

# Lecture Note #7: Some More Functions

BUSI 201: Business Data Analysis

Fall 2023

## Topic 1. The HLOOKUP Function

Similar to the VLOOKUP function we covered in a previous class, the HLOOKUP function returns a certain value. While the VLOOKUP function looks *vertically* down the first column of the table array to find the unique identifier, the HLOOKUP function looks *horizontally* across the first row of the table array to find the identifier.

A screenshot of Microsoft Excel showing a table of asset data. The table has columns for Ticker, Asset, Asset Type, Quantity, Purchase Price, and Current Price. The rows contain various stocks and bonds. The table is selected, and the formula bar shows =VLOOKUP(D2, A1:C10, 5, 0). The status bar at the bottom indicates 'Ready'.

	Ticker	Asset	Asset Type	Quantity	Purchase Price	Current Price
3	AAPL	Apple Inc.	Stocks	100	\$15,000.00	\$17,500.00
4	MSFT	Microsoft	Stocks	75	\$20,000.00	\$22,000.00
5	AMZN	Amazon.com	Stocks	50	\$320,000.00	\$350,000.00
6	GOOGL	Google	Stocks	60	\$250,000.00	\$270,000.00
7	IBM	IBM	Stocks	40	\$13,000.00	\$12,000.00
8	TSLA	Tesla Inc.	Stocks	30	\$65,000.00	\$70,000.00
9	JNJ	Johnson & Johnson	Stocks	50	\$15,000.00	\$16,000.00
10	PG	Procter & Gamble	Stocks	60	\$13,000.00	\$14,000.00
11	XOM	Exxon Mobil	Stocks	70	\$6,000.00	\$6,500.00
12	NFLX	Netflix Inc.	Stocks	40	\$45,000.00	\$48,000.00
13	SPY	SPDR S&P 500 ETF	ETFs	25	\$40,000.00	\$42,000.00
14	XLK	Shares Tech ETF	ETFs	30	\$15,000.00	\$16,000.00
15	BND	Vanguard Bond ETF	ETFs	100	\$8,000.00	\$8,500.00
16	EEM	Shares Emerging Markets ETF	ETFs	35	\$4,500.00	\$4,800.00
17	USGOV	US Treasury	Bonds	500	\$100,000.00	\$102,000.00
18	CORP	Corporate Bond	Bonds	300	\$12,000.00	\$12,200.00
19	MUNI	Municipal Bond	Bonds	200	\$9,000.00	\$9,200.00
20	HYLD	High-Yield Bond	Bonds	150	\$7,500.00	\$7,800.00
21	TIPS	Treasury Inflation-Protected Securities	Bonds	75	\$11,000.00	\$11,200.00
22	VNQ	Real Estate ETF	Real Estate	15	\$10,000.00	\$10,500.00

Figure 1: VLOOKUP

A screenshot of Microsoft Excel showing a table of real estate data. The table has columns for Property Code, RE001, RE002, RE003, and RE004. The rows contain various property details like State, County, City, Square Footage, etc. The table is selected, and the formula bar shows =HLOOKUP("RE001", A1:F10, 2, 0). The status bar at the bottom indicates 'Ready'.

Property Code	RE001	RE002	RE003	RE004
State	CA	TX	NY	FL
County	Los Angeles	Harris	Queens	Miami-Dac
City	Los Angeles	Houston	New York	Miami
Square Footage	2000	1800	2200	1600
Bedrooms	3	4	5	2
Bathrooms	2.5	3	4	2
Garage Spaces	2	2	3	1
Year of Construction	1990	1985	2005	1980
Renovation Year	2015	2020	2018	2019
Days on the Market	30	45	60	15
Asking Price	\$550,000	\$400,000	\$750,000	\$300,000
Flooring	Hardwood	Carpet	Hardwood	Tile
Heating	Central	Radiant	Forced Air	Central
Cooling	Central	Central	Central	Window
HOA	\$300	\$250	\$400	\$150

Figure 2: HLOOKUP

HLOOKUP is used when the unique ID is aligned in a single row, as shown in Figure 2, and VLOOKUP is appropriate when the data is arranged like Figure 1, where the unique ID is aligned in a single column. The syntax of HLOOKUP is similar to that of VLOOKUP.

```
= HLOOKUP(LOOKUP VALUE,  
          RANGE WHERE LOOKUP VALUE IF LOCATED,  
          ROW NUMBER IN THE RANGE CONTAINING VALUE TO RETURN,  
          [EXACT/APPROXIMATE MATCH] )
```

Navigate to the worksheet HLOOKUP\_DATA in the workbook BUSI201-LEC07-Workbook.xlsx. You should find a table with information on some real estate properties on the market in various regions across the U.S. Suppose you want to extract information on the county the property is located in, the number of bedrooms and bathrooms, and the asking price of four properties: RE008, RE002, RE010, and RE001. Fill out the table located in cells B20 : F24.

