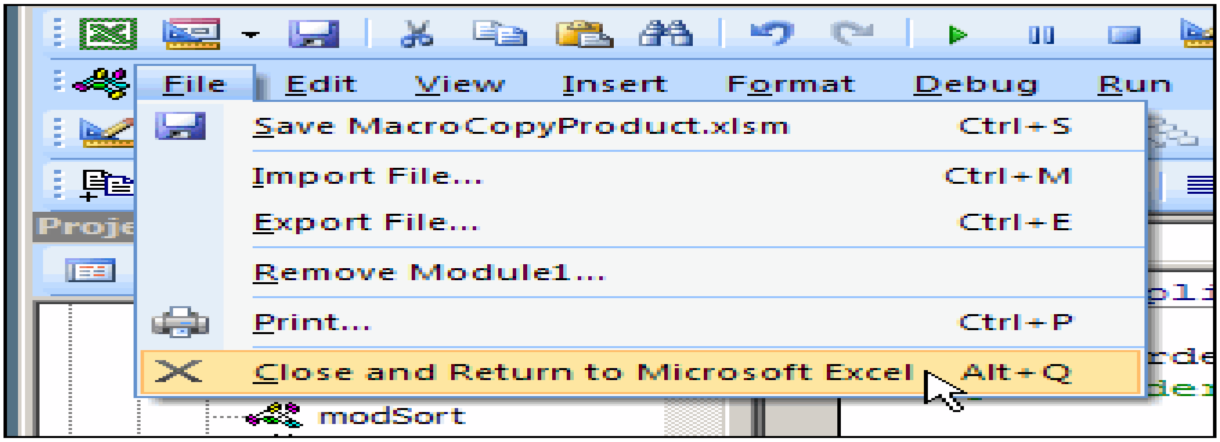
To accommodate for an increase in rows, we could change the 50 to 500. Then, if rows are added, they'll be included in the filter. There are more sophisticated ways to deal with a range that changes size, but this works for now.

```
Sub CopyOrdersABC()
' Open Orders file, copy Binders to new workbook

    Workbooks.Open Filename:= _
        "C:\Data\StationeryShort2007.xlsx"
    Sheets("Data").Select
    ActiveSheet.Range("$A$1:$J$500").AutoFilter _
        Field:=7, Criteria1:="Binder"
    Range("A1:J500").Select
    Selection.Copy
    Workbooks.Add
    ActiveSheet.Paste
End Sub
```

Test the Changes

After you have changed the recorded code, close the VBE.



Then, run the macro again, to test the changed code.

1. On the Ribbon, click the Developer tab, then click Macros.
2. In the Macro dialog box, click on the name of your macro.
3. At the right of the dialog box, click Run.

If the revised macro worked well, you can save the workbook that stores the macro.

SUBROUTINES AND FUNCTIONS:

Functions and subroutines are FORTRAN's subprograms. Most problems that require a computer program to solve them are too complex to sit down and work all the way through them in one go. Using subprograms allows you to tackle bite size pieces of a problem individually. Once each piece is working correctly you then put the pieces together to create the whole solution. To implement functions and subroutines, first write a main program that references all of the subprograms in the desired order and then start writing the subprograms. This is similar to composing an outline for an essay before writing the essay and will help keep you on track.

Functions

The purpose of a function is to take in a number of values or arguments, do some calculations with those arguments and then return a single result. There are some functions which are written into FORTRAN and can be used without any special effort by you, the programmer. They are called intrinsic functions. There are over 40 intrinsic functions in FORTRAN and they are mainly concerned with mathematical functions.

The general way to activate a function is to use the function name in an expression. The function name is followed by a list of inputs, also called arguments, enclosed in parenthesis:

answer = functionname (argumentl, argument2, . . .

Example

PRINT*, ABS (T)	The compiler evaluates the absolute value of T and prints it out
Y = SIN (X) + 45	The compiler calculates the value of sin x, adds 45 then puts the result into the variable Y, where x is in radians.
M=MAX(a,b,c,d)	The compiler puts the maximum value of a, b, c and d into the variable M. If a=2, b=4, c=1 and d=7, then M would have a value of 7.
C=SQRT (a* * 2 +b* * 2)	The compiler evaluates the expression, a**2+b**2, sends that value to the SQRT function, and places the answer in the variable

As shown by the MAX function example above, a function may have one or more arguments but will only give one result. Also, as shown by the SQRT function example above, the argument for a function does not have to be a variable. It can be an expression or even a constant if you want to reference it again. One last item to remember, you must use result of a function call in an assignment statement or a PRINT statement, as shown in the examples above.

External Functions

The intrinsic functions in FORTRAN are useful but there will be a time when there is no intrinsic function to meet your needs. When this occurs you may write your own function subprogram.

You have to do one thing in the main program to use an external function. You need to declare the function name in the variable declaration section. Function names follow the same rules as for variable names: less than six letters or numbers and beginning with a letter. Because of this, function names should not be used as variable names. Once that is done and the function is written, activating it is just like activating an intrinsic function.

Now you are ready to write your function. There are a few rules for writing external functions:

- Function subprograms and any other subprograms are placed after the END statement of the main program.
- They are started with a line that includes the type of value the function will return, the function name, and the list of arguments the function takes as inputs.
- Any variables the function uses, including the arguments, must be declared in the function right after the first line. The function name is not declared within the function.
- You must use the function name in an assignment statement within the function. This is how the compiler knows which value to pass back to the main program.

- A function must finish with RETURN and END statements.

The example program below shows how to write an external function which calculates the average of three numbers. Note the argument list in the main program does not use the same variable names as the argument list in the function. This is not a problem because a function is a self contained entity whose only tie with the main program is the order of the values in the argument list. So in the first reference to the function, the value in A (5.0) gets transferred to x, the value in B (2.0) to Y and the value in c (3.0) to z. However, in the third reference to the function, it is the squared values (25.0, 4.0, 9.0) that are transferred to x, Y and z respectively in the function. Note also that the variable SUM is used only in the function and therefore is declared only in the function.

Example Program

```
      PROGRAM FUNDEM
C      Declarations for main program
      REAL A,B,C
      REAL AV, AVSQ1, AVSQ2
      REAL AVRAGE
C      Enter the data
      DATA A,B,C/5.0,2.0,3.0/

C      Calculate the average of the numbers
      AV = AVRAGE(A,B,C)
      AVSQ1 = AVRAGE(A,B,C) **2
              AVSQ2 = AVRAGE(A**2,B**2,C**2)

              PRINT *,'Statistical Analysis'
      PRINT *,'The average of the numbers is:',AV
      PRINT *,'The average squared of the numbers: ',AVSQl
      PRINT *,'The average of the squares is: ', AVSQ2
      END

     REAL FUNCTION AVRAGE(X,Y,Z)
     REAL X,Y,Z,SUM
     SUM = X + Y + Z
     AVRAGE = SUM /3.0
     RETURN
     END
```

Subroutines

You will want to use a function if you need to do a complicated calculation that has only one result which you may or may not want to subsequently use in an expression. Recall the external function example program where the average was called and then squared in one line.

