

Lecture Note #18: Data Analysis Tools Part #1

BUSI 201: Business Data Analysis

Spring 2024

Topic 1. What-If Analysis: Scenarios

We will now examine some tools built into Excel that allows quick and simple data analysis. The basic three tools included in the What-If analysis in Excel are “scenarios,” “goal seek,” and “data table.” We will start off our discussion about the built-in tools by examining the use of scenarios. When you have a table or dataset that has some elements calculated using formulae for functions, and some manual inputs that determine those values, you may use the scenario manager to see “what would happen if some values had been different”?

	A	B	C	D	E	F	G	H	I
1									
2	Revenue, Cost, and Profit								
3	Unit Price	\$	200.00	→	Manual				
4	VAT		8%	→	Manual				
5	Quantity		1,500	→	Manual				
6	Total Revenue	\$	276,000.00	→	=C\$3*(1-\$C\$4)*\$C\$5				
7	Production Cost	\$	150.00	→	=IF(\$C\$5<=1500,150+150*\$C\$5-0.1*\$C\$5^2,\$C\$5*100)				
8	Marketing Cost	\$	50,000.00	→	=IF(\$C\$5>1000,50000,IF(\$C\$5<=1000,25000,0))				
9	Total Cost	\$	50,150.00	→	=C\$7+\$C\$8				
10	Profit	\$	225,850.00	→	=C\$6-C\$9				
11									

Figure 1: WHAT-IF

Navigate to worksheet WHAT-IF of the workbook BUSI201-LEC18-Workbook.xlsx to find a small table recording revenue and cost data from a hypothetical firm. As it stands now, each unit of the item this firm produces sells at \$200, and they sell 1,500 units, where the value added tax is set at 8%. The total revenue of this firm, production cost, advertising cost, and profit are all calculated using functions or some formula.

Observing the Effect of Changes in VAT

Suppose you are interested in checking out the effect of a change in the value added tax (VAT) on the firm's profit. Of course you may simply change the entry in cell C4 to whatever value you are interested in to check the changes in cell C10. However, altering existing data is rarely a good idea, especially when we have tools will achieve the goal without the need to do so.

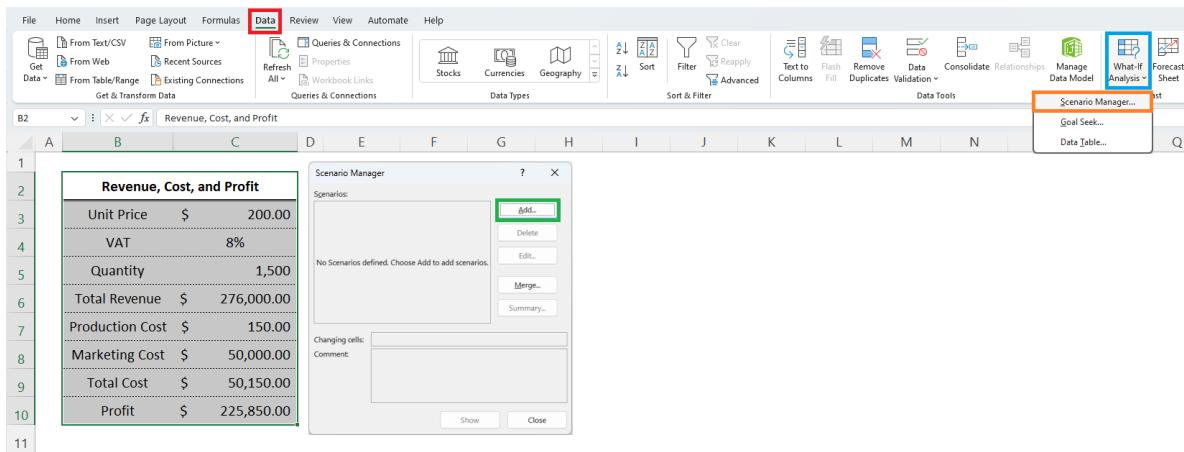


Figure 2: Initiating Scenario Manager

See Figure 2. Navigate to the **Data** tab, select the **What-If Analysis** tool, and from the drop-down menu select **Scenario Manager**. Note that we do not have any scenarios added at this point. Click on **Add** to add a new scenario. To see how to add a new scenario, refer to Figure 3.

