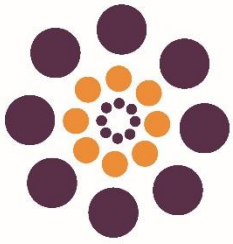
Financial Modelling in Excel (Intermediate)

Online Course Notes

Module 3 of 6

"Essential Formulas"



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MODULE THREE: Essential Formulas

Module Three consists of 5 videos:

1. Aggregation Functions
2. LOOKUP Fundamentals
3. Practical Capital Budgeting with LOOKUP functions
4. Using FORECAST / TREND functions
5. Formula Selection

Log into your online course and download the Excel templates on each video page. Follow along with the video demonstration, and save your model. Note that the Excel models in Module Two are not required uploads for this course, however, you are welcome to submit them if you'd like us to check that you're on the right track.

Video 3.1: Aggregation Functions

Recommended Reading: See the section on "Aggregation Functions" in Chapter 6, page 130 of Using Excel for Business Analysis. Below is an extract from this chapter:

Aggregation functions such as COUNTIF and SUMIF are very handy functions to know for modelling. They add or count ranges of data, and count amongst some of my favourite, most frequently used functions. Although we don't need them for our model in our business case, you may also like to check out SUMIFS and COUNTIF if you need to handle multiple criteria. If you have a copy of "Using Excel for Business Analysis, the instructions for these other functions are on page 133.

COUNTIF

COUNTIF is used to count the cells that match specified criteria.

Background: For example, let's say you have sold $6,160 worth of different products on a particular day, as shown below:

C14 =SUM(C2:C13)

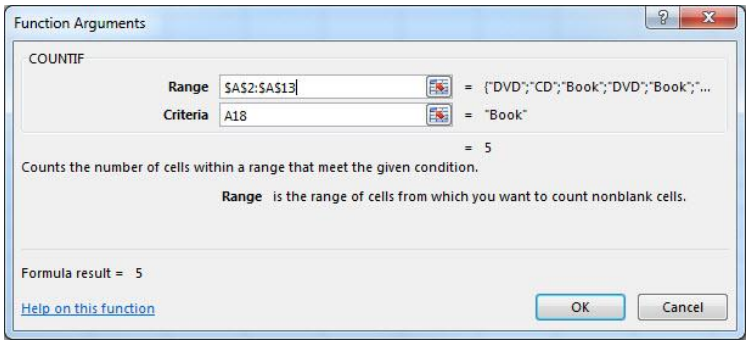
	A	B	C	D	E	F
1	**Product**	**Customer**	**Sales $**			
2	DVD	Lim	$410			
3	CD	Jenny	$810			
4	Book	Faisal	$220			
5	DVD	Peter	$350			
6	Book	Lim	$530			
7	Book	Jenny	$660			
8	DVD	Faisal	$620			
9	Book	Peter	$560			
10	Book	Lim	$460			
11	CD	Jenny	$950			
12	DVD	Faisal	$310			
13	DVD	Peter	$280			
14	**Total**		$6,160			
15						
16						
17	**Summary**	**Count #**	**Sales $**			
18	Book					
19	CD					
20	DVD					
21	**Total**					
22						

Sales List

You'd like to know how many (in terms of number of products) you've sold of each product: books, CDs, and DVDs.

1. In cell **B18**, use the Formula Wizard and find the COUNTIF function. (Simply begin typing **=COUNTIF(**and then Control+A, or hit the fx symbol next to the formula bar)

2. Highlight the product names in column B for the range, and the word “Book” in cell **A18** for the critieria. Do not type in the word “Book”! It needs to be linked to the input cell so that we can then copy down the formula.
3. Your function wizard box should look like this:



COUNTIF Function Wizard Dialog Box

4. Press OK. The answer is 4. Your formula should look like: =**COUNTIF(A2:A13,A18)**.
5. Change your formula to use absolute referencing as follows: =**COUNTIF($A$2:$A$13,A18)** and copy the formula down the range. You don't want absolute referencing on the criteria, because it needs to change its row references to **CD** and **DVD** as you copy down the formula.

(As a shortcut, highlighting B2:B13 in the formula bar and pressing F4 (Command+T in Excel for Mac 2011) will set absolute references **$B$2:$B$13**. Remember that each time you press F4 (or Command+T in Excel for Mac 2011) it will scroll through the various absolute, relative or mixed cell referencing options.

6. Copy the formula down, and add a total at the bottom. Your sheet should now look something like this:

B18 =COUNTIF($A$2:$A$13,A18)

	A	B	C	D	E	F	G
1	**Product**	**Customer**	**Sales $**				
2	DVD	Lim	$410				
3	CD	Jenny	$810				
4	Book	Faisal	$220				
5	DVD	Peter	$350				
6	Book	Lim	$530				
7	Book	Jenny	$660				
8	DVD	Faisal	$620				
9	Book	Peter	$560				
10	Book	Lim	$460				
11	CD	Jenny	$950				
12	DVD	Faisal	$310				
13	DVD	Peter	$280				
14	**Total**		**$6,160**				
15							
16							
17	**Summary**	**Count #**	**Sales $**				
18	Book	5					
19	CD	2					
20	DVD	5					
21	**Total**	**12**					
22							

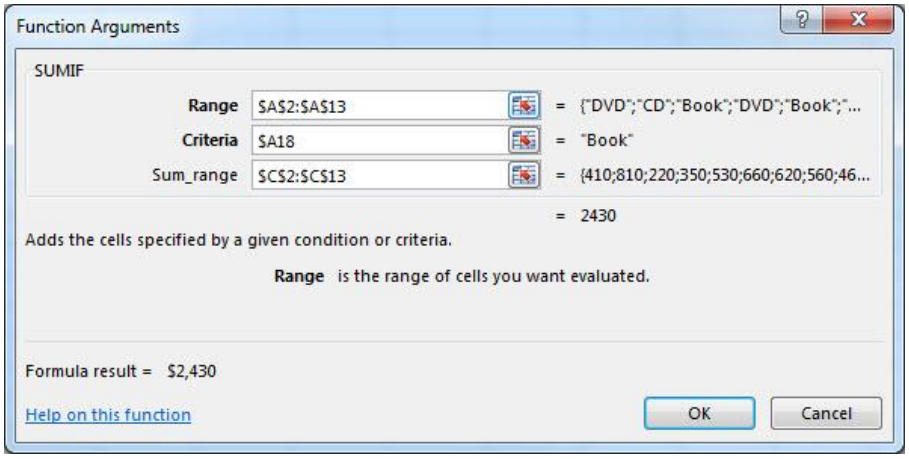
Completed COUNTIF Function

SUMIF

SUMIF is similar to COUNTIF but it sums rather than counts the values of cells in a range that meet a given criteria. SUMIF can be used in place of a PivotTable, and doing so is preferable as it uses less memory, and (most importantly) because SUMIF formulas are live links. PivotTables do not update automatically, which can cause errors in models if not refreshed correctly. Therefore, although quicker to build, PivotTables are sometimes avoided in favour of a SUMIF function in financial modelling.