Subroutines, on the other hand, can return several results. However, calls to subroutines cannot be placed in an expression.

In the main program, a subroutine is activated by using a CALL statement which include the subroutine name followed by the list of inputs to and outputs from the subroutine surrounded by parenthesis. The inputs and outputs are collectively called the arguments.

A subroutine name follows the same rules as for function names and variable names: less than six letters and numbers and beginning with a letter. Because of this, subroutine names should be different than those used for variables or functions.

As with functions, there are some rules for using subroutines. Keep these in mind when writing your subroutines:

- You do not need to declare the subroutine name in the main program as you do with a function name.
- They begin with a line that includes the word SUBROUTINE, the name of the subroutine, and the arguments for the subroutine.

One way of indicating which variables are inputs and which are outputs is to put the inputs on the first line, use a continuation marker and put the outputs on the second line. See the example program for an application of this programming style.

All variables used by the subroutine, includJing the arguments, must be declared in the subroutine. The subroutine name is not declared anywhere in the program.

A subroutine is finished off with a RETURN and an END statement.

Exercise 4: Subroutines

In larger programs it is good programming style to include after the FUNCTION or SUBROUTINE statements comments explaining the meanings of the arguments and what the subprogram does.

A hint when you are debugging your programs: When extraordinary, incorrect numbers start appearing from nowhere as your program runs, you probably have not got your subroutine arguments in the right order in either the main program or in the subroutine. The same trick applies to functions. Example Program

```
      PROGRAM SUBDEM
   REAL A,B,C,SUM,SUMSQ
   CALL INPUT( + A,B,C)
      CALL CALC(A,B,C,SUM,SUMSQ)
      CALL OUTPUT(SUM,SUMSQ)
      END

      SUBROUTINE INPUT(X, Y, Z)
```

```
REAL X,Y,Z
PRINT *,'ENTER THREE NUMBERS => '
READ *,X,Y,Z
RETURN
END

SUBROUTINE CALC(A,B,C, SUM,SUMSQ)
REAL A,B,C,SUM,SUMSQ
SUM = A + B + C
SUMSQ = SUM **2
RETURN
END

SUBROUTINE OUTPUT(SUM,SUMSQ)
REAL SUM, SUMSQ
PRINT *,'The sum of the numbers you entered are: ',SUM
PRINT *,'And the square of the sum is:',SUMSQ
RETURN
END
```

Now go to the exercises and work your way through the subprograms and functions.

TYPES OF FUNCTIONS AND SUBPROGRAMS

Functions and subprograms can be grouped into several categories;

- Intrinsic or "built-in" functions
- Statement or "one-line" functions (Note: This link is optional)
- Function subprograms
- Subroutines

INTRINSIC FUNCTIONS

The intrinsic functions are the set of "built-in" or library functions that all versions of FORTRAN provide. These are such things as SIN, COS, EXP,...

The user of these functions "passes" one or more arguments to the function.

e.g., Y = COS(0.0) ABMX = MAX (A,B)
0.0, A and B are called "arguments"

FUNCTION SUBPROGRAMS

A FUNCTION subprogram is a "mini-program", that is, a collection of program statements which make it look like a program.

Functions, being separate entities, perform separate, specific tasks.

Functions are defined outside of the main program. They can either be written after the END of the main program or in another file altogether. Since they are separate from the main program they can be used again by other programs by simply attaching them to the other program or putting them in a library.

The general form of a FUNCTION looks like;

FUNCTION name (arguments)
declarations
subprogram statements
RETURN
END

- The function name must follow the same rules as the names for PROGRAM statements. (<=6 char's, 1st is a letter)
- The arguments that appear in the function definition are called "dummy" or "formal" arguments. These can be thought of as "place holders" for the actual arguments which will be "passed" to it when the function is referenced. Arguments are separated by commas and enclosed by parentheses.

  Actual arguments are the values of the real arguments used when the function is referenced in an executable statement.

  It is important to remember that their names may be different, yet they must agree in total number and type.

- Just like in a main program, the variables in the argument list must be TYPED, this includes the FUNCTION NAME. Normal default naming conventions apply for integers/reals.
- Somewhere in the collection of executable statements, the FUNCTION NAME MUST BE GIVEN A VALUE.
- Just like intrinsic functions, a user-written FUNCTION returns a single value.
- The subprogram is terminated with an END statement. It is common practice to use a RETURN statement just before the END, but it is not required. A RETURN could also be placed elsewhere in the function which will cause the function to exit back to the calling program.
- FUNCTIONS contain:
  - Opening documentation
  - Comments scattered liberally throughout
  - Any executable FORTRAN statement
  - Even references to other functions/subroutines
- An example: a function that calculates the factorial of the input number, N.

```
      FUNCTION FACTRL (N)
C This function computes n!, i.e. n*(n-1)*(n-2)*...*1
      INTEGER FACTRL, N, I
      FACTRL = 1
```

```
      IF ( N .GT. 1 ) THEN
        DO 10 I = 2, N
          FACTRL = FACTRL * I
10      CONTINUE
      END IF
      END
```

This function could immediately follow the main program which references it. A reference to this function in the main program might look like;

```
         :
      TERMA = FACTRL (4)     (24 will be stored for TERMA)
         :
```

Note that 4 is the ACTUAL ARGUMENT in this case. An INTEGER VARIABLE could also have been used.

IMPORTANT: ARGUMENTS MUST AGREE IN NUMBER AND TYPE.

SUBROUTINES:

Subroutines are very much like FUNCTIONS in that they are independent program units or modules, but they differ from functions in several important ways.

1. Functions return a single value to the program that references them whereas SUBROUTINES may return more than one value, or none at all.