The screenshot shows the Microsoft Excel interface with the 'HLOOKUP\_DATA' sheet selected. The top part of the sheet displays a large table with columns for Property Code (RE001 to RE010) and various property details like State, County, City, Square Footage, etc. The bottom part of the sheet displays a smaller table with columns for Property Code, County, Bedrooms, Bathrooms, and Asking Price, with rows for RE008, RE002, RE010, and RE001.

	B	C	D	E	F	G	H	I	J	K	L	M
2	Property Code	RE001	RE002	RE003	RE004	RE005	RE006	RE007	RE008	RE009	RE010	
3	State	CA	TX	NY	FL	IL	AZ	WA	CO	NC	GA	
4	County	Los Angeles	Harris	Queens	Miami-Dade	Cook	Micropia	King	Denver	Wake	Fulton	
5	City	Los Angeles	Houston	New York	Miami	Chicago	Phoenix	Seattle	Denver	Raleigh	Atlanta	
6	Square Footage	2000	1800	2200	1600	2500	1900	2800	2100	2300	1950	
7	Bedrooms	3	4	5	2	4	3	4	3	4	3	
8	Bathrooms	2.5	3	4	2	3.5	2.5	3.5	2.5	3	2.5	
9	Garage Spaces	2	2	3	1	2	2	3	2	2	1	
10	Year of Construction	1990	1985	2005	1980	1995	2002	2010	1988	1998	2008	
11	Renovation Year	2015	2020	2018	2019	2016	2021	2017	2020	2015	2019	
12	Days on the Market	30	45	60	15	75	40	90	55	70	50	
13	Asking Price	\$550,000	\$400,000	\$750,000	\$300,000	\$600,000	\$350,000	\$800,000	\$450,000	\$475,000	\$380,000	
14	Flooring	Hardwood	Carpet	Hardwood	Tile	Hardwood	Carpet	Hardwood	Tile	Carpet	Hardwood	
15	Heating	Central	Radiant	Forced Air	Central	Radiant	Forced Air	Radiant	Forced Air	Radiant	Forced Air	
16	Cooling	Central	Central	Central	Window	Central	Central	Central	Central	Central	Central	
17	HOA	\$300	\$250	\$400	\$150	\$300	\$200	\$500	\$250	\$300	\$200	
18												
19												
20	Property Code	County	Bedrooms	Bathrooms	Asking Price							
21	RE008											
22	RE002											
23	RE010											
24	RE001											
25												

Figure 3: The HLOOKUP\_DATA Sheet

For instance, to find the number of bedrooms for property code RE002 in cell D22, we can use the HLOOKUP function as follows:

$$= \text{HLOOKUP} (\$J2, \$C\$2:\$L\$17, 5, 0)$$

## Topic 2. The XLOOKUP Function

We have covered two distinct types of lookup functions: the VLOOKUP for data that are stacked *vertically*, and the HLOOKUP for data that are stacked *horizontally*. It is challenging to think of any other method of organizing data that is comprehensible, while neither being stacked vertically nor horizontally. So, you may wonder, what is the purpose of this XLOOKUP function?

