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Tom Arnold
University of Richmond, tarnold@richmond.edu

Summer Liu
University of Richmond, sliu@richmond.edu

Cassandra D. Marshall
University of Richmond, cmarshal@richmond.edu

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Tom Arnold, CFA, CIPM
The Robins School of Business
Department of Finance
102 UR Drive
University of Richmond, VA 23173
tarnold@richmond.edu
O: 804-287-6399
F: 804-289-8878

Summer Liu
The Robins School of Business
Department of Finance
102 UR Drive
University of Richmond, VA 23173
O: 804-289-8623
F: 804-289-8878
sliu@richmond.edu

Cassandra D. Marshall
The Robins School of Business
Department of Finance
102 UR Drive
University of Richmond, VA 23173
O: 804-287-1851
F: 804-289-8878
cmarshal@richmond.edu

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Converting NPV and IRR Cash Flows into a Financial Calculator Using an Excel Template

An Excel template is developed that converts a series of cash flows on a timeline into the associated keystrokes for the TI BAII-Plus financial calculator in order to calculate NPV and IRR. Unlike videos and other presentations, the student is able to see, all at once, the keystrokes required for the financial calculator within the template after the student enters the correct inputs for how the cash flows occur through time. Many times, this crucial link of translating the cash flows through time into the financial calculator is lost. Further exercises are provided to reinforce proficiency.

INTRODUCTION

One of the challenges of an introductory finance class is transitioning students from identifying cash flows on a timeline to assessing the cash flows for an NPV or IRR calculation using a financial calculator (TI BAII Plus is used in this presentation). The student's tendency is to try to memorize keystrokes from similar problems rather than retaining the concept of time value of money based on when cash flows are received through time. To remediate this tendency, a template in Excel is developed that translates the cash flows on a timeline into the appropriate keystrokes on the financial calculator for calculating the NPV and IRR. By design, the template emphasizes understanding the question's context and entering the cash flows on the timeline correctly to produce the corresponding keystrokes. For instance, in the capital budgeting topic, the student needs to understand what cash flows are relevant and incremental to the project before calculating the NPV or IRR. This design helps solidify the time value of money concepts for which the calculator is merely an aid for generating the correct result.

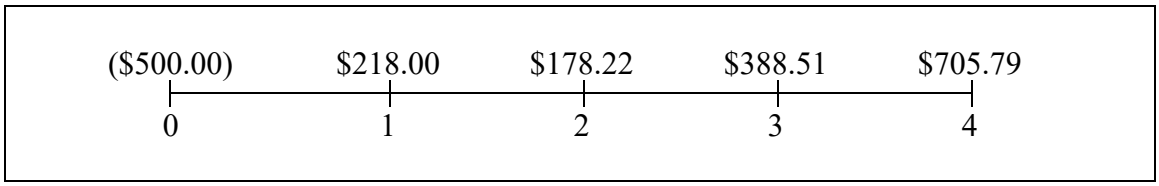
In the next section the Excel template is developed for five time periods (longer timeline templates are also available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/). The second section introduces some conceptual exercises to reinforce time value of money concepts when using the financial calculator. The third section concludes the presentation.

SECTION 1: THE NPV-IRR EXCEL TEMPLATE

To provide a context for using the Excel template, introduce a project that has a cost of $500.00 and starting next year, produces annual cash inflows of $218.00 in Year 1,

$178.22 in Year 2, $388.51 in Year 3, and $705.79 in Year 4. The discount rate for the project is 9.00% APR. A timeline presentation for the project is provided in Figure 1.

Figure 1: Timeline Presentation of Project Cash Flows



Taking the present value of all the cash flows produces the NPV:

$$\$650.00 = \frac{(\$500.00)}{(1+9\%)^0} + \frac{\$218.00}{(1+9\%)^1} + \frac{\$178.22}{(1+9\%)^2} + \frac{\$388.51}{(1+9\%)^3} + \frac{\$705.79}{(1+9\%)^4} \quad (1)$$

In Figure 2, the first part of the Excel template is developed to have the cash flows entered as inputs onto a timeline and to also have the discount rate as an input. Using Excel functions, the NPV and IRR are computed within the spreadsheet.