Background: Let's say that you'd like to know how much (in terms of dollar value) you've sold of each product: books, CDs, and DVDs.

1. Select cell C18. Find the SUMIF wizard or start typing =**SUMIF(**. Because there are several fields required for this function, I'd recommend you use the wizard, as it's easier to find your way through the function.
2. The items you are adding together go in the Range field, the criteria you are looking for in that range goes in the Criteria field, and the numbers you want to sum together go in the Sum_range field.
3. Your wizard should look like this:



SUMIF Function Wizard Dialog Box

4. Press OK. The answer is 1,870. Your formula should be: **=SUMIF(A2:A13,A18,C2:C13)**
5. Add in the absolute referencing, and copy the formula down the range. Your formula should be **=SUMIF($A$2:$A$13,$A18,$C$2:$C$13).** You don't need absolute referencing on the criteria (A18), because it needs to change its reference as you copy down the formula.
6. Add a total. Your sheet should now look like this:

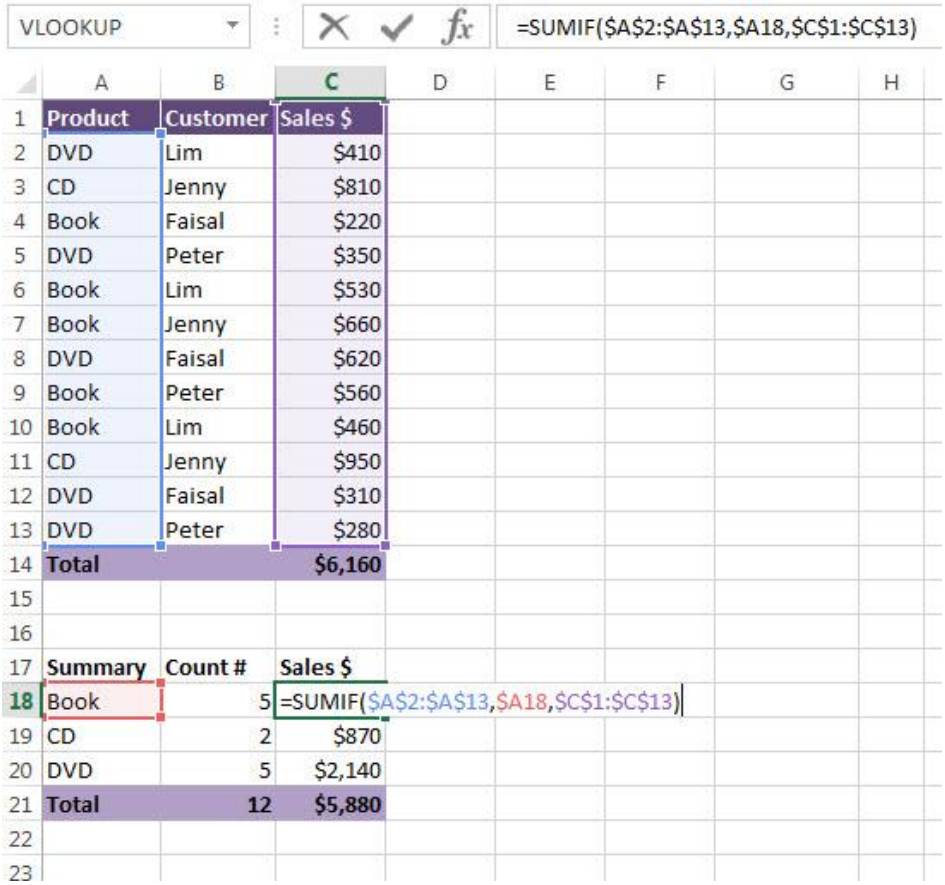
C18 | =SUMIF($A$2:$A$13,$A18,$C$2:$C$13)

	A	B	C	D	E	F	G	H
1	**Product**	**Customer**	**Sales $**					
2	DVD	Lim	$410					
3	CD	Jenny	$810					
4	Book	Faisal	$220					
5	DVD	Peter	$350					
6	Book	Lim	$530					
7	Book	Jenny	$660					
8	DVD	Faisal	$620					
9	Book	Peter	$560					
10	Book	Lim	$460					
11	CD	Jenny	$950					
12	DVD	Faisal	$310					
13	DVD	Peter	$280					
14	**Total**		**$6,160**					
15								
16								
17	**Summary**	**Count #**	**Sales $**					
18	Book	5	$2,430					
19	CD	2	$1,760					
20	DVD	5	$1,970					
21	**Total**	**12**	**$6,160**					

Completed SUMIF Function

We've now got a summary report at the bottom, showing us how much we have sold in terms of number and dollar value.

Be careful: If your Range and your Sum_range don't match up, your result will be wrong. For example **=SUMIF($A$2:$A$10,A18,$C$1:$C$13)** will give you an incorrect result without warning! This is a very easy mistake to make, and quite common in financial modelling. You can see in Figure 6.6 that the totals are not the same because the SUMIF function is picking up the incorrect range. This is the same for COUNTIF functions, but it is not a problem with the SUMIFS, as the formula will return an error and therefore you will notice the error straightaway, unlike the SUMIF function.