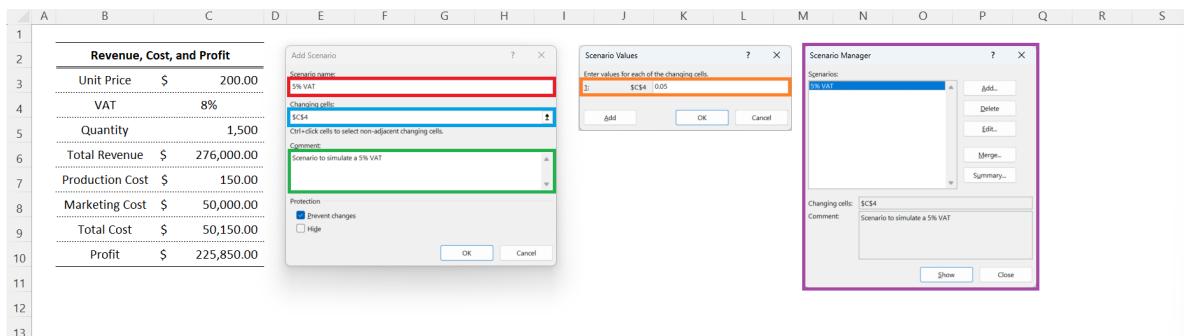


Figure 3: Setting Up a 5% VAT Scenario

Once you click **Add** in the scenario manager, you will see a new window titled **Add Scenario** as shown in Figure 3. In the **red box**, set a name for the scenario you will be setting up. In this example, we will be examining the profit when the VAT is lowered to 5% all else equal. So we name this scenario **5% VAT**. Next, in the **blue box**, choose the cell(s) that we will be changing. In this scenario, we will be changing the value of VAT, which is in cell C4. The **green box** is optional, but you may attach a more detailed explanation of the scenario, if it is sufficiently complex. Once you click **Ok**, you can set up the scenario you wish to simulate in the **orange box**, where we type in **0.05**. Clicking **Ok**, you will be brought back to the scenario manager in the **purple box**.

Add more scenarios, specifically, scenarios where the VAT is 8%, 11%, and 14%. Then the Scenario manager will resemble the one displayed in Figure 4. Selecting one of the scenarios we created in the red box, and clicking on **Show**, we can see the table itself changing to simulate the revenue, costs, and profit information.

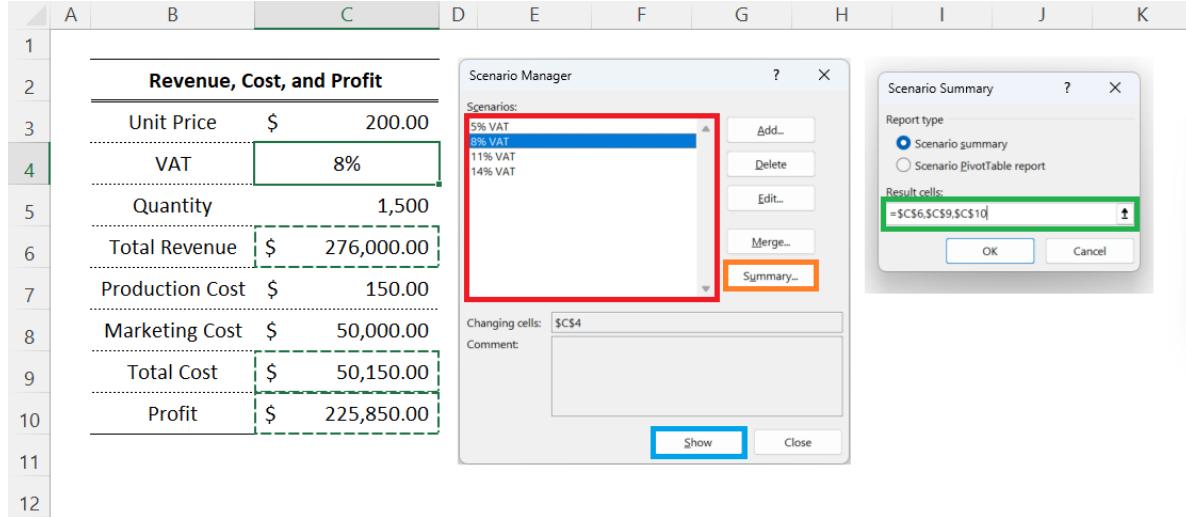


Figure 4: Scenario Manager with Multiple Rules

However, the more interesting option is to use the **Summary** option, which will generate a new worksheet with a summary of all existing scenarios. Suppose that we are interested in the relationship between VAT, total revenue, total cost, and profit. Then you can select the cells that hold the values of total revenue (C6), total cost (C9), and profit (C10), and select **Ok**.¹