The primary limitation of the VLOOKUP and HLOOKUP functions is that the lookup value (unique identifier) must be located in the first column/row, respectively. This restriction exists because VLOOKUP returns values to the *right* of the lookup value, and HLOOKUP returns values *below* the lookup value. For instance, refer to Figure 4, which represents a hypothetical data sheet from a hospital system, where individuals are uniquely identified by their patient ID number.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date	Full Name	Age	Patient ID	Procedure	Cost	Return	Network	Pharma	Patient ID	Full Name	Date	Cost		
Aug/07/23	Emily Johnson	55	PID-001	Blood Pressure Measurement	\$ 27.88	No	No	Yes	PID-006					
Aug/12/23	Benjamin Smith	55	PID-002	Blood Tests	\$ 267.61	Yes	Yes	No	PID-002					
Aug/20/23	Ava Williams	17	PID-003	X-ray	\$ 103.57	No	No	No	PID-021					
Aug/24/23	Liam Anderson	67	PID-004	Ultrasound	\$ 377.08	No	Yes	No	PID-018					
Aug/28/23	Olivia Brown	52	PID-005	Electrocardiogram	\$ 273.07	No	No	Yes						
Sep/02/23	Jackson Martinez	33	PID-006	Colonoscopy	\$ 29.80	No	No	No						
Sep/06/23	Sophia Davis	42	PID-007	Endoscopy	\$ 370.67	Yes	Yes	Yes						
Sep/10/23	Noah Wilson	68	PID-008	MRI	\$ 13.96	No	No	Yes						
Sep/13/23	Emma Garcia	52	PID-009	CT Scan	\$ 303.60	No	Yes	No						
Sep/15/23	William Jones	15	PID-010	Mammogram	\$ 352.11	Yes	Yes	Yes						
Aug/04/23	Isabella Taylor	30	PID-011	Biopsy	\$ 354.63	No	Yes	Yes						
Aug/17/23	James Clark	62	PID-012	Surgery	\$ 276.26	Yes	No	No						
Aug/22/23	Mia Hernandez	25	PID-013	Laparoscopy	\$ 98.18	No	Yes	Yes						
Aug/31/23	Jackson Martinez	33	PID-006	Catheterization	\$ 207.10	Yes	No	Yes						
Sep/01/23	Charlotte White	50	PID-015	Dialysis	\$ 51.72	No	Yes	No						
Sep/05/23	Ethan Lewis	45	PID-016	Ventilation	\$ 224.30	No	Yes	No						
Sep/08/23	Harper Hall	44	PID-017	Chemotherapy	\$ 397.83	Yes	No	Yes						
Sep/11/23	Elijah Turner	32	PID-018	Radiation Therapy	\$ 147.96	Yes	Yes	Yes						
Sep/14/23	Amelia Scott	70	PID-019	Physical Therapy	\$ 164.92	Yes	Yes	Yes						
Sep/16/23	Alexander Rodriguez	57	PID-020	Cardiac Bypass Surgery	\$ 114.86	Yes	Yes	No						

Figure 4: The XLOOKUP\_DATA Sheet

While the data is organized *vertically*, we may be tempted to use the VLOOKUP function. However, we can observe that the unique patient ID is located in column E, which is in the middle of the table. Therefore, if we want to use the unique patient ID to look up information about this patient, we can use the XLOOKUP function. The syntax of the XLOOKUP function is as follows:

```
= XLOOKUP(LOOKUP VALUE,  
          RANGE WHERE THE LOOKUP VALUE IS LOCATED,  
          RANGE WHERE THE RETURN VALUE IS LOCATED,  
          [WHAT TO RETURN WHEN LOOKUP VALUE NOT FOUND],  
          [EXACT/APPROXIMATE MATCH],  
          [SEARCH DIRECTION] )
```

The arguments are similar, but not identical to those of VLOOKUP. Let's go over the correct solution for cell M3, where we attempt to find the full name of PID-006:

= XLOOKUP (\$L3, \$E\$3:\$E\$22, \$C\$3:\$C\$22, "Not Found", 0, 1)