	A	B	C	D	E	F	G	H
1	**Product**	**Customer**	**Sales $**					
2	DVD	Lim	$410					
3	CD	Jenny	$810					
4	Book	Faisal	$220					
5	DVD	Peter	$350					
6	Book	Lim	$530					
7	Book	Jenny	$660					
8	DVD	Faisal	$620					
9	Book	Peter	$560					
10	Book	Lim	$460					
11	CD	Jenny	$950					
12	DVD	Faisal	$310					
13	DVD	Peter	$280					
14	**Total**		**$6,160**					
15								
16								
17	**Summary**	**Count #**	**Sales $**					
18	Book	5	=SUMIF($A$2:$A$13,$A18,$C$1:$C$13)					
19	CD	2	$870					
20	DVD	5	$2,140					
21	**Total**	**12**	**$5,880**					
22								
23								

Incorrect SUMIF Calculation

> ***TIP:*** *We can see that there is an error because the totals in rows 11 and 21 are not matching, but you might like to make this more obvious by adding an error check below the summary in cell C22 to pick up errors such as this. This can be done using a simple minus or equals formula, or see the section on "Building Error Checks" in Chapter 4 for more detail on how to create an error check.*

Video 3.1: LOOKUP Fundamentals

Recommended Reading:
- See the section on "LOOKUP Formulas" in Chapter 6, page 127 of Using Excel for Business Analysis. Below is an extract from this chapter:
- Also see the blog article on Which LOOKUP?

LOOKUP functions are very often used in financial modelling and analysis—sometimes a little too often in my opinion. They are useful to know, but sometimes another function would create a more robust solution.

VLOOKUP stands for Vertical Lookup. It can be used anytime you have a list of data with the key field in the leftmost column, and it is by far the most commonly used form of LOOKUP formula.

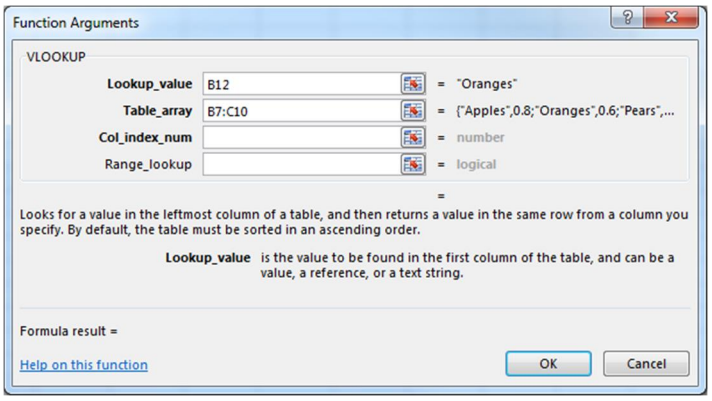
Open up the accompanying Excel file "LOOKUPs".

Background: Let's say you have a shopping price list as shown. In cell **C12**, we'd like to find out how much it will cost to buy four oranges, using a VLOOKUP.

How to Create a VLOOKUP

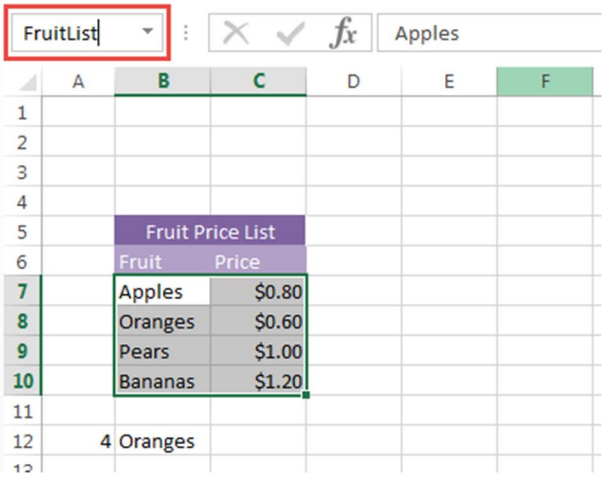
The following is a step-by-step process for creating a VLOOKUP.

1. Find and select the VLOOKUP function. Using the wizard is probably going to be the easiest for VLOOKUPs, as there are four parameters it needs.
2. The first parameter is the criteria we are testing, in this case the word Oranges, so enter B12 in the first field.
3. The next parameter is the table, which contains the data you want to reference. This is where it gets tricky. The criteria you are looking for must always be in the far left-hand column of the data table you are referencing in the table array. So, in this case, the data we are referencing will be the range **B7:C10**. Here is what your wizard should look like so far:



VLOOKUP Dialog Box

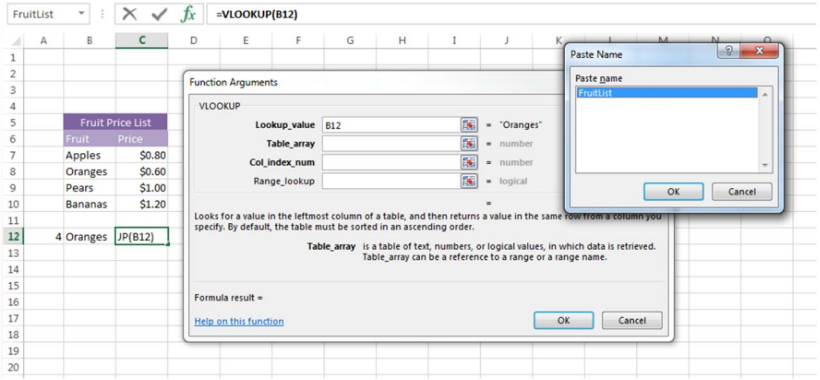
4. Now, if you were going to copy this formula down the page, you would have to use absolute referencing for the table array, or use a named range. Let's create a named range here.
5. Press Escape to cancel out of the wizard and create a named range for the whole table. Highlight the range **B3:C6** and type over the name box in the top left-hand corner of your screen with the word **FruitList**, and press Enter. We can now use this in the VLOOKUP. Now that we have used a named range, we won't have to worry about absolute referencing in our VLOOKUP formula. See below:



Creating a Named Range

6. Go back into the VLOOKUP wizard again, re-reference the lookup value to B8, and either select the table array in the second field box, or simply type in **FruitList**. Make sure you have spelt it the same way as your named range! If you can't remember what you called it, use the F3 shortcut as shown below.