The "Scenario Summary" worksheet contains the following data:

Scenario Summary						
Current Values:	5% VAT	8% VAT	11% VAT	14% VAT		
Changing Cells:	\$C\$4	8%	5%	8%	11%	
Result Cells:	\$C\$6 \$C\$9 \$C\$10	\$ 276,000.00 \$ 50,150.00 \$ 225,850.00	\$ 285,000.00 \$ 50,150.00 \$ 234,850.00	\$ 276,000.00 \$ 50,150.00 \$ 225,850.00	\$ 267,000.00 \$ 50,150.00 \$ 216,850.00	\$ 258,000.00 \$ 50,150.00 \$ 207,850.00

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.

Figure 5: Scenario Summary

This will automatically generate a new worksheet named **Scenario Summary**, which is shown in Figure 5. Each column represents the different scenarios we set up in the previous stage, and each row represents the variables of interest.

¹Hold down the **ctrl** key while left-clicking the three cells to select the three non-adjacent cells.

Naming Cells

One problem that may be evident while observing the scenario summary is that the changing and result cells don't have proper names. We as the creator of this table may understand each cell, but it is not clear to any other observer. We can give names to individual cells to avoid this issue. Select the cell that you want to name (in this example, the red box), and then enter an appropriate name in the orange box.²

The screenshot shows a Microsoft Excel spreadsheet titled "Revenue, Cost, and Profit". The table contains the following data:

	Unit Price	\$	200.00
	VAT		8%
	Quantity		1,500
6	Total Revenue	\$	276,000.00
7	Production Cost	\$	150.00

The cell containing "276,000.00" is highlighted with a red box. The formula bar at the top shows the formula `=C3*(1-C4)*C5`. The "Name Manager" dialog box is open in the ribbon, with the "Defined Names" tab selected. The "Name" column lists "Revenue" and the "Refers to" column shows the formula `=C3*(1-C4)*C5`.

Figure 6: Assigning Names to Cells

Then, repeat the process to create the scenario summary, and we get a table with the cell addresses being replaced with the names that we assigned as displayed in Figure 7. This table is much easier to read to the creator, and also clearly delivers information to a reader without access to the raw data.

A	B	C	D	E	F	G	H	I	
1	Scenario Summary								
2	Current Values: 5% VAT 8% VAT 11% VAT 14% VAT								
3	Changing Cells:								
4			VAT	8%	5%	8%	11%	14%	
5	Result Cells:								
6			Revenue	\$ 276,000.00	\$ 285,000.00	\$ 276,000.00	\$ 267,000.00	\$ 258,000.00	
7			Cost	\$ 50,150.00	\$ 50,150.00	\$ 50,150.00	\$ 50,150.00	\$ 50,150.00	
8			Profit	\$ 225,850.00	\$ 234,850.00	\$ 225,850.00	\$ 216,850.00	\$ 207,850.00	
9	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.								
10									
11									
12									
13									

Figure 7: Scenario Summary with Names

²If you made a mistake, or wish to edit or remove a name, select **Name Manager** under the Formula tab.

Checking Multiple Scenarios: Changing Quantity and VAT

We can also add another variable to the list of scenarios. Suppose you are interested what happens to revenue, cost, and profit when either VAT changes, or when the production quantity changes. Then, we can simply add more scenarios to the mix as shown in Figure 8.