Please see Figure 5 for the color-coded zones chosen as arguments in the XLOOKUP function.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Date	Full Name	Age	Patient ID	Procedure	Cost	Return	Network	Pharma	Patient ID	Full Name	Date	Cost		
Aug/07/23	Emily Johnson	55	PID-001	Blood Pressure Measurement	\$ 27.88	No	No	Yes	PID-006					
Aug/12/23	Benjamin Smith	55	PID-002	Blood Tests	\$ 267.61	Yes	Yes	No	PID-002					
Aug/20/23	Ava Williams	17	PID-003	X-ray	\$ 103.57	No	No	No	PID-021					
Aug/24/23	Liam Anderson	67	PID-004	Ultrasound	\$ 377.08	No	Yes	No	PID-018					
Aug/28/23	Olivia Brown	52	PID-005	Electrocardiogram	\$ 273.07	No	No	Yes						
Sep/02/23	Jackson Martinez	33	PID-006	Colonoscopy	\$ 29.80	No	No	No						
Sep/06/23	Sophia Davis	42	PID-007	Endoscopy	\$ 370.67	Yes	Yes	Yes						
Sep/10/23	Noah Wilson	68	PID-008	MRI	\$ 13.96	No	No	Yes						
Sep/13/23	Emma Garcia	52	PID-009	CT Scan	\$ 303.60	No	Yes	No						
Sep/15/23	William Jones	15	PID-010	Mammogram	\$ 352.11	Yes	Yes	Yes						
Sep/18/23	Isabella Taylor	30	PID-011	Biopsy	\$ 354.63	No	Yes	Yes						
Sep/04/23	James Clark	62	PID-012	Surgery	\$ 276.26	Yes	No	No						
Sep/17/23	Mia Hernandez	25	PID-013	Laparoscopy	\$ 98.18	No	Yes	Yes						
Sep/22/23	Jackson Martinez	33	PID-014	Catheterization	\$ 207.10	Yes	No	Yes						
Sep/31/23	Charlotte White	50	PID-015	Dialysis	\$ 51.72	No	Yes	No						
Sep/01/23	Ethan Lewis	45	PID-016	Ventilation	\$ 224.30	No	Yes	No						
Sep/05/23	Harper Hall	44	PID-017	Chemotherapy	\$ 397.83	Yes	No	Yes						
Sep/08/23	Elijah Turner	32	PID-018	Radiation Therapy	\$ 147.96	Yes	Yes	Yes						
Sep/11/23	Amelia Scott	70	PID-019	Physical Therapy	\$ 164.92	Yes	Yes	Yes						
Sep/14/23	Alexander Rodriguez	57	PID-020	Cardiac Bypass Surgery	\$ 114.86	Yes	Yes	No						

Figure 5: An Example of XLOOKUP

## The Three “Optional” Arguments

There are three optional arguments in the XLOOKUP function, and they function as follows:

- 4th Argument:

[WHAT TO RETURN WHEN LOOKUP VALUE IS NOT FOUND]

Value to return when XLOOKUP cannot find the lookup value in the data.

- 5th Argument:

[EXACT/APPROXIMATE MATCH]

Identical to VLOOKUP. Typically, we use only the exact match, so we usually stick to “0.”

- 6th Argument:

[SEARCH DIRECTION]

The default (1) is a “Top-to-Bottom” search. However, we can also use “-1” if we want Excel to search the data “Bottom-to-Top.”

## Topic 3. The AND / OR Functions

Up to this point, we have covered functions that can either take a single condition, such as the IF or VLOOKUP functions, and functions that can evaluate multiple conditions, like the SUMIFS function. For functions that only accept a single condition argument, we can use the AND and/or OR functions to assess multiple conditions in a single line.