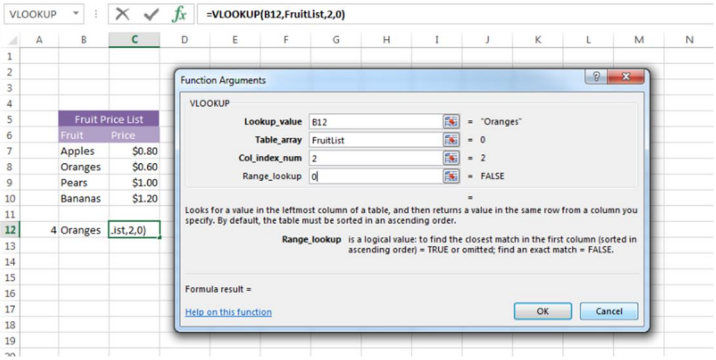
TIP: *When referencing a named range in a formula, you can also use the F3 paste name shortcut to bring up a list of all named ranges in the model.*



Using the F3 shortcut to Paste Name in a VLOOKUP

7. The third field called Col_index_num tells Excel in which column the value is found. We need to tell the function which column in the table array we want it to return. In this case, we want it to tell us the price. So, counting from the far left- hand side of the table array (starting in column B), we want it to return the second column. So we enter a number 2 in the Col_index_num field.
8. The optional fourth parameter tells Excel if a close match is okay. If you want an exact match, enter zero; otherwise leave it blank. You may also enter TRUE or FALSE, but typing a zero or leaving it blank is quicker. Click OK to complete the formula.
9. The wizard should look like Figure 6.18 and the formula should now be =**VLOOKUP(B12,FruitList,2,0)** If you didn't use a named range (as shown in the video), your formula will be =**VLOOKUP(B12,B7:B10,2,0)**

There are very few instances where you want a close match. (See the section below on "Using a Close Match VLOOKUP"). In most VLOOKUPs, you want an exact match, so enter a zero in the last field.



Completed VLOOKUP Function

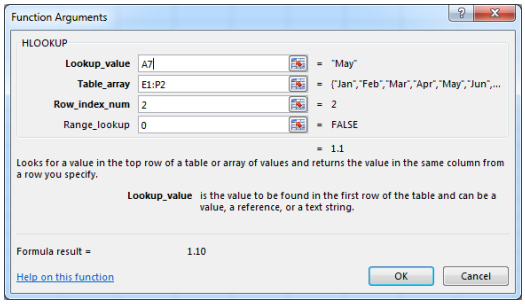
10. Now, try changing the word *oranges* to *apples*. The price should change.
11. Lastly, we need to multiply the price by the number of items we are purchasing. Change your formula to =**VLOOKUP(B12,FruitList,2,0)*A12** (or =**VLOOKUP(B12,B7:B10,2,0)*A12** if you didn't use a named range.)

HLOOKUP

An HLOOKUP works in a very similar way, except that it is orientated horizontally instead of vertically.

Background: In the example on your Excel file on the HLOOKUP sheet, we want to pick up the seasonality corresponding to the month shown in cell **A7**.

1. Go to cell **B7** and insert the HLOOKUP function wizard
2. Insert the ranges, and your function wizard dialog box should look like this:



HLOOKUP Function Wizard

3. Multiply the result by the sales amount, and you formula should be: **=HLOOKUP(A7,E1:P2,2,0)*B4**
4. Try changing the month in cell **A7** and watch your amount change.

Using a Close Match VLOOKUP

Background: Let's say you have a tiered pricing structure, as shown on the LOOKUP tab of your provided workbook.

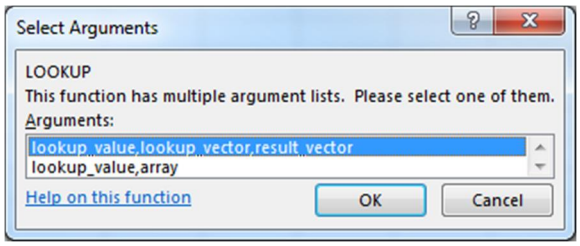
1. Add a VLOOKUP as you normally would, but instead of zero in the last field, add the value TRUE
2. Your formula should look like this: **=VLOOKUP(A3,E3:G7,3,TRUE)**
3. Try putting a zero in the last field, and you'll see the formula returns an error. Change it back again.
4. Multiply it by the number of items, and copy it down. Your formula in cell B3 should be: **VLOOKUP(A3,E3:G7,3,TRUE)*A3**

LOOKUP Function

An even better way of doing this would be to use a LOOKUP. The LOOKUP function is much simpler than either the VLOOKUP or the HLOOKUP, and it has the added advantage of being able to have the results column or row either to the left or the right of the criteria column or row—a huge advantage. However, the data *must* be sorted in alphabetical order or it won't work. This does limit its usage significantly, and it is for this reason that it is far less popular than the VLOOKUP or HLOOKUP formulas.

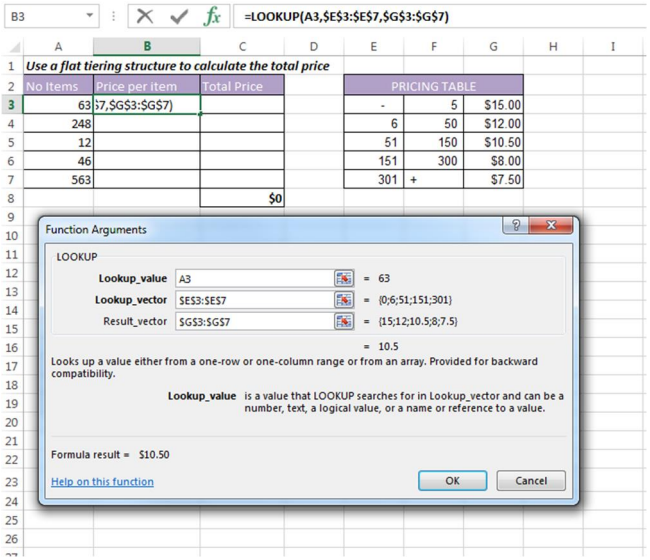
It's worth knowing how it works, though, so here's a brief example. Select LOOKUP from the Function Wizard

1. There are two types; choose the first option as shown here:



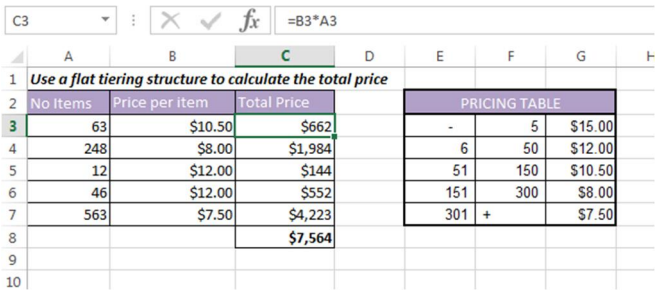
LOOKUP Function Option

2. Similar to an HLOOKUP or VLOOKUP, the criteria being tested goes in the first field.
3. The column (or row) containing the criteria goes in the second field, and then the column (or row) containing the result goes in the last field. See below:



LOOKUP Function Dialog Box

4. Copy the LOOKUP function down, and multiply the price by the total amount to complete the pricing table as shown below:



Completed Pricing Calculation

Note that this works exactly the same whether the data is shown vertically or horizontally. Importantly, unlike a VLOOKUP or HLOOKUP, it does not matter whether the result data is to the left or right, above or below the lookup data.