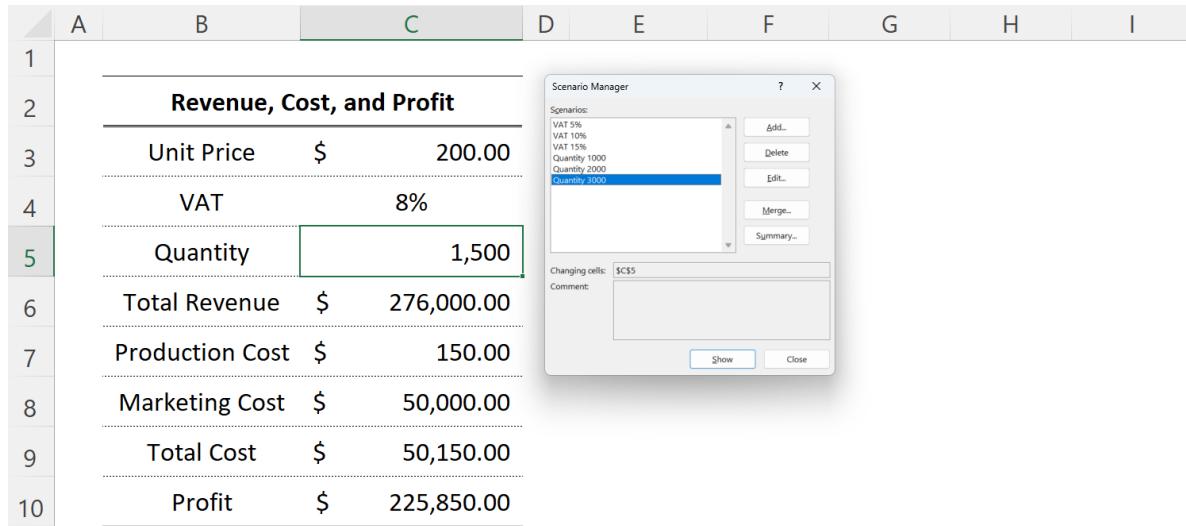


Figure 8: Adding More Scenarios

Creating a scenario summary table based on the scenarios listed above, we get the table shown in Figure 9. The “baseline” will always be the value that populated the table when the summary report was created. In our example, the default VAT was 8%, and default quantity was 1,500. This is why we first see the revenue, cost, and profit when VAT changes while quantity is 1500 in the **red box**, then see the results when quantity changes keeping VAT constant at 8% in the **blue box**.

A	B	C	D	E	F	G	H	I	J	K
Scenario Summary										
Current Values:		VAT 5%	VAT 10%	VAT 15%	Quantity 1000	Quantity 2000	Quantity 3000			
Changing Cells:										
VAT	8%	5%	10%	15%	8%	8%	8%			
Quantity	1,500	1,500	1,500	1,500	1,000	2,000	3,000			
Result Cells:										
Revenue	\$ 276,000.00	\$ 285,000.00	\$ 270,000.00	\$ 255,000.00	\$ 184,000.00	\$ 368,000.00	\$ 552,000.00			
Cost	\$ 50,150.00	\$ 50,150.00	\$ 50,150.00	\$ 50,150.00	\$ 75,150.00	\$ 250,000.00	\$ 350,000.00			
Profit	\$ 225,850.00	\$ 234,850.00	\$ 219,850.00	\$ 204,850.00	\$ 108,850.00	\$ 118,000.00	\$ 202,000.00			
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.										

Figure 9: Scenario Summary with VAT and Quantity

Checking Multiple Scenarios: Changing Quantity and VAT Simultaneously

What if we want to check scenarios not covered in the previous example? For instance, what is the firm's profit when VAT is 10% and quantity is 3,000? This is not provided in the previous table. In order to simulate this scenario, we must set up a slightly more complex scenario where two values are allowed to change at the same time. When we want to change two variables simultaneously, call up the Add Scenario window, and in the **red box**, fill in the cell addresses of all variables you wish to change. Then, the **Scenario Values** window will pop up with multiple variables. You can see the results in the **orange box**.