The screenshot shows a Microsoft Excel spreadsheet with the following structure:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
2	Order ID	Date	Customer	Sales Rep	Category	Item ID	Quantity	Revenue	Profit	Margin			Revenue > 500 AND Profit Margin > 5%	Revenue > 500 OR Profit Margin > 5%	Revenue < 500 AND Profit Margin < 5%	Revenue < 500 OR Profit Margin < 5%	
3	ORD202309100001	9/10/2023	John Smith	Alice Johnson	Electronics	E123	14	\$ 742.16	\$ 36.37	4.90%							
4	ORD202309100002	9/10/2023	Emily Davis	Michael Wilson	Clothing	C456	10	\$ 317.25	\$ 26.65	8.40%							
5	ORD202309100003	9/10/2023	Robert Brown	Jessica Miller	Home Appliances	HA789	1	\$ 111.46	\$ 3.90	3.50%							
6	ORD202309100004	9/9/2023	Sarah Johnson	David Smith	Electronics	E123	8	\$ 232.96	\$ 19.57	8.40%							
7	ORD202309100005	9/8/2023	James Wilson	Jennifer White	Clothing	C456	7	\$ 50.20	\$ 2.45	4.90%							
8	ORD202309100006	9/8/2023	Linda Johnson	Michael Wilson	Home Appliances	HA789	13	\$ 94.57	\$ 3.01	5.20%							
9	ORD202309100007	9/8/2023	William Brown	Alice Johnson	Electronics	E123	9	\$ 773.49	\$ 57.24	7.40%							
10	ORD202309100008	9/7/2023	Susan Johnson	Jessica Miller	Clothing	C456	8	\$ 83.67	\$ 6.86	8.20%							
11	ORD202309100009	9/7/2023	Michael Smith	David Smith	Home Appliances	HA789	10	\$ 351.30	\$ 18.62	5.30%							
12	ORD202309100010	9/6/2023	Olivia White	Jennifer White	Electronics	E123	5	\$ 685.80	\$ 25.37	3.70%							
13	ORD202309100011	9/6/2023	Henry Davis	Alice Johnson	Clothing	C456	5	\$ 561.59	\$ 55.60	9.90%							
14	ORD202309100012	9/5/2023	Emily Wilson	Michael Wilson	Home Appliances	HA789	11	\$ 714.00	\$ 26.42	3.70%							
15	ORD202309100013	9/5/2023	William Wilson	Jessica Miller	Electronics	E123	8	\$ 654.00	\$ 27.47	4.20%							
16	ORD202309100014	9/4/2023	Susan Davis	David Smith	Clothing	C456	10	\$ 971.59	\$ 43.72	4.50%							
17	ORD202309100015	9/4/2023	James Brown	Jennifer White	Home Appliances	HA789	8	\$ 724.91	\$ 7.97	1.10%							
18	ORD202309100016	9/3/2023	Linda Johnson	Alice Johnson	Electronics	E123	6	\$ 189.02	\$ 2.84	1.50%							
19	ORD202309100017	9/3/2023	Robert Smith	Michael Wilson	Clothing	C456	4	\$ 957.49	\$ 77.56	8.10%							
20	ORD202309100018	9/2/2023	Sarah Davis	Jessica Miller	Home Appliances	HA789	12	\$ 130.52	\$ 10.31	7.90%							
21	ORD202309100019	9/2/2023	Olivia Brown	David Smith	Electronics	E123	12	\$ 877.39	\$ 21.06	2.40%							
22	ORD202309100020	9/1/2023	Michael Wilson	Jennifer White	Clothing	C456	7	\$ 475.29	\$ 15.21	3.20%							
23																	
24																	
25																	
26																	
27																	
28																	
29																	
30																	
31																	
32																	
33																	
34																	

Below the table, there are tabs for 'VLOOKUP\_DATA', 'HLOOKUP\_DATA', 'XLOOKUP\_DATA', 'AND.OR' (which is selected), and 'HELPER'. There is also a '+' button to add more tabs.

Figure 6: The AND\_OR Sheet

If we want to populate cell M3 with an indicator to check if the order ID ORD202309100001 generated revenue greater than \$500 and if the profit margin for filling that order was greater than 5%, we can use a simple IF function:

$$= \text{IF}(I3>500, \text{IF}(K3>0.05, 1, 0), 0)$$

Meanwhile, if we aim to fill cell N3:

$$= \text{IF}(I3>500, 1, \text{IF}(K3>0.05, 1, 0))$$

When checking between two conditions, this is relatively straightforward. However, we may encounter situations where we need to verify if an entry satisfies dozens of conditions simultaneously or if it satisfies at least one of a dozen conditions. In such scenarios, we can rely on the AND or OR functions to streamline this process.

## The AND Function

Consider the worksheet AND\_OR in the workbook BUSI201-LEC07-Workbook.xlsx. You will find some sales data, but for this exercise, we will focus on the revenue (column I) and the profit margin (column K). Suppose we want to create a column that acts as an indicator. For example, column M should display:

$$M3 = \begin{cases} 1, & \text{if Revenue} > 500 \text{ and Profit Margin} > 5\% \\ 0, & \text{otherwise} \end{cases}$$

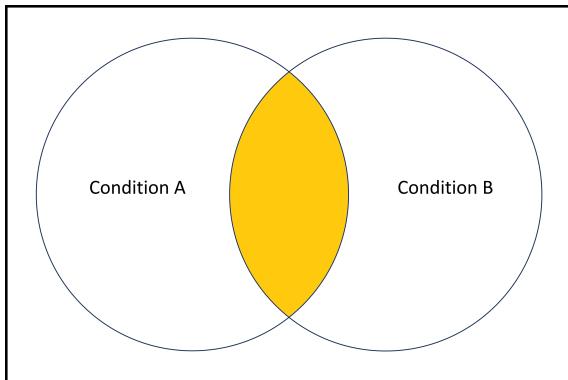


Figure 7: AND Function Diagram

To achieve this goal, we can use the AND function, which returns TRUE if all the conditions provided as arguments are met simultaneously. In other words, the AND function will return TRUE only if all logic tests pass, and it will return FALSE if any of the conditions are not met.