Figure 2: Financial Calculator Template in Excel Cash Flow Portion

	A	B	C	D	E
1	**Project Cash Flows:**				
2					
3	**Period:**	**Cash Flow:**	Frequency:	ID:	
4	0	**$ (500.00)**		1	
5	1	**$ 218.00**	1	100	
6	2	**$ 178.22**	1	200	
7	3	**$ 388.51**	1	300	
8	4	**$ 705.79**	1	400	
9	5				
10					
11	**Discount rate:**	**9.00%**			
12	**NPV:**	$ 650.00			
13	**IRR:**	47.49%			

Cells B4 through B9 and B11 are inputs provided by the user

Cell formulas are in the appendix

A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/

Column C (Frequency:) and Column D (ID:) are not necessary for the visual presentation, but are necessary for generating the financial calculator presentation. The instructor can

hide these two columns or format this portion to a white font so that the student does not get distracted or confuse the frequency column with the frequency inputs in the calculator. However, be aware that the student may accidentally delete these cells when using a white font.

Figure 3 is a continuation of the spreadsheet and provides that associated financial calculator keystrokes.

Figure 3: Financial Calculator Template in Excel Calculator Portion Based on Figure 2 Cash Flows

	F	G	H	I	J	K	L	M	N	O
1	**Financial Calculator:**									
2										
3	**To clear the cash flow inputs, use the following key sequence:**									
4										
5	CF		2ND		CE|C					
6										
7										
8	**KEY:**	**Calculator Screen:**		**Your Input:**		**KEY:**		**KEY:**		
9	CF	CF0=		-500.00		ENTER		↓		
10		C01		218.00		ENTER		↓		
11		F01=		1.00		ENTER		↓		
12		C02		178.22		ENTER		↓		
13		F02=		1.00		ENTER		↓		
14		C03		388.51		ENTER		↓		
15		F03=		1.00		ENTER		↓		
16		C04		705.79		ENTER		↓		
17		F04=		1.00		ENTER		↓		
18		C05								
19										
20										
21										
22	**KEY:**	**Calculator Screen:**		**Your Input:**		**KEY:**		**KEY:**		
23	NPV	I = 0.00		9.00		ENTER		↓		
24		NPV = 0								
25	CPT	NPV = 650.00								
26										
27	**KEY:**	**Calculator Screen:**								
28	IRR	IRR = 0.00								
29	CPT	IRR = 47.49								
30										
31	**NOTE: A rate is presented in the calculator as X.XX instead of X.XX%, i.e. 6.00 instead of 6.00%**									
Cell formulas are in the appendix A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/										

The student will not intuitively know how to implement the keystrokes (black cells with white font), which means instruction is required. The student needs to enter the cash flows into the calculator:

- First, clear the calculator's cash flow (CF) inputs using the following keystroke sequence: (CF)-(2ND)-(CE|C).
- Next, implement the cash flow (CF) function of the calculator by pressing the (CF) key.
- The calculator screen displays: CF0 =, which requires an input for the cash flow at Year 0. Enter: -500.00 and then press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: C01, which requires an input for the cash flow at Year 1. Enter: 218.00 and then press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: F01 = 1.00, 1.00 is the default input and means the cash flow of C01 only occurs once, which is correct in this instance. To continue, press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: C02, which requires an input for the cash flow at Year 2. Enter: 178.22 and then press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: F02 = 1.00, 1.00 is the default input and means the cash flow of C02 only occurs once, which is correct in this instance. To continue, press (ENTER) key and then the down arrow key (↓).

- The calculator screen displays: C03, which requires an input for the cash flow at Year 3. Enter: 388.51 and then press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: F03 = 1.00, 1.00 is the default input and means the cash flow of C03 only occurs once, which is correct in this instance. To continue, press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: C04, which requires an input for the cash flow at Year 4. Enter: 705.79 and then press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: F04 = 1.00, 1.00 is the default input and means the cash flow of C04 only occurs once, which is correct in this instance. To continue, press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: C05, there is no input required for this problem because there is no cash flow beyond Year 4.

With the cash flows inputted into the calculator, NPV and IRR calculations can be generated. For NPV:

- Implement the NPV function of the calculator by pressing the (NPV) key.
- The calculator screen displays: I =, which requires an input for the discount rate for the project. Enter: 9.00 (note: 9.00 is interpreted by the calculator as 9.00%) and then press (ENTER) key and then the down arrow key (↓).
- The calculator screen displays: NPV = 0, which means the calculator is ready to compute the NPV: press (CPT) key and the NPV is computed as 650.00.