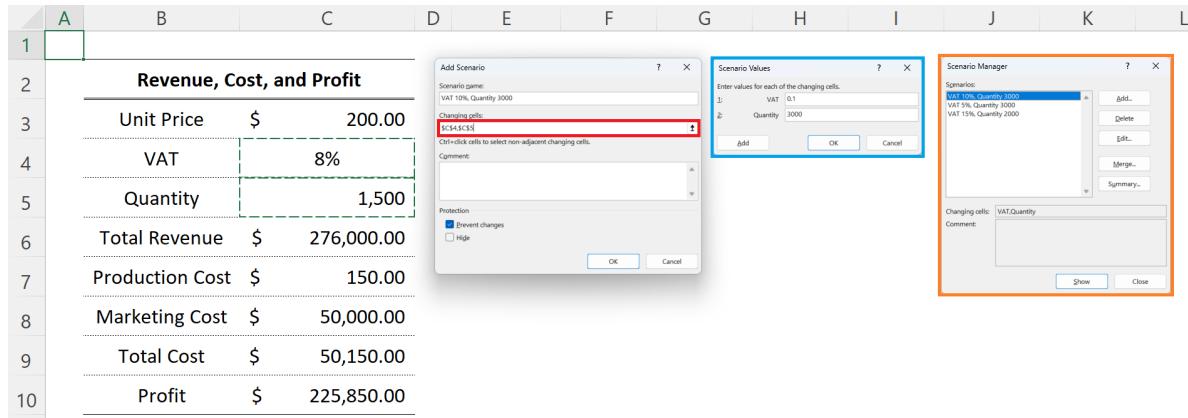


Figure 10: Adding More Scenarios

Creating the scenario summary table with the setup shown in Figure 10, we will get a table that resembles that shown in Figure 11. It takes a bit more time setting up the scenarios, but this will provide more flexibility compared to the previous example.

A	B	C	D	E	F	G	H							
1	Scenario Summary													
Current Values: VAT 10%, Quantity 3000 VAT 5%, Quantity 3000 VAT 15%, Quantity 2000														
Changing Cells:														
	VAT	8%		10%		5%	15%							
	Quantity	1,500		3,000		3,000	2,000							
Result Cells:														
	Revenue	\$ 276,000.00		\$ 540,000.00	\$ 570,000.00	\$ 340,000.00								
	Cost	\$ 50,150.00		\$ 350,000.00	\$ 350,000.00	\$ 250,000.00								
	Profit	\$ 225,850.00		\$ 190,000.00	\$ 220,000.00	\$ 90,000.00								
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.														

Figure 11: Scenario Summary with VAT and Quantity

Topic 2. What-If Analysis: Goal Seek

Goal seek is a What-If Analysis tool that allows us to find values that will get us to reach a certain goal. This is rather abstract, so let us learn what this means by going through an example. Staying on the WHAT-IF worksheet, suppose that you want to find how many units of output we need to produce for a \$300,000 profit. To start off the analysis, navigate to Data, select What-If Analysis, Goal Seek.³

Revenue, Cost, and Profit		
Unit Price	\$	200.00
VAT		8%
Quantity		1,500
Total Revenue	\$	276,000.00
Production Cost	\$	150.00
Marketing Cost	\$	50,000.00
Total Cost	\$	50,150.00
Profit	\$	225,850.00

Figure 12: Initiating Goal Seek

The Goal Seek pop-up window requires three inputs. First, in the **red box**, we select the cell that contains the value that we are trying to set to a certain value. In our example, we want to set profit to 300,000, so the correct cell will be C10. Then, in the **blue box**, we fill in the target value. Finally, the **orange box** in our example is the cell C5 since we want to find the quantity of output that gets us to the 300,000 profit mark.

Revenue, Cost, and Profit		
Unit Price	\$	200.00
VAT		8%
Quantity		4,167
Total Revenue	\$	766,666.67
Production Cost	\$	416,666.67
Marketing Cost	\$	50,000.00
Total Cost	\$	466,666.67
Profit	\$	300,000.00

Figure 13: Results from Goal Seek

³We skip discussing Solver at this stage...

Topic 3. What-If Analysis: Data Table

Data table is an alternative to scenarios, which can make trying out various scenarios a bit easier. Suppose you wanted to check out numerous values of quantity, and the resulting profit. It would be tedious to set up scenarios one by one. In this case, we can rely on data tables. Suppose that we want to observe how profit will evolve over 8 values of output quantities ranging from 2,000 to 9,000.