However, you would only use a LOOKUP for numerical values where the numbers are sorted and you want a close match, not an exact match. You would not use a LOOKUP function for text, as shown in the last fruit shopping list VLOOKUP example, because it will only return a close match, and this is dangerous. This makes the LOOKUP function almost useless in many cases where a lookup is required. The only time a modeller would use a LOOKUP is when they specifically want a close match. See the table below for the advantages of the different LOOKUP functions just described.

Advantages and Disadvantages of LOOKUP Functions

FUNCTION	Advantages	Disadvantages
VLOOKUP	• Data does not need to be sorted alphabetically as long as you use 0 or FALSE in the last field.	• The column number is hard-coded, so if a column is inserted, it can mess up the formula. (You can use a MATCH formula to fix this.) • The column containing the results *must* be to the right-hand side of the column containing the lookup criteria.
HLOOKUP	• Data does not need to be sorted alphabetically as long as you use 0 or FALSE in the last field.	• The row number is hard-coded, so if a row is inserted, it can mess up the formula. (You can use a MATCH formula to fix this.) • The row containing the results *must* be to the right-hand side of the row containing the lookup criteria.
LOOKUP	• The column/row number is not hard-coded. • It does not matter where the columns or rows are in relation to each other.	• Data *must* be sorted or it will give the wrong result.

Video 3.3: Practical Capital Budgeting with LOOKUP Functions

Background: In this example, we are going to create a five year repayment schedule from our capex budget. This example makes use of both exact match and close match LOOKUPs to get some practice in how to use these functions in financial models.

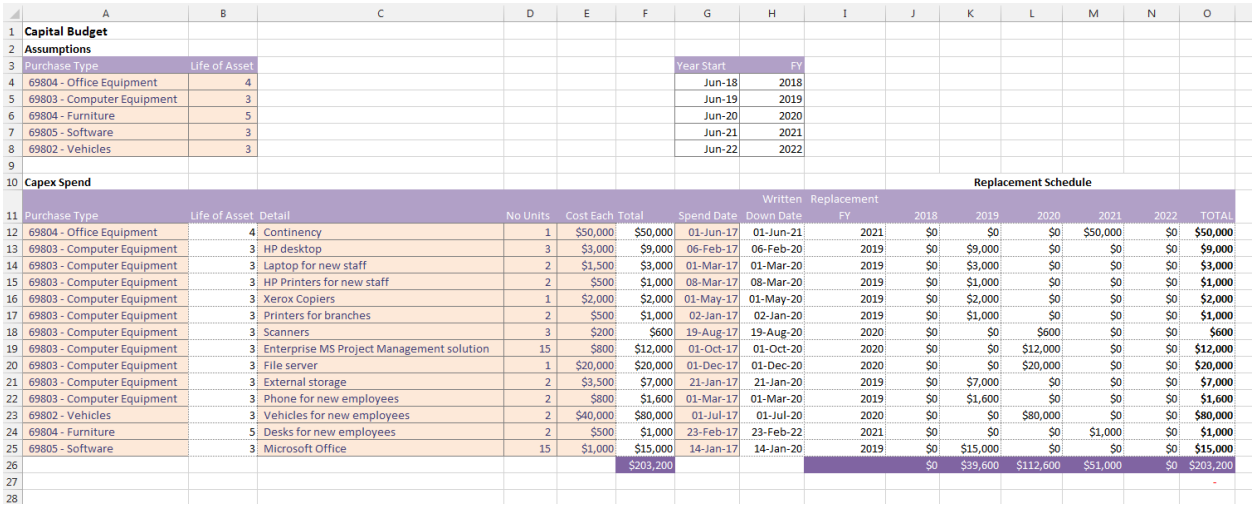
We're going to calculate exactly when the asset is going to come to the end of its useful life. Here are some instructions (with hints!) for how to approach this problem. Pause the video, and have a go at doing this on your own before you continue.

1. Open up the file "Practical Capital Budgeting" and go to the "Schedule" tab in your workbook as shown
2. In column B, we need to calculate the life of the asset based on the Asset Purchase Type and the asset table in the Assumptions section at the top. (Hint: Ordinary exact match VLOOKUP)
3. In column F we need to calculate the total cost based on the cost multiplied by the number of units purchased
4. In column H we need to show the written down date (the date at which the asset will be fully depreciated) based on the amount of time that has elapsed since the spend date (Hint: try out the EDATE function if you haven't used it before.)
5. In column I we now need to calculate which financial year this written down date falls into. We can do this using the financial years table in the Assumptions section at the top (Hint: use a close match VLOOKUP or a LOOKUP function)
6. In columns J to N we can then see if the date in the table matches the replacement financial year in column I. (Hint: use an IF statement)
7. Add your totals, and an error check to make sure that all the capex spend has been included in your replacement schedule.

Once you've had a chance to complete this model on your own, watch the video and walk through the following steps:

1. In cell **B12** your formula should be **=VLOOKUP(A12,$A$4:$B$8,2,0)**. Copy it down.
2. In cell **F12** your formula should be **=E12*D12**. Copy it down.
3. In cell **H12** your formula should be **=EDATE(G12,B12*12)**. Change the formatting to show the day as well as month if you prefer. Copy it down.
4. In cell **I12** your formula should be **=VLOOKUP(H12,$G$4:$H$8,2,TRUE).** Or a LOOKUP function will work just as well. Copy it down.
5. In cell **J12** your formula should be **=IF(J$11=$I12,$F12,0)**. Copy this across and down the block of **J12:N25**.
6. Add the totals in column O and in row 26
7. In cell **O27**, add an error check to make sure that all the spend has been included in the replacement schedule. Your formula should be **=O26-F26**.