2. Functions return values via the function name; subroutines return values via arguments.

3. A functions is referenced by using its name in an expression, whereas a subroutine is referenced by a CALL statement.

The general form of a SUBROUTINE is similar to that of a FUNCTION (and thus other program units);

```
SUBROUTINE name (arguments)
declarations
subprogram statements
RETURN
END
```

- NAME is the name given to the subroutine and must follow the same rules as variables. However, NAME can not have a type. .
- The subroutines has a list of arguments which are optional (the parens are omitted if there are no arguments).
- In a subroutine, values are returned via the arguments. This means that if an argument is changed in the subroutine then the corresponding ACTUAL argument is changed in the CALLing program.
- Subroutines are more versatile than functions because they can modify arguments, use them without modification, or require no arguments at all.
- As in functions it is a general practice, but not required, to use a RETURN statement before the END. A RETURN statement elsewhere in the subroutine will return control back to the calling program.

The subroutine is "called" as follows:

CALL name (arguments)

* IMPORTANT: The number and type of the arguments in the CALLing statement must agree with the number and type of the arguments in the SUBROUTINE.

- Some subroutine examples;

```
With no arguments          With input/output arguments

SUBROUTINE MESSAG          SUBROUTINE CONVER (R, TH, X, Y)
                           REAL R, TH, X, Y
PRINT*,'THIS MESSAGE'
RETURN                     X = R * COS(TH)
END                        Y = R * SIN(TH)
                           RETURN
                           END
```

The subroutine on the left has no arguments and simply prints out a message when it is called.

The subroutine on the right uses the values for R, TH in polar coords and converts these into rectangular coords using the output variables X, Y.

- Separate sets of INPUT and OUTPUT variables are used quite often in subroutines. Typically, the INPUT values are listed first, and the OUTPUT arguments are last.

PASSING ARGUMENTS

Actual arguments are "passed" to the subprograms and used in place of the formal arguments. As previously stated, the actual arguments may have different names than the formal arguments BUT they must agree in NUMBER and TYPE.

Simple variables are the easiest to pass, but there are several implications to consider.

* Note that you can use an expression as an actual argument. The expression will be evaluated before passing and the type must agree with the formal argument.

Arrays are passed by using the array's name. There are a few notes to consider.

* The corresponding array argument in the subroutine must be dimensioned no larger than the actual array in the main program.

* Note that an array element is handled the same as a simple variable. i.e, ALPHA(4) refers to one simple variable.

* Arrays may have "adjustable" dimensions, that is you may dimension an array in a subroutine based on the value of one of the arguments.

```
SUBROUTINE STUFF (AX, BX, N)
REAL AX(N), BX(N)
     :
```

Here's how the main program might look in this case:

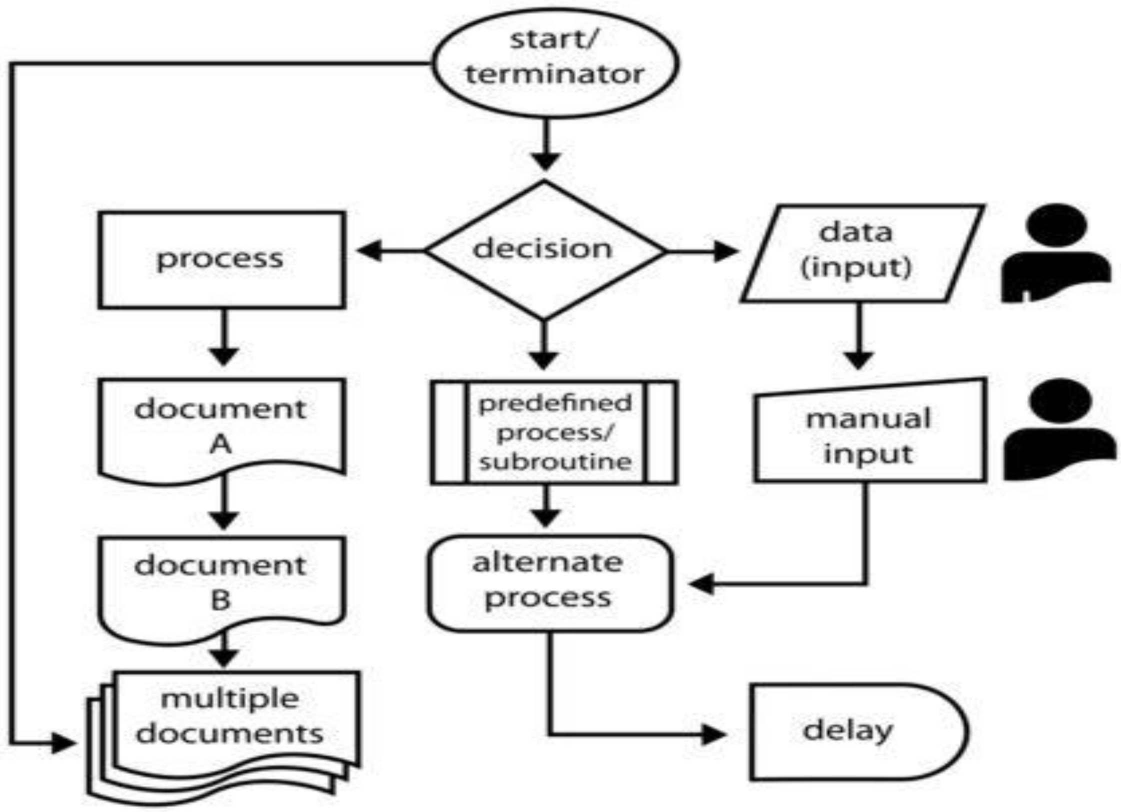
```
C   PROGRAM COMPUTE
      REAL X(100), Y(100)
C read in some data.  Check to make sure n is less than or equal to 100.
      open(1,file='xy.data')
      READ(1,*) NPTS
      IF (N .GT. 100) THEN
        write(6,*) ' N too large for program.  Make dimensions bigger and try
again'
        stop
      ELSE
        DO 100 I=1,NPTS
          READ(1,*) X(I), Y(I)
  100   CONTINUE
      END IF
C
C CAll subroutine STUFF to do some "stuff":
      CALL STUFF(X,Y,NPTS)
           .
           .
           .
      END
      SUBROUTINE STUFF(AX,BX,N)
      REAL AX(N), BX(N)
         :
C Subroutine STUFF starts directly after the END statement of the main
program.
C
```

Your subprograms can either directly follow your main program in one file, or may be exist as separate files and be compiled separately and then linked.

DECISION RULES:

A decision rule is a set of conditions that classify records. The rule predicts an outcome in the target field.

Viewing the decision rules helps you determine which conditions are likely to result in a specific outcome. For example, consider some hypothetical decision rules that could predict churn. These rules might identify classifications based on the ranges for customer age and number of previous claims. From these rules, you might observe that customer who have no or 1 claim and are older than 50 are more likely to churn. The decision rule corresponds to a branch in a decision tree.