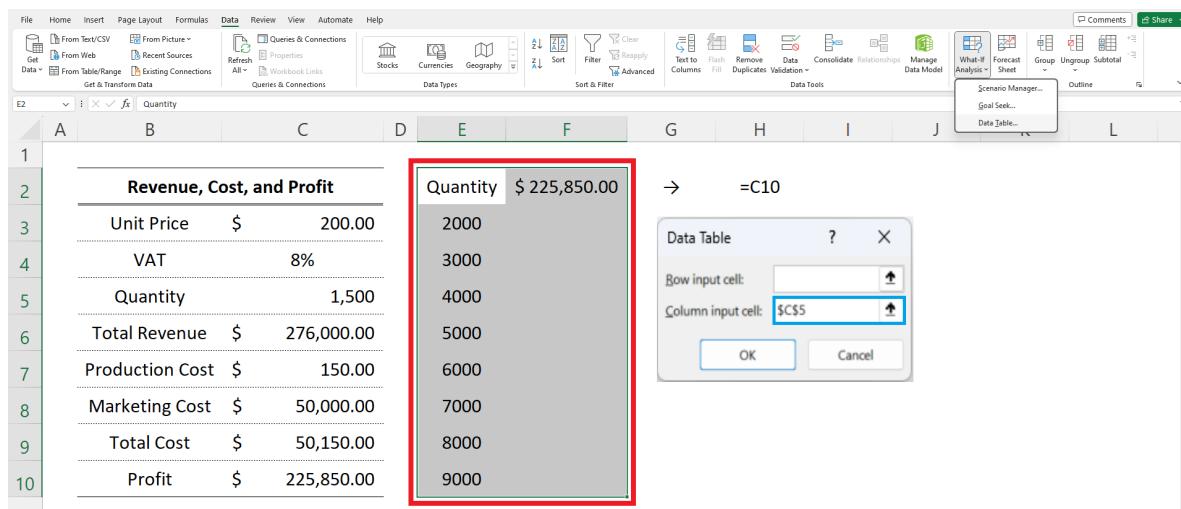


Figure 14: Initiating Data Table

We must set up an empty table as shown in the red box in Figure 14. The values in column E may be entered manually, but the value in cell F2 must reference the cell containing the profit formula, which in our case will be C10. The blue box references the cell C5, which is the cell that contains information on quantity in the original table. This value belongs in the Column input cell, as the table we constructed in Figure 14 varies along the column. If the setup is correct, you will see that the empty table has been filled with profit values in Figure 15.

The screenshot shows the results of the Data Table. The original table data is in rows 2-10. A new table with 9 rows is in rows 11-19, showing profit values for quantities 2000, 3000, 4000, 5000, 6000, 7000, 8000, and 9000.

Revenue, Cost, and Profit		
Unit Price	\$	200.00
VAT		8%
Quantity		1,500
Total Revenue	\$	276,000.00
Production Cost	\$	150.00
Marketing Cost	\$	50,000.00
Total Cost	\$	50,150.00
Profit	\$	225,850.00
Quantity	\$	225,850.00
2000	\$	118,000.00
3000	\$	202,000.00
4000	\$	286,000.00
5000	\$	370,000.00
6000	\$	454,000.00
7000	\$	538,000.00
8000	\$	622,000.00
9000	\$	706,000.00

Figure 15: Results from Data Table

Multiple Outcome Variables in Data Tables

If you want to check the profit, revenue, and cost information for different values of output quantities, repeat the process with a slightly modified setup. Simply add the desired variables to the empty table as seen in Figure 16.

	A	B	C	D	E	F	G	H	K
1					Profit	Revenue	Cost		
2					Quantity	\$ 225,850.00	\$ 276,000.00	\$ 50,150.00	
3	Revenue, Cost, and Profit				2000				
4	Unit Price	\$ 200.00			3000				
5	VAT	8%			4000				
6	Quantity	1,500			5000				
7	Total Revenue	\$ 276,000.00			6000				
8	Production Cost	\$ 150.00			7000				
9	Marketing Cost	\$ 50,000.00			8000				
10	Total Cost	\$ 50,150.00			9000				
	Profit	\$ 225,850.00							
11									
12									

Figure 16: Data Table with Multiple Outcomes

Filling out the data table pop-up, we find the table is filled as desired in Figure 19. Note that the revenue and cost values in the empty data table (cells G2 and H2) must reference the revenue and cost values in cells C6 and C9, just as the profit value references cell C10.

	A	B	C	D	E	F	G	H	I	J	K
1					Profit	Revenue	Cost				
2					Quantity	\$ 225,850.00	\$ 276,000.00	\$ 50,150.00			
3	Revenue, Cost, and Profit				2000	\$ 118,000.00	\$ 368,000.00	\$ 250,000.00			
4	Unit Price	\$ 200.00			3000	\$ 202,000.00	\$ 552,000.00	\$ 350,000.00			
5	VAT	8%			4000	\$ 286,000.00	\$ 736,000.00	\$ 450,000.00			
6	Quantity	1,500			5000	\$ 370,000.00	\$ 920,000.00	\$ 550,000.00			
7	Total Revenue	\$ 276,000.00			6000	\$ 454,000.00	\$ 1,104,000.00	\$ 650,000.00			
8	Production Cost	\$ 150.00			7000	\$ 538,000.00	\$ 1,288,000.00	\$ 750,000.00			
9	Marketing Cost	\$ 50,000.00			8000	\$ 622,000.00	\$ 1,472,000.00	\$ 850,000.00			
10	Total Cost	\$ 50,150.00			9000	\$ 706,000.00	\$ 1,656,000.00	\$ 950,000.00			
11	Profit	\$ 225,850.00									