8. Your completed model should look something like this:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Capital Budget**														
2	**Assumptions**														
3	Purchase Type	Life of Asset					Year Start	FY							
4	69804 - Office Equipment	4					Jun-18	2018							
5	69803 - Computer Equipment	3					Jun-19	2019							
6	69804 - Furniture	5					Jun-20	2020							
7	69805 - Software	3					Jun-21	2021							
8	69802 - Vehicles	3					Jun-22	2022							
9															
10	**Capex Spend**											**Replacement Schedule**			
11	Purchase Type	Life of Asset	Detail	No Units	Cost Each	Total	Spend Date	Written Down Date	Replacement FY	2018	2019	2020	2021	2022	TOTAL
12	69804 - Office Equipment	4	Continency	1	$50,000	$50,000	01-Jun-17	01-Jun-21	2021	$0	$0	$0	$50,000	$0	**$50,000**
13	69803 - Computer Equipment	3	HP desktop	3	$3,000	$9,000	06-Feb-17	06-Feb-20	2019	$0	$9,000	$0	$0	$0	**$9,000**
14	69803 - Computer Equipment	3	Laptop for new staff	2	$1,500	$3,000	01-Mar-17	01-Mar-20	2019	$0	$3,000	$0	$0	$0	**$3,000**
15	69803 - Computer Equipment	3	HP Printers for new staff	2	$500	$1,000	08-Mar-17	08-Mar-20	2019	$0	$1,000	$0	$0	$0	**$1,000**
16	69803 - Computer Equipment	3	Xerox Copiers	1	$2,000	$2,000	01-May-17	01-May-20	2019	$0	$2,000	$0	$0	$0	**$2,000**
17	69803 - Computer Equipment	3	Printers for branches	2	$500	$1,000	02-Jan-17	02-Jan-20	2019	$0	$1,000	$0	$0	$0	**$1,000**
18	69803 - Computer Equipment	3	Scanners	3	$200	$600	19-Aug-17	19-Aug-20	2020	$0	$0	$600	$0	$0	**$600**
19	69803 - Computer Equipment	3	Enterprise MS Project Management solution	15	$800	$12,000	01-Oct-17	01-Oct-20	2020	$0	$0	$12,000	$0	$0	**$12,000**
20	69803 - Computer Equipment	3	File server	1	$20,000	$20,000	01-Dec-17	01-Dec-20	2020	$0	$0	$20,000	$0	$0	**$20,000**
21	69803 - Computer Equipment	3	External storage	2	$3,500	$7,000	21-Jan-17	21-Jan-20	2019	$0	$7,000	$0	$0	$0	**$7,000**
22	69803 - Computer Equipment	3	Phone for new employees	2	$800	$1,600	01-Mar-17	01-Mar-20	2019	$0	$1,600	$0	$0	$0	**$1,600**
23	69802 - Vehicles	3	Vehicles for new employees	2	$40,000	$80,000	01-Jul-17	01-Jul-20	2020	$0	$0	$80,000	$0	$0	**$80,000**
24	69804 - Furniture	5	Desks for new employees	2	$500	$1,000	23-Feb-17	23-Feb-22	2021	$0	$0	$0	$1,000	$0	**$1,000**
25	69805 - Software	3	Microsoft Office	15	$1,000	$15,000	14-Jan-17	14-Jan-20	2019	$0	$15,000	$0	$0	$0	**$15,000**
26						$203,200				$0	$39,600	$112,600	$51,000	$0	$203,200
27															-
28															

Note, for this example you can find the completed version of this model by right-hand clicking on the tab and un-hiding the worksheet.

Video 3.4: Using FORECAST/TREND Functions

Recommended Reading: See the section on "Regression Analysis" in Chapter 6, page 161 of Using Excel for Business Analysis. Below is an extract from this chapter:

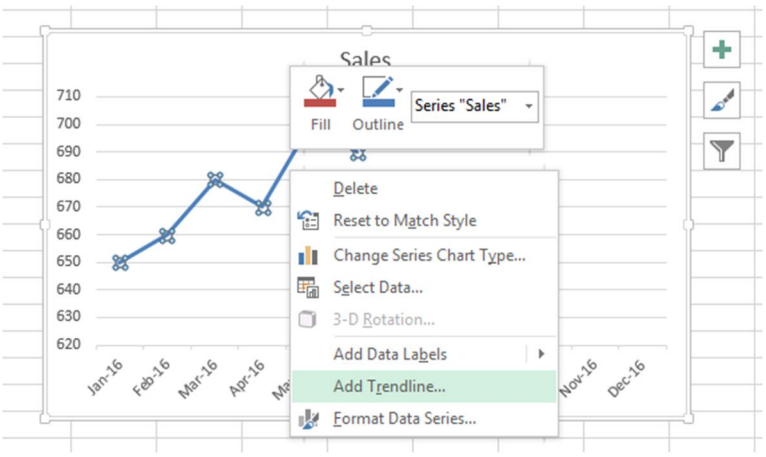
The FORECAST function in Excel predicts or forecasts data based on historical data, using the linear trend. These functions are a simple way of performing regression analysis in Excel, and are useful to include in forecasting models. The TREND function almost always gives the exact same result (but uses the least-squares method instead of the linear trend), so for our purposes, the two can be used interchangeably.

Select the FORECAST (or TREND) function from the Formula Wizard. Basically:

- X is the date or number for which you want the numbers to be forecast
- Known y's is the known historical data
- Known x's is the known historical dates or numbers

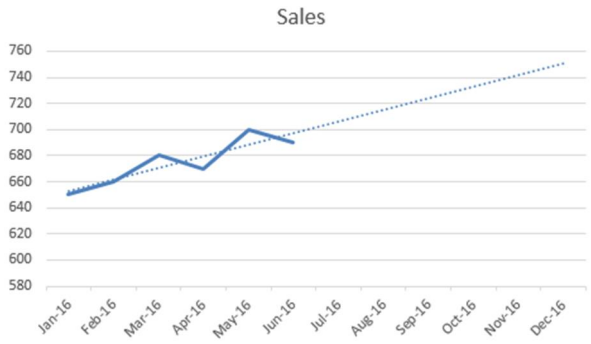
Background: Let's say, for example, that you have the following historical data available, and you need to provide a forecast for Jul-16, as shown on the "FORECAST" sheet.