MESSAGE BOX AND INPUT BOX

Input Box and Message Box are two useful functions. Each opens a dialog window, which closes when the user responds. The Input Box is used to get input from the user and Message Box is used for output. These illustrated in this simple message program. The following is its listing:

```
Private Sub Button1_Click (ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button 1.Click
            Dim strName As String
            strName = InputBox("What is your name?")
            MsgBox("Thanks, " & strName & ".  I have been waiting weeks for someone to do that.")
            End Sub
```

In this example, the Input Box function has one argument, a string that is used to **prompt** the user. The function returns whatever the user enters. (If the user clicks on the *cancel* button, a string of length zero is returned).

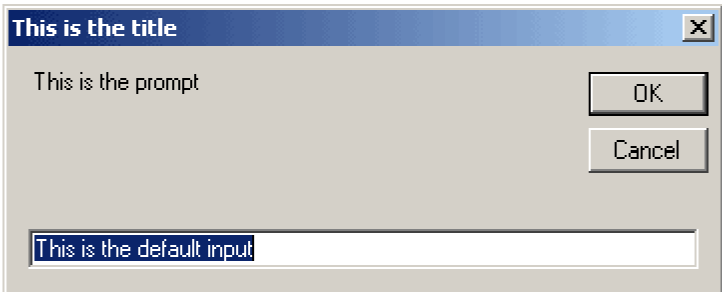
The Message Box function also has one argument in this example. It is a string to be displayed in the message box.

The InputBox function requires at least one argument (the prompt), but it has 4 optional arguments. The optional arguments are a title (string), a default input value (string), and X and Y coordinates (numeric) that determine the position of the input window on the screen.

For example, this program:

```
Dim strUserIn As String
strUserIn = InputBox("This is the prompt", "This is the title", "This is the default input", 1, 1)
```

produces this InputBox in the uppler left corner (1, 1) of the screen:



Similarly, the MsgBox function requires one argument, a string with the message, but has 2 optional arguments, a numeric code that indicates which buttons to display on the message box and a string title for the message box.

The button code is most interesting. Using it, you can put *OK*, *Cancel*, *Retry*, and other buttons on the message box, The following are some of the allowable button code values:

Code	Buttons displayed
0	OK (the default)
1	OK and Cancel
2	Abort, Retry, and Ignore
3	Yes, No, and Cancel
4	Yes and No
5	Retry and Cancel

You can experiment with these and check the online help for other MsgBox options.

For example, this program:

```
Dim intButton As Integer
intButton = MsgBox("This is the message", 3, "This is the title")
```

Produces this InputBox:

If there are multiple buttons on a message box, the programmer might also want to know which one the user clicked. The following table shows the values the MsgBox function can return:

The user clicked	Value returned
OK	1
Cancel	2
Abort	3
Retry	4
Ignore	5
Yes	6
No	7

Finally, we should note that the Show method of the Message Box class may be used as an alternative to the MsgBox function. For example, the following statement displays a Message Box with a greeting:

```
MessageBox.Show("Hiya kids, Hiya! Hiya!")
```

Like the MsgBox function, the Show method returns a value that can be tested later in the program to see which button the user had clicked on, for example:

```
Dim bob As Integer
bob = MessageBox.Show("Hiya kids, Hiya! Hiya!")
```

DEBUGGING

To debug a program, user has to start with a problem, isolate the source code of the problem, and then fix it. A user of a program must know how to fix the problem as knowledge about problem analysis is expected. When the bug is fixed, then the software is ready to use. Debugging tools (called debuggers) are used to identify coding errors at various development stages. They are used to reproduce the conditions in which error has occurred, then examine the program state at that time and locate the cause. Programmers can trace the program execution step-by-step by evaluating the value of variables and stop the execution wherever required to get the value of variables or reset the program variables. Some programming language packages provide a debugger for checking the code for errors while it is being written at run time.

Here's the debugging process:

1. Reproduce the problem.
2. Describe the bug. Try to get as much input from the user to get the exact reason.
3. Capture the program snapshot when the bug appears. Try to get all the variable values and states of the program at that time.
4. Analyse the snapshot based on the state and action. Based on that try to find the cause of the bug.
5. Fix the existing bug, but also check that any new bug does not occur.

DESIGNING ADVANCED FINANCIAL MODELS USING VISUAL BASIC APPLICATION USER FORMS

Automation is the buzz word in today's corporate world. Whether it is manufacturing industry or the service industry, all businesses are aiming to reduce the human element for critical processes and tasks to improve efficiency and output. As a finance aspirant, you will see this trend in finance companies as well. Calculators are replaced by laptops, ledgers are replaced by spreadsheets and hard bound documented financial models are replaced by dashboards. If you want to pursue a career in finance, it is of utmost important for you to know the latest trends in your domain, and more importantly how to use automation in your day to day activities as a finance professional. In this article, I will tell you about financial modeling using advanced functions like VBA (Visual Basic Application) in excel.

Advantages of Financial Modeling using VBA

1. Excellent output with minimum input

You must have used Excel at some point in your student life. But how much do you actually know about the power of Excel? Excel comes with the most astonishing tools when it comes to financial modeling. Explore the options in order to fully utilize the potential offering in excel. There are so many commands and functions which, not many people know, but are embedded in Excel and can yield excellent results if utilized properly.

2. Speedy operations

One of the biggest advantages of using excel and VBA in financial modeling is the speed at which your data set is processed. Once the logic is defined and variables are set, all you have to do is feed in the required data in the variables' cells and with the click of a button you can arrive at data points which otherwise are very time consuming to arrive at.

3. Accuracy

If you input the correct data, and maintain a sound logic in designing your algorithms, there is no way on earth you can get wrong analysis output. Humans are bound to make mistakes, but Excel doesn't have that flaw. And accuracy is of utmost importance while analyzing large sets of data, especially when the numbers (input or output) represent a huge sum of money.

4. Ease of comprehension

Excel enables you to represent your data in a visually appealing as well as easy to understand way. There are many chart options that help you in representing analysis in a very simplified manner. Features like trend lines, bubble charts, pie-in-pie charts and 3D charts are very useful and save a lot of comprehension time on the part of stakeholders and decision makers.

How to Create a Financial Model Using Excel and VBA?

According to me, the key to creating a good financial model is having a systematic approach. Before even starting on creating a model, take a minute out and systematically design a broad structure of your model on a piece of paper. It will immensely help you in the actual creation of your model. Following are the seven steps you should follow while creating a financial model using excel and VBA:

1. Define the problem

The first step here should be establishing the need behind creating a financial model. Try to ask yourself this question – "what problem statement does this model aim to address?''. Depending on the answer, you will be able to determine what all insights you need from the model. I sincerely suggest that please discuss this with as many stake holders of the model as possible. It will give you clarity and the third person perspective.