For IRR:

- Implement the IRR function of the calculator by pressing the (IRR) key.
- The calculator screen displays: IRR = 0, which means the calculator is ready to compute the IRR: press (CPT) key and the IRR is computed as 47.49, which means 47.49%.

After receiving instruction on how the calculator works and how the template "mirrors" the keystrokes, the instructor can provide more NPV-IRR exercises to reinforce how cash flows are entered into the calculator to produce NPV and IRR calculations. Repetition is necessary and generally, the sooner, the better.

The template adjusts automatically to accommodate various cash flows and is able to consolidate repeated cash flows correctly using the frequency function available on the financial calculator. This will be demonstrated further in the next section.

SECTION 2: FURTHER EXERCISES

Demonstrate that a bond's yield-to-maturity is the IRR for the bond:

First, price a $1,000.00 five-year bond with 8% annual coupons and yield-to-maturity of 7% APR. If the students are using a financial calculator, the bond price is $1,041.00:

(N) set to 5

(I/Y) set to 7.00

(PMT) set to 80.00

(FV) set to 1,000.00

(CPT) followed by (PV): -1,041.00

Have the students enter the cash flows into the Excel template (Figures 5 and 6).

Figure 5: Financial Calculator Template in Excel Cash Flow Portion (Bond Price)

	A	B	C	D	E
1	**Project Cash Flows:**				
2					

3	Period:	Cash Flow:	Frequency:	ID:	
4	0	$ (1,041.00)		1	
5	1	$ 80.00	1	100	
6	2	$ 80.00	2	100	
7	3	$ 80.00	3	100	
8	4	$ 80.00	4	100	
9	5	$ 1,080.00	1	200	
10					
11	Discount rate:	7.00%			
12	NPV:	$ 0.00			
13	IRR:	7.00%			

Cells B4 through B9 and B11 are inputs provided by the user

Cell formulas are in the appendix

A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/

Figure 6: Financial Calculator Template in Excel Calculator Portion Based on Figure 5 Cash Flows

	F	G	H	I	J	K	L	M	N	O
1	Financial Calculator:									
2										
3	To clear the cash flow inputs, use the following key sequence:									
4										
5	CF		2ND		CE|C					
6										
7										
8	KEY:	Calculator Screen:		Your Input:		KEY:		KEY:		
9	CF	CF0=		-1041.00		ENTER		↓		
10		C01		80.00		ENTER		↓		
11		F01=		4.00		ENTER		↓		
12		C02		1080.00		ENTER		↓		
13		F02=		1.00		ENTER		↓		
14		C03								
15										
16										
17										
18										
19										
20										
21										
22	KEY:	Calculator Screen:		Your Input:		KEY:		KEY:		
23	NPV	I = 0.00		7.00		ENTER		↓		
24		NPV = 0.00								
25	CPT	NPV = 0.00								
26										
27	KEY:	Calculator Screen:								
28	IRR	IRR = 0.00								
29	CPT	IRR = 7.00								
30										
31	NOTE: A rate is presented in the calculator as X.XX instead of X.XX%, i.e. 6.00 instead of 6.00%									

Cell formulas are in the appendix A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/

The first thing the student needs to perform correctly is entering the correct amounts and timing of the cash flows from the timeline. Two common mistakes are having the fifth cash flow be $1,000.00 instead of $1,080.00 or if using the Excel templates that can accept more cash flows, having the fifth cash flow be $80.00 and the sixth cash flow be $1,000.00. Again, the template forces the student to understand the correct timeline for the underlying cash flows.

Second, notice, when the cash flows are entered correctly, the IRR is 7.00%, which is the yield-to-maturity. Third, when viewing the cash flow keystrokes for the cash flow (CF) function of the calculator, notice there are only two cash flows inputted after Year 0: 80.00 and 1080.00. This exercise demonstrates how the "frequency" function of the financial calculator works. "F01=" is the frequency or number of times the cash flow is the value set at C01 (80.00 in this case). Although the default is 1.00, it can be changed to 4.00 to reflect four annual cash flows of $80.00. The next cash flow "C02" is 1080.00 and is considered to occur after the four annual cash flows of $80.00, i.e. in Year 5.