If we were to quickly chart these numbers, we could add a linear trend line to visually see what we expect the forecast to look like. Create the chart by highlighting all the data, and then selecting the Line Chart from the Insert Tab on the Ribbon. To create the linear trend line, right-click on the series and select Add Trendline. See below:



Inserting a Linear Trend Line

We can see from the trajectory of the trend line that, based on historical data, the sales in July 2016 should be somewhere between 700 and 710. The formula tells us the slope, which is what the FORECAST function uses to calculate the projections. See below:



Linear Trend Line

This is exactly how the FORECAST formula calculates forecasts: It looks at the historical relationship between the X-axis and the Y-axis, and projects based on these numbers.

1. To create the FORECAST function, select cell **B8**
2. Bring up the =FORECAST Formula Wizard. The inputs for our formula fields will be:

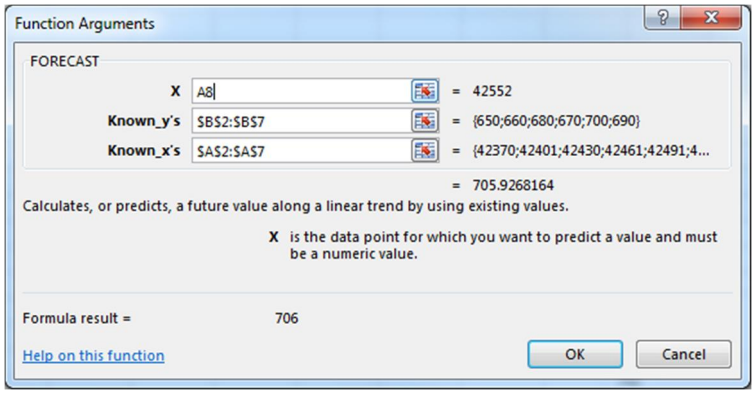
   • X: A8 (Jul-16) as the date for which we want to forecast.

   • Known_y's: **B2:B7** (650-690) as the historical data we know already.

   • Known_x's: **A2:A7** (Jan-16-Jun-16) as the corresponding years for the numbers we know already.

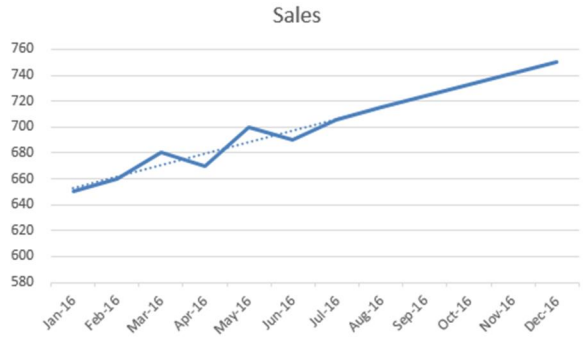
   TIP: *Be sure to use absolute referencing in the second two ranges of your FORECAST function. If you don't, then the forecast's original data range will move, making it less accurate over time.*

3. Your Formula Wizard should look something like the image below:



FORECAST Function Wizard

4. The forecast sales for Jul-16 is 706, and the line chart which you created earlier will show forecasted values which match the trend line exactly as shown below:

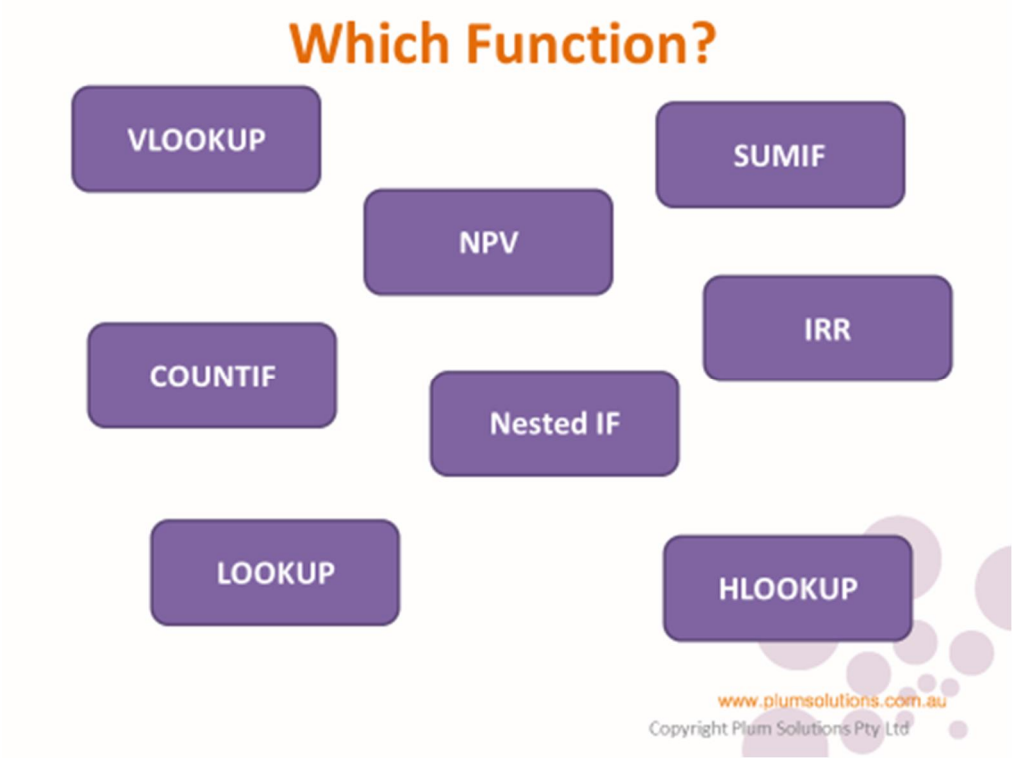


Completed Line Chart Showing Results of FORECAST

> ***Note:*** *If you were in a hurry, you could have simply highlighted the original data, and dragged it down, returning the exact same results as the FORECAST or TREND functions! However, this will hard-code the data, make it very difficult to audit, so using a function to forecast your data is much better financial modelling practice.*