2. Structure the logic

You should know that VBA is nothing but a programming language that enables logic and a defined outcome using a string of characters. This is the most time consuming part of creating a financial model using VBA in excel. Please be very careful while structuring the logic and syntax, as even a small error on your part can lead to huge discrepancies in the model. You need not be an expert in VBA to do so, just stick to the basics and try to simplify the logic as much as possible.

3. Identify the input variables

This is one of the trickiest parts of financial modeling using Excel. There are variables – independent and dependent. Independent variables are usually the scattered numbers that you feed in without using any formulae. Their value or function doesn't change unless you manually change those numbers. While on the other hand dependent variables will vary depending on the independent variables. To give you a very simple example – if you want to calculate service tax of 10% that you pay in a restaurant, you will need a bill amount. That bill amount becomes the independent variable, whereas the tax that you would end up paying becomes the dependent variable as it depends on the bill amount. Make sure that the input variables are correctly entered into the spreadsheet and correct function is applied to arrive at the output.

4. Define the output

The output is the reason why you are making this model in the first place. Make sure that it gets calculated in the right manner and format the output cells appropriately. For example – if your output that you want is in percentage terms, and if the output cell is not formatted in the right manner, there is high probability that you might get misleading numbers. Let's say the output value is 10%, but if the cell is not formatted in percentage it might show the figure as 0.1.

5. Pilot run

After you have done the above mentioned things, try out the model with some dummy numbers. I suggest, use simple and smaller numbers to do this. Use multiples of hundreds or thousands for independent variables since it becomes easier for you to manually check the desired output. Another thing that you should keep in mind here is that do not use large sets of data initially. Start by using small data sets, which makes identifying bugs and errors easier when compared to large sets of data. If your model is very big, or in other words has a lot of formulae and algorithms, you can test run at every step and at regular intervals before running the pilot at the end of completion.

6. Record/document the model

Once you have done the pilot test of you model, the next step is to record all your logic, syntax, functions and formulae, preferably in a word document or notepad. Even better if you spend a little more time and prepare a process document with screen shots. It has two advantages – one – it would be easier for you or someone else to replicate a few common functions at a later stage for the same model or some other model that you might work on. And two, if there are any changes that are to be made at a later stage; you would exactly know where to do the edits. It would save a lot of time for you if you have it readily documented at some place rather than playing around with the model worksheet.

7. Monitor and update

Your work doesn't end with the completion of the model… You should ideally go back to the model every once in a while to look for bugs, redundancies and errors. It is highly unlikely that you would be able to come up with an excellent model at the first go. Keep on trying to simplify it and monitor the output at regular intervals. Here are a few things that you should keep in mind while you are working on a model in Excel. Apart from the functions and formulae that you will use, the following things will help you in smooth operations and ultimately a better and faster output:

1. Use of short cuts

Since we have established that speed carries a lot of importance, using keyboard short cuts will enable faster work and improved efficiency. There are short cuts right from opening up tool bars to creating formulae to running an entire macro. Please start using these short cuts at a very early stage, because with a little bit of practice you will know how much time and effort is saved by using those.

2. Using Excel Help

You cannot possibly know everything about Excel whatever your level of expertise is. Please do not shy away from using the inbuilt Help option in your excel. Everything you need to know about functions and formulae will be there. If the language and explanation there isn't enough for you, then you can always go online and look up for help. The point is, please make sure that you use this option, it will save up a lot of your time.

3. Conditional formatting

Use of various colors, fonts, sizes and signs can give a whole new look and feel to the dashboard of your financial model. It has been proved very helpful to the modelers around the globe to make their models user-friendly and efficient.

4. Nomenclature

Naming you columns and rows appropriately carries a lot of weight in financial modeling. Avoid using ambiguous titles. Be precise. It would be helpful for other people who might use this model without your presence.

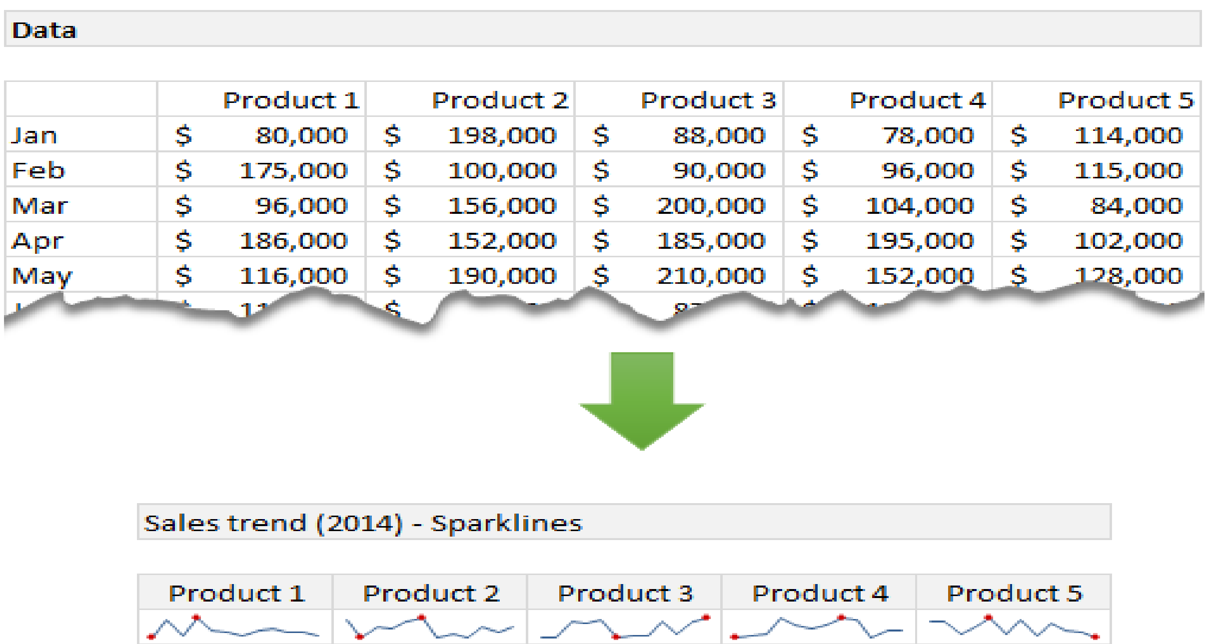
OTHER ADVANCED FEATURES

We all know that Excel is packed with tons of powerful features, libraries of formulas and galleries of interesting charts, making it one of the most useful tools for business analysts. I believe that, among the great secrets of Excel, there are several that are easy to use and quickly add value to your work. Let’s take a look at these features—what I like to call the low-hanging fruit— including Sparklines, Conditional Formatting, Slicers and a few simple but useful formulas you may not have noticed.