Demonstrate a capital budgeting project with repeated cash flows:

If the bond valuation topic is taught after the NPV and IRR concepts, the student may not understand the exercise above. Below is another example of repeated cash flows in the context of capital budgeting.

Assume a project has $450 initial cost, followed by annual cash flows of $60 in Year 1, $60 in Year 2, $70 in Year 3, $250 in Year 4, and $250 in Year 5. If the discount

rate is 9%, the NPV of the project is $49.19 and the IRR is 12.13%. The cash flow timeline is presented in Figure 7. Figure 8 shows the keystrokes produced by the template.

Figure 7: Financial Calculator Template in Excel Cash Flow Portion (Repeated Cash Flows)

	A	B	C	D	E
1	**Project Cash Flows:**				
2					
3	**Period:**	**Cash Flow:**	Frequency:	ID:	
4	0	**$ (450.00)**		1	
5	1	**$ 60.00**	1	100	
6	2	**$ 60.00**	2	100	
7	3	**$ 70.00**	1	200	
8	4	**$ 250.00**	1	300	
9	5	**$ 250.00**	2	300	
10					
11	**Discount rate:**	**9.00%**			
12	**NPV:**	$ 49.19			
13	**IRR:**	12.13%			

Cells B4 through B9 and B11 are inputs provided by the user

Cell formulas are in the appendix

A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/

Figure 8: Financial Calculator Template in Excel Calculator Portion Based on Figure 7 Cash Flows

	F	G	H	I	J	K	L	M	N	O
1	**Financial Calculator:**									
2										
3	**To clear the cash flow inputs, use the following key sequence:**									
4										
5	CF		2ND		CE|C					
6										
7										
8	**KEY:**	**Calculator Screen:**		**Your Input:**		**KEY:**		**KEY:**		
9	CF	CF0=		-450.00		ENTER		↓		
10		C01		60.00		ENTER		↓		
11		F01=		2.00		ENTER		↓		
12		C02		70.00		ENTER		↓		
13		F02=		1.00		ENTER		↓		
14		C03		250.00		ENTER		↓		
15		F03=		2.00		ENTER		↓		
16		C04								
17										
18										
19										

20								
21								
22	**KEY:**	**Calculator Screen:**	**Your Input:**	**KEY:**		**KEY:**		
23	NPV	I = 0.00	9.00	ENTER		↓		
24		NPV = 0.00						
25	CPT	NPV = 49.19						
26								
27	**KEY:**	**Calculator Screen:**						
28	IRR	IRR = 0.00						
29	CPT	IRR = 12.13						
30								
31	**NOTE: A rate is presented in the calculator as X.XX instead of X.XX%, i.e. 6.00 instead of 6.00%**							
Cell formulas are in the appendix A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/								

Note that there are multiple repeated cash flows -- $60 in Year 2 and Year 3, and $250 in Year 4 and Year 5. By changing the "F01" and "F03" inputs from the default value to two, the student can effectively save time by entering three cash flows instead of five.

Demonstrate the existence of two IRRs:

Change the project cash flows to an initial cost of $366,000.00, followed by annual cash flows of $856,000.00 in Year 1 and -$500,000.00 in Year 2. To provide context, the project is a mine that requires a cost of $366,000.00 to open and then a cost of $500,000.00 in Year 2 to shutter the mine. Assuming a discount rate of 15.00%, the NPV for the project is $275.99 with an IRR 13.23% (13.2337% to be more precise, see Figures 9 and 10).

Figure 9: Financial Calculator Template in Excel Cash Flow Portion (Two IRRs)

	A	B	C	D	E
1	**Project Cash Flows:**				
2					
3	**Period:**	**Cash Flow:**	Frequency:	ID:	
4	0	**$ (366,000.00)**		1	
5	1	**$ 856,000.00**	1	100	
6	2	**$ (500,000.00)**	2	200	
7	3				
8	4				
9	5				
10					

11	**Discount rate:**	**15.00%**			
12	**NPV:**	$ 275.99			
13	**IRR:**	13.23%			

Cells B4 through B9 and B11 are inputs provided by the user

Cell formulas are in the appendix

A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/

Figure 10: Financial Calculator Template in Excel Calculator Portion Based on Figure 9 Cash Flows