Visualized in a Venn diagram as shown in Figure 7, the AND function will yield TRUE for objects in the shaded zone, representing the intersection of two sets.

The basic syntax of the AND function is as follows:

= AND (LOGIC\_TEST\_1, [LOGIC\_TEST\_2], ...)

For cell M3, we can use the AND function as follows:

= AND (I3 > 500, K3 > 0.05)

Please note that there is no need to use absolute/mixed references in this case, and percentages are represented in the numerical form of 0.05, not as 5%. Try filling the remaining cells in column M using the AND function and column O with the corresponding conditions.

## The OR Function

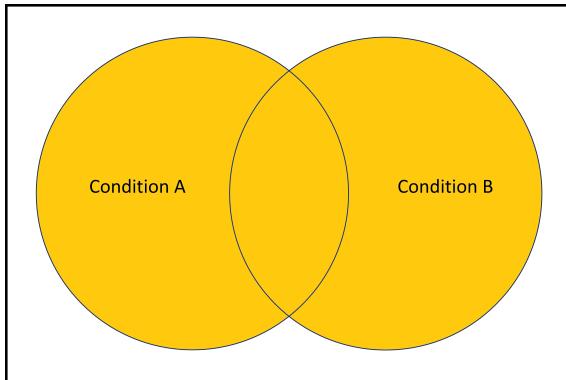


Figure 8: OR Function Diagram

Another useful function to employ when checking multiple conditions simultaneously is the OR function. In terms of set theory, the OR function is the *union* equivalent of the AND function, as shown in Figure 8.

In other words, it returns TRUE if *any* of the conditions are met and will return FALSE only if *none* of the conditions are met. We can use the OR function to fill out the cells in columns N and P.

Since the syntax of the OR function is identical to that of the AND function, cell N3 should read:

$$= \text{OR} (\text{I3} > 500, \text{K3} > 0.05)$$

## The AND and OR Functions with the IF Function

We can also combine the AND and OR functions in conjunction with the IF function to output 0 for FALSE and 1 for TRUE. The syntax will be:

$$= \text{IF} (\text{AND} (\text{LOGIC\_TEST\_1}, [\text{LOGIC\_TEST\_2}], \dots), 1, 0)$$

## Topic 4. Helper Columns

In many scenarios, especially when dealing with multiple conditions, it's useful to employ what is known as a *helper column*. Please navigate to the **HELPER** sheet, which is essentially a copy of the **AND\_OR** sheet with two new columns **M** and **N** with information that can assist us.

The screenshot shows the 'HELPER' sheet in Excel. It contains a table of order data with columns: Order ID, Date, Customer, Sales Rep, Category, Item ID, Quantity, Revenue, Profit, Margin, Revenue > \$500, Profit Margin > 5%, Revenue > 500 AND Profit Margin > 5%, Revenue < 500 AND Profit Margin > 5%, Revenue > 500 OR Profit Margin > 5%, Revenue < 500 AND Profit Margin < 5%, and Revenue < 500 OR Profit Margin < 5%. The data includes various orders from different customers like John Smith, Alice Johnson, etc., across categories like Electronics, Clothing, and Home Appliances.

Figure 9: The **HELPER** Sheet

In cells **M3** and **N3** of the **HELPER** sheet, we can utilize the **IF** function to create "indicator" variables indicating whether the revenue generated from the order exceeds \$500 and whether the profit margin was greater than 5%. You can use the following formulas to achieve the result shown in Figure 10:

$$M3 := IF(I3>500, 1, 0)$$

$$N3 := IF(J3>0.05, 1, 0)$$

The screenshot shows the 'HELPER' sheet with the helper columns filled in. Column **M** contains values 1 or 0 based on whether Revenue > \$500. Column **N** contains values 1 or 0 based on whether Profit Margin > 5%. The rest of the columns remain the same as in Figure 9.

Figure 10: Helper Columns Filled Out

Now that the helper columns are ready, filling out the original table becomes more straightforward. For example, consider cell P3, where we want to check if the order generates more than \$500 in revenue and also has a profit margin greater than 5%:

$$= \text{IF}(M3+N3=2, 1, 0)$$

The condition  $M3+N3=2$  is met only when both the revenue and profit conditions are satisfied. Therefore, it's equivalent to using the AND function or writing out the slightly longer nested IF function.