Sparklines:

Sparklines, first introduced in Excel 2010, are charts that provide simple visualization representations of trends across a row of your data—in a single worksheet cell. Sparklines offer excellent real-estate savings on crowded dashboard worksheets and can be extremely insightful for the amount of space used. This feature is unbelievably cool and ridiculously simple to use. And yet, not many analysts capitalize on these powerful tiny charts.

To create your own Sparklines, select the data range and on the ribbon click **Insert** and then select the **Sparklines**type—Line, Column or Win/Loss. Next enter the target range where you want the Sparkline displayed. That’s all there is to it.


Data

	Product 1	Product 2	Product 3	Product 4	Product 5
Jan	$ 80,000	$ 198,000	$ 88,000	$ 78,000	$ 114,000
Feb	$ 175,000	$ 100,000	$ 90,000	$ 96,000	$ 115,000
Mar	$ 96,000	$ 156,000	$ 200,000	$ 104,000	$ 84,000
Apr	$ 186,000	$ 152,000	$ 185,000	$ 195,000	$ 102,000
May	$ 116,000	$ 190,000	$ 210,000	$ 152,000	$ 128,000

Conditional Formatting:

The options available in the Conditional Formatting feature allow you to quickly create heat maps, turning a table of data into a continuous spectrum of colors for insightful visual analysis. This is a simple and effective way to explore your data and find interesting patterns.

Below is a heat map where the color scale option was applied in literally 10 seconds from the same sales data used in the Sparklines example above to illustrate the high (dark green) and low (white) sales data across products and time.

Sales trend (2014) - as heatmap

	Product 1	Product 2	Product 3	Product 4	Product 5
Jan	$ 80,000	$ 198,000	$ 88,000	$ 78,000	$ 114,000
Feb	$ 175,000	$ 100,000	$ 90,000	$ 96,000	$ 115,000
Mar	$ 96,000	$ 156,000	$ 200,000	$ 104,000	$ 84,000
Apr	$ 186,000	$ 152,000	$ 185,000	$ 195,000	$ 102,000
May	$ 116,000	$ 190,000	$ 210,000	$ 152,000	$ 128,000
Jun	$ 111,000	$ 210,000	$ 87,000	$ 130,000	$ 84,000
Jul	$ 96,000	$ 105,000	$ 108,000	$ 160,000	$ 120,000
Aug	$ 116,000	$ 125,000	$ 108,000	$ 204,000	$ 78,000
Sep	$ 132,000	$ 105,000	$ 204,000	$ 192,000	$ 111,000
Oct	$ 110,000	$ 160,000	$ 120,000	$ 80,000	$ 92,000
Nov	$ 110,000	$ 130,000	$ 204,000	$ 128,000	$ 90,000
Dec	$ 96,000	$ 160,000	$ 228,000	$ 124,000	$ 72,000
ALL	**$ 1,424,000**	**$ 1,791,000**	**$ 1,832,000**	**$ 1,643,000**	**$ 1,190,000**

To create a heat map using Conditional Formatting, select your raw data and then on the ribbon under **Home**, click **Conditional Formatting** > **Color Scales** and then pick a color scale. You can also adjust color scale options by editing the formatting rule.

SMALL and LARGE functions:

While everyone knows MAX and MIN functions, very few take advantage of LARGE and SMALL—functions that help you find the first, second or nth largest (or smallest) value in your data.

Using the same sales data from the examples above, the LARGE functions is able to quickly identify the top two products for each month of our data. See the example below; done with the help of INDEX and MATCH, two other super useful functions for analysis.

Sales Analysis - top 2 products per month

	1		2	
Jan	Product 2	$ 198,000	Product 5	$ 114,000
Feb	Product 1	$ 175,000	Product 5	$ 115,000
Mar	Product 3	$ 200,000	Product 2	$ 156,000
Apr	Product 4	$ 195,000	Product 1	$ 186,000
May	Product 3	$ 210,000	Product 2	$ 190,000
Jun	Product 2	$ 210,000	Product 4	$ 130,000
Jul	Product 4	$ 160,000	Product 5	$ 120,000
Aug	Product 4	$ 204,000	Product 2	$ 125,000
Sep	Product 3	$ 204,000	Product 4	$ 192,000
Oct	Product 2	$ 160,000	Product 3	$ 120,000
Nov	Product 3	$ 204,000	Product 2	$ 130,000
Dec	Product 3	$ 228,000	Product 2	$ 160,000
ALL	Product 3	$ 1,832,000	Product 2	$ 1,791,000

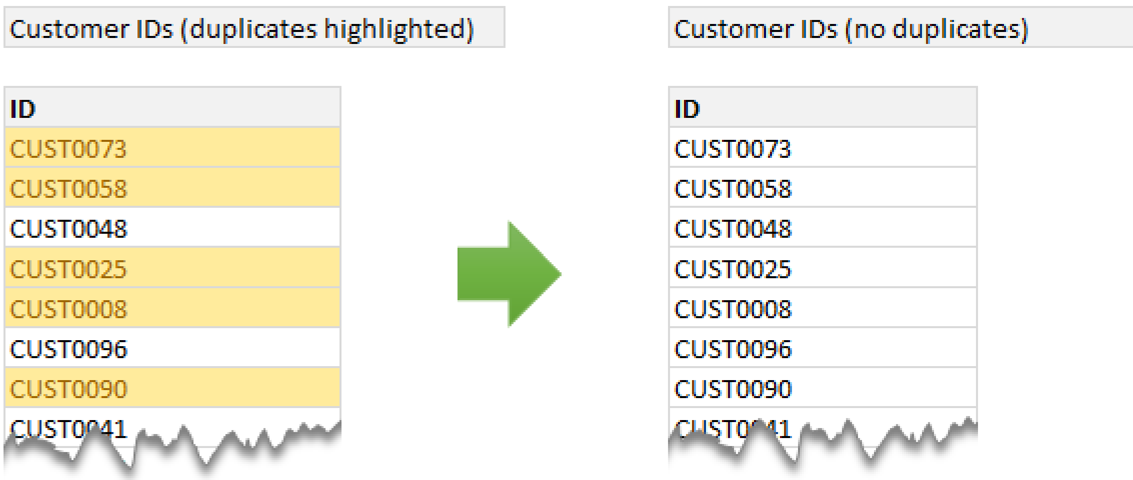
INDEX & MATCH formulas fetch product names

LARGE formula fetches first & second highest values

For more on these formulas, download this workbook: Powerful Excel features.