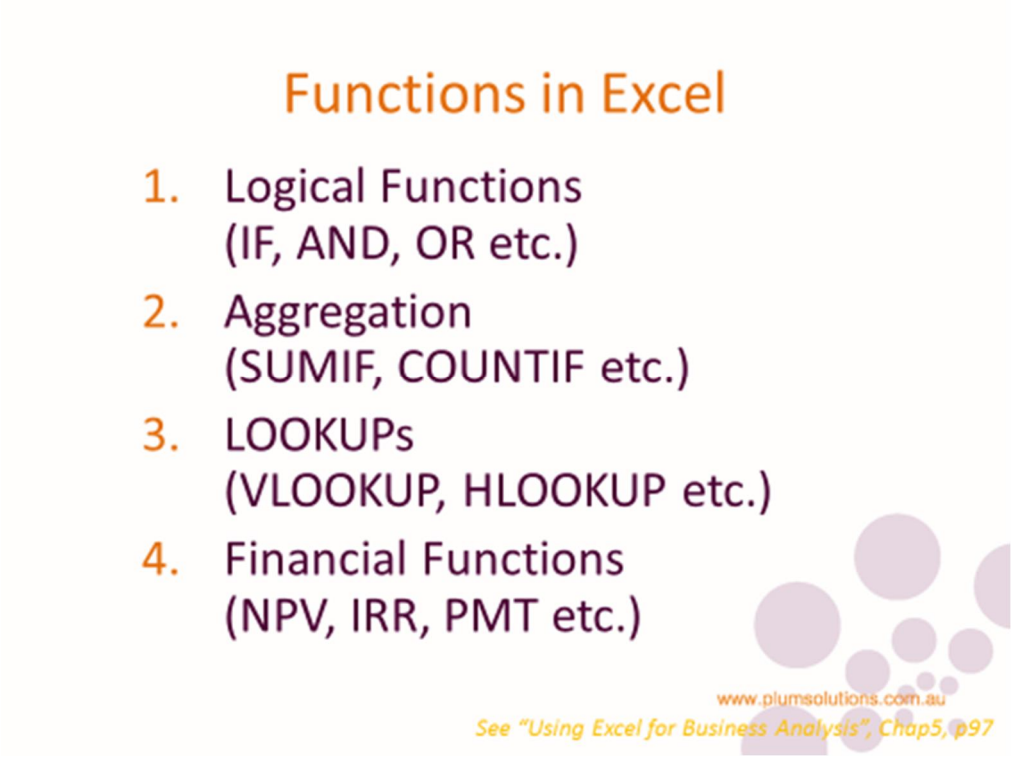
Video 3.5: Formula Selection

Recommended Reading: See the section on "Formulas and Functions in Excel" in Chapter 5, page 97 of Using Excel for Business Analysis. Below is an extract from this chapter:



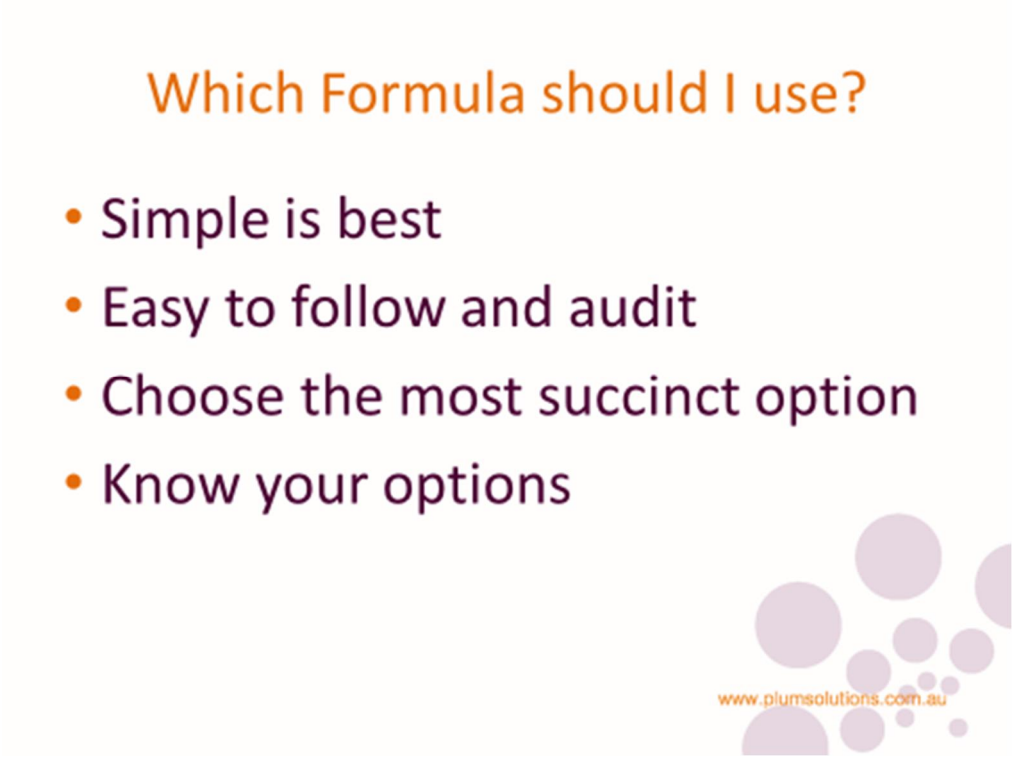
Because there are hundreds of functions in Excel, you should familiarise yourself with as many as possible, so that you know what is available. For use in business analysis, the most useful functions fall into the categories of logical, aggregation, lookup, and financial. The most commonly used functions in financial modelling are listed here:

1. **Logical** functions (IF, AND, etc.) are used when you need to evaluate a condition. For example: "Shall we include tax in our calculation?" If the user enters **yes**, the calculation will include the tax; if **no**, it is excluded.
2. **Aggregation** functions (SUMIF, COUNTIF, etc.) are helpful when there is a lot of data arranged either vertically or horizontally that must be added together.
3. **Lookup** functions (HLOOKUP, VLOOKUP, etc.) are used when you need to look up a value to return a single amount.
4. **Financial** functions (NPV, IRR, PMT, etc.) can usually be created manually using a long and complicated formula, but the pre-defined function in Excel saves time and makes it much easier to calculate commonly used financial calculations such as net present value, interest payments, or depreciation amounts.



There is a bit more to choosing the right function, however, than simply knowing lots and lots of functions in Excel. Choose the simplest formula to perform the task you need it to do. Choose one that is not overly complicated and don't try to do too much in one cell. If it starts getting difficult to decipher, consider breaking the formula into several parts.

As with most tools in financial modelling, you should choose the simplest option— not because you don't know how to do a more sophisticated function, but because you want to make the model as clear, simple, and transparent as possible. However, you still need to arm yourself with as many different functions as possible. The more you know, the more options you have available to you, and the more likely you are to find the best solution



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