Figure 17: Data Table with Multiple Outcomes

Two Variable Data Tables

Similar to our discussion in scenario management, we may want to observe the profit when quantity and VAT vary at the same time. Suppose we are still interested in the output between 2,000 and 9,000, but additionally we want to know what profit would be when VAT varies between 5% to 20%. In this case, the correct setup can be found in Figure 18.

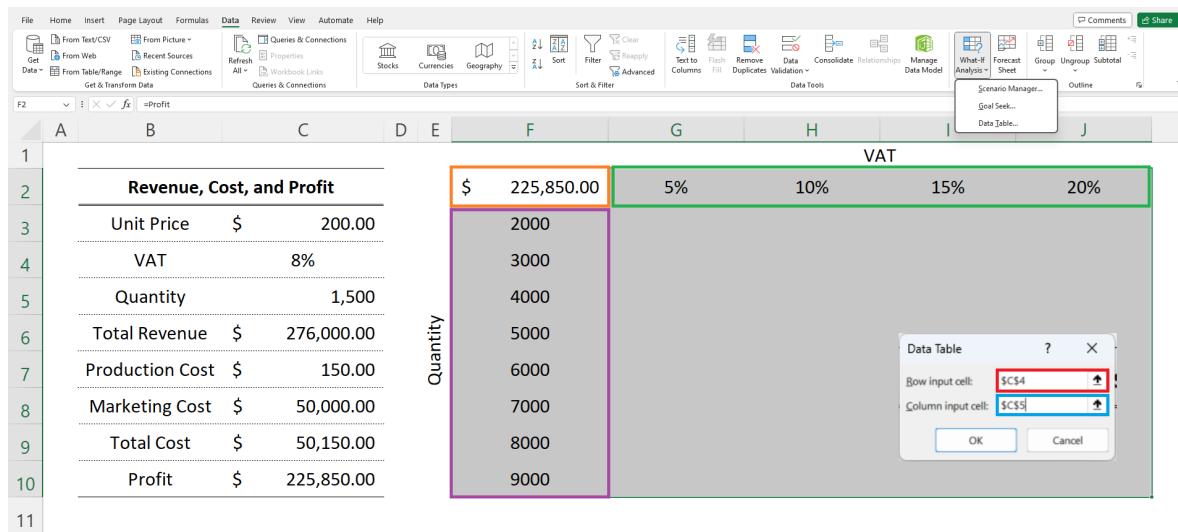


Figure 18: Data Table with Multiple Variables

The reference to profit values is now located in cell F2, and the values for VAT is in the range G2:J2, and the values for quantity is in F3:F10. Since VAT varies along a row, the VAT value in the original table populates the red box, and the quantity value belongs in the blue box. If set up correctly, we will get the data table in Figure 19.

Revenue, Cost, and Profit			VAT				
		\$ 225,850.00	5%	10%	15%	20%	
Unit Price	\$ 200.00	2000	\$ 130,000.00	\$ 110,000.00	\$ 90,000.00	\$ 70,000.00	
VAT	8%	3000	\$ 220,000.00	\$ 190,000.00	\$ 160,000.00	\$ 130,000.00	
Quantity	1,500	4000	\$ 310,000.00	\$ 270,000.00	\$ 230,000.00	\$ 190,000.00	
Total Revenue	\$ 276,000.00	5000	\$ 400,000.00	\$ 350,000.00	\$ 300,000.00	\$ 250,000.00	
Production Cost	\$ 150.00	6000	\$ 490,000.00	\$ 430,000.00	\$ 370,000.00	\$ 310,000.00	
Marketing Cost	\$ 50,000.00	7000	\$ 580,000.00	\$ 510,000.00	\$ 440,000.00	\$ 370,000.00	
Total Cost	\$ 50,150.00	8000	\$ 670,000.00	\$ 590,000.00	\$ 510,000.00	\$ 430,000.00	
Profit	\$ 225,850.00	9000	\$ 760,000.00	\$ 670,000.00	\$ 580,000.00	\$ 490,000.00	

Figure 19: Data Table with Multiple Variables