Remove Duplicates:

There are many constants in corporate life and cleaning and organizing data is one of them. Remove Duplicates, a feature introduced in Excel 2007, remains one of my favorites. It is very easy to use and solves an important problem we all face—duplicates in data.

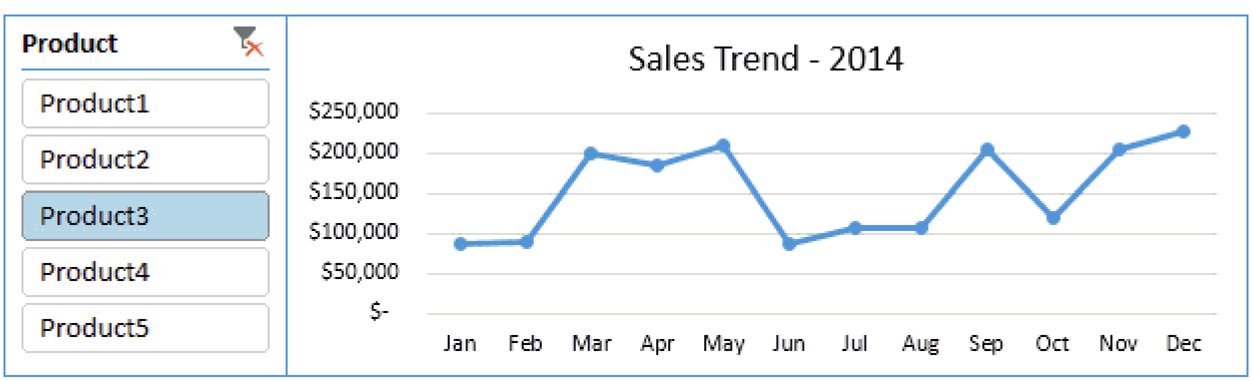


Just select the data and then on the ribbon under **Data**, click the **Remove Duplicates** button and watch Excel clean your data. It's that simple.

Slicers:

Think of Slicers as visual filters. They help you quickly narrow down to a subset of data and visualize it (either in a raw data format or through a connected chart). Slicers were introduced in Excel 2010 and became even better in Excel 2013.

For example, we can quickly create an interactive sales trend chart using slicers. When presenting sales data, we can now easily toggle between the different products using the same chart.



To add a slicer to your charts in Excel 2013, select the data range and on the ribbon click **Insert > Slicer**, then select the part of your data that you want to use as a filter. For the example above, we chose the Product column. Then you are done!

Objectives:

- Use MS-Access for data and conditional formatting
- Group, ungroup, and protect data
- Create, record, edit, and link macros
- Create procedures, functions, methods, and Excel objects
- reate Visual Basic application by adding controls and menus to the form
- Write program to handle errors and events
- Create, encrypt, and package a database
- Import and export data in MS-Access
- Perform synchronization and sharing of database

ACTUAL MODEL BUILDING

The Excel model building will review a step by step example of building a model from the ground up. The direction is still somewhat high level, but included a sample model that follows the prescribed guidelines. The model has already been built to completion, but it can be used to help you follow along and provide context for the high level steps referenced.

Step 1: Build Output Tabs Shell – Understand Your Requirements

Most people who've implemented software will tell you that the majority of errors occur during the requirements gathering phase of the project. (For those of you who haven't done an implementation, this is the phase of the project where you figure out what your software actually needs to do) Excel model building faces the exact same issue. Before you start building, you should figure out what outputs your model needs to generate. These requirements will greatly influence every subsequent step you take. For example, if you need to build multiple scenarios, you may need to leave space to input different scenario assumptions. If you need to conduct sensitivity analysis, then you may need to use Excel Data Table or build a sensitivity tornado chart.

Understanding your exact requirements first is not always possible, but you should always try to be as definitive as you can. The worst case scenario is investing several hours into building a model that can't generate the type of outputs you actually need.

In this adjusted snapshot of the sample model, you can see here that the requirements are to build a five your P&L forecast. In the model download, you'll note that I've also included a "Sales Revenue by City" report as an additional requirement.

Company P&L Forecast
all values in thousands

	2013	2014	2015	2016	2017	2018
	Actual	*Fcst*	*Fcst*	*Fcst*	*Fcst*	*Fcst*
Revenue	**$ 16,698.4**					
Nitro	$ 4,624.5					
Infinity	$ 5,278.8					
Durango	$ 6,795.1					
COGS	**$ 10,004.8**					
Nitro	$ 2,081.0					
Infinity	$ 3,167.3					
Durango	$ 4,756.5					
Gross Margin	**$ 6,693.5**					
SG&A	**$ 5,180.0**					
Salaries	$ 2,553.0					
Rent & Utilities	$ 1,346.0					

Step 2: Build Calculations on Paper – Determine Inputs Required

It's always tempting to jump right into Excel to start building your model immediately. But whenever you're dealing with a really complex model, it's always useful to step back with just a pen and paper to sketch out your intended plan. While not everyone uses this step, it can definitely help you gain perspective on your work and prevent you from missing critical ideas.

Step 3: Build Input Tabs and Gather the Required Values

Once you've sketched out your calculations, you should have a pretty good idea of what inputs you need to build your model. As mentioned in the tab structure post, you can have three kinds of inputs: drivers, static inputs, and data tables. As a best practice, you should try to ensure that all of your inputs are in as few tabs as possible, with the minor exception of breaking them up into different tabs between these three categories. This is critical because one of the biggest transparency complaints people have when dealing with second hand models is that they can't find out where they're supposed to input values.

On many occasions, you won't have the actual input value you need when you begin building your model. In this situation, it's best to input a dummy figure, or some rough historical average, so you can continue the model building process. Just make sure to add a notation so you remember to come back and update it.

The example below shows the Drivers tab within the sample model.

Drivers

	2013	2014	2015	2016	2017	2018
Total Annual Sales Growth		3.0%	3.0%	4.0%	4.0%	5.0%
Product Share Allocation						
Nitro	28%	30.0%	35.0%	40.0%	40.0%	50.0%
Infinity	32%	30.0%	25.0%	25.0%	25.0%	20.0%
Durango	41%	40.0%	40.0%	35.0%	35.0%	30.0%
Total	100%	100%	100%	100%	100%	100%
Annual COGS Changes						
Nitro		2.0%	3.0%	3.0%	3.0%	4.0%
Infinity		2.0%	2.0%	1.0%	1.0%	0.0%
Durango		-5.0%	-4.0%	-3.0%	-2.0%	-2.0%
SG&A Increases						
Salaries		2.0%				
Rent & Utilities		5.0%				
Legal & Insurance		3.0%				
Other		2.0%				

Step 4: Load Data Tables

Data tables represent a slightly more complex input than drivers or static inputs. As a general rule, any table that has more rows and / or columns that you can fit and view on your laptop screen deserves its own tab. Make sure that you use proper database formatting for these tables, as it is very possible that someone will take the table and load it into another file in the future.

In the sample model, we have a data table representing Total Product Sales by Territory in 2013.

Total Product Sales by Territory 2013

State	County	City	Product	Total Sales (K)
WA	King	Seattle	Nitro	$ 495.1
WA	Walla Walla	Walla Walla	Nitro	$ -
WA	King	Kirkland	Nitro	$ 524.0
WA	Grays Harbor	Aberdeen	Nitro	$ 513.7
NY	Monroe	Rochester	Nitro	$ 811.1
NY	Onondaga	Syracuse	Nitro	$ -
NY	Tompkins	Ithaca	Nitro	$ -
CA	San Joaquin	Stockton	Nitro	$ 669.3
CA	Los Angeles	Los Angeles	Nitro	$ 362.3
CA	San Mateo	Daly City	Nitro	$ 875.7
CA	Sacramento	Sacramento	Nitro	$ 373.3
WA	King	Seattle	Infinity	$ 940.2
WA	Walla Walla	Walla Walla	Infinity	$ 958.8
WA	King	Kirkland	Infinity	$ 487.9
WA	Grays Harbor	Aberdeen	Infinity	$ 561.4

Step 5: Build Calculations off of Inputs, Drivers, and Data Tables

At this point we've finished most of the setup tasks for model building and are ready to get into the heart of the exercise. Your knowledge of database theory and Excel formulas will definitely come in handy here. The calculation tabs are probably the least uniform aspect of Excel models. This is because, for any given goal, there are several ways to get to your solution. While it would be ideal to build your model in the most efficient way possible during your first try, this is rarely possible. The fact is good model building requires trial and error. Only by going through different iterations of your model can you create the best possible outcome.

One best practice to keep in mind is that you should try to do most of your calculations in your calculation tabs and not in your output tabs. While it can definitely be faster to do calculations in the output tabs, it may make it harder for someone to audit your file in the future. By keeping all calculations in a defined area, you'll significantly increase both the consistency and the transparency of your file. The major exception to this rule is if you're just doing a sum, count, or lookup. Since these formulas summarize your data, they are appropriate for the output section.

Step 6: Link Calculated values to Output Tabs and Finalize Formatting of Output Tabs

By now the data you've run your calculations and should be very close to the exact values you need in your output tabs. You may still need to use some summary formulas to arrange your data based on your initial requirements. Since the output tabs are primarily for display, take time to format these for printing and apply Visual Design techniques. Additionally, make them as transparent as possibly by including sources, unit values, and any other beneficial documentation.

Step 7: Build Your Index Tab

At this point, you should have the majority of your tabs in place for your model. Building your Index Tab will significantly help summarize the scope and functionality of your model. Make sure that every tab you've created is documented and described. If you realize that any tabs are unnecessary, remove them. You will probably need to update this tab periodically if any aspect of your model changes.

An example below of the Index Tab for the sample model.

MBA Excel Sample Model v1.0

Tab Index

Tab Name	Description
Drivers	Key Variables used to generate forecast and conduct both Sensitivity a
Static Inputs	Historical inputs and static assumptions such as Interest rate and Taxes
Sales Database	Data Table showing all company sales revenue by Product, City, Count
Calculation	Performs key calculations to feed into the P&L
P&L	Five Year Forecast of the Company's P&L
City	Company Revenue by City in 2013

Color Keys

Tabs	Cells
Input Tab	Input Cell
Input Tab	Washington
Data Tab	California
Calculation Tab	New York
Output Tab	Pulled Value

Step 8: Link Key Output Values to Drivers Tab to Perform Scenario and Sensitivity Analysis

As you get towards the end of the model building process, it's very likely that you'll want to conduct some form of scenario or sensitivity analysis. To prepare for this step, you should determine what output values are the most important to your analysis and link them back to your drivers tab. The process for doing so is relatively simple and shouldn't take much more than using the equals sign to write a simple linking formula. Additionally, you'll obviously need to understand which of your drivers are most likely to change and have a reasonable range of possible values for these variables. These factors will be completely dependent on the specific type of model you are building. Another potential option for sensitivity analysis is to use Excel's Watch Window feature. While this is a great tool for sensitivity specifically, linking your output values to the drivers tab is the best way to create defined scenarios.

SG&A Increases	
Salaries	2.0%
Rent & Utilities	5.0%
Legal & Insurance	3.0%
Other	2.0%

Output KPIs

	2014	2015	2016	2017	2018
Revenue	$ 17,199.3	$ 17,715.3	$ 18,423.9	$ 19,160.9	$ 20,118.9
COGS	$ 10,096.0	$ 10,398.9	$ 10,667.4	$ 11,161.2	$ 11,447.7
Net Income	$ 977.7	$ 1,174.0	$ 1,233.3	$ 1,446.2	$ 1,531.8

Step 9: Create Documentation and Finish Index Tab

As mentioned before, few Excel models ever have adequate documentation. This additional step adds to your workload and no one really enjoys doing it. However, having documentation can make a huge difference to whomever you might hand your off work to. I like to think of documentation as an insurance policy; put in a little work now, and you'll significantly reduce the need to answer questions in the future. You'll also be much less likely to forget your own methodology if you ever need to come back to your file.
Documentation doesn't have to be a long winded user guide that takes several hours to write. It can take the form of comment boxes in cells, notes in formulas, or just a separate tab in the Excel document explaining your assumptions. All of these things further the transparency of your model and should be included if possible.

For the sample model, included the documentation as a linked web page, in case it needs to be updated in the future.

Step 10: Add Cell & Workbook Protection Where Appropriate

This last step is important if you plan to either widely distribute your file or solicit inputs from your colleagues. This is especially important in the latter scenario because before you save a new version of your file, you want cell protection in areas that should not be adjusted as well as a clear understanding of what sections your colleagues had the ability to change. The process of protecting your file is fairly simple: you just need to choose which cells will be editable by other users and then assign a password to your workbook.

You'll notice in the sample model, I've protected the Index Tab where the link to the documentation exists. That way, it reduces the likelihood that this sample model will be sent out without the accompanying documentation.

----oooOooo---