	F	G	H	I	J	K	L	M	N	O
1	**Financial Calculator:**									
2										
3	**To clear the cash flow inputs, use the following key sequence:**									
4										
5	CF		2ND		CE|C					
6										
7										
8	**KEY:**	**Calculator Screen:**		**Your Input:**		**KEY:**		**KEY:**		
9	CF	CF0=		-366000.00		ENTER		↓		
10		C01		856000.00		ENTER		↓		
11		F01=		1.00		ENTER		↓		
12		C02		-500000.00		ENTER		↓		
13		F02=		1.00		ENTER		↓		
14		C03								
15										
16										
17										
18										
19										
20										
21										
22	**KEY:**	**Calculator Screen:**		**Your Input:**		**KEY:**		**KEY:**		
23	NPV	I = 0.00		15.00		ENTER		↓		
24		NPV = 0.00								
25	CPT	NPV = 275.99								
26										
27	**KEY:**	**Calculator Screen:**								
28	IRR	IRR = 0.00								
29	CPT	IRR = 13.23								
30										
31	**NOTE: A rate is presented in the calculator as X.XX instead of X.XX%, i.e. 6.00 instead of 6.00%**									

Cell formulas are in the appendix

A copy of this spreadsheet is available at: https://scholarship.richmond.edu/finance-faculty-publications/XX/

Next, change the project discount rate to 20.6461%. Notice the NPV will be approximately $0.00, which indicates that 20.6461% is also an IRR (one can then emphasize that an IRR is the discount rate that sets NPV equal to zero). However, the financial calculator will not actually find this second IRR. To be fair to an introductory student, this type of revelation can cause a lot of confusion, but generally it is worth demonstrating to show that project metrics become more complicated when there are negative cash flows within the project instead of only at the beginning of the project. Further, if desired, modified techniques, such as, modified IRR (MIRR) can be introduced as a means of addressing the multiple IRR issue.

CONCLUSION

There are available Excel templates already for time value of money and the financial calculator (e.g. Alexander, Arnold, and Farizo (2022)) that generally cover annuities and there are a number of YouTube videos for the financial calculator that cover NPV and IRR with usually a single example. However, the cash flow (CF) function of the financial calculator can be complicated to implement in the beginning and students really benefit from seeing multiple applications rather than just a single example in a three-minute video. Further, the idea of reflecting the cash flows from a timeline into the financial calculator is generally missing from these presentations.

The Excel template presented addresses these shortcomings of videos and provides the ability within a classroom setting to demonstrate how the cash flows on a timeline dictate the inputs for a financial calculator. Multiple examples can be presented in class with a financial calculator in hand and with a full presentation of all of the necessary keystrokes being illustrated by the template at a single glance. Whereas, with a video, if

you miss a keystroke, it is necessary to reverse the video or to start the video from the beginning.

APPENDIX

Cell formulas for Figures 2 and 3:

Note:

The expression " " are double quotes around a blank line space

The following cells are merged together: G9 and H9, G10 and H10, G11 and H11, G12 and H12, G13 and H13, G14 and H14, G15 and H15, G16 and H16, G17 and H17, G18 and H18, G19 and H19, G20 and H20, G23 and H23, G24 and H24, G25 and H25, G28 and H28, G29 and H29, I9 and J9, I10 and J10, I11 and J11, I12 and J12, I13 and J13, I14 and J14, I15 and J15, I16 and J16, I17 and J17, I18 and J18, I19 and J19, I20 and J20, I23 and J23, I24 and J24, I25 and J25, and cells F31 through O31

Cells that are black with white script: set the cell background as black with the font set as white.

CELL B12: =NPV(B11,B4:B9)*(1 + B11)

CELL B13: =IRR(B4:B9, B11)

CELL C5: =IF(AND(B5 < > "", B5 = B4), 1 + C4, IF(B5 = "", "", 1))
Copy this cell into cells C6 through C9

CELL D4: =IF(B4 < > "", 1, "")

CELL D5: =IF(AND(C5 > 0, C5 < > ""), 100, "")

CELL D6: = IF(AND(C6 > 1, C6 < > ""), D5, IF(C6 = "", "", D5 + 100))
Copy this cell into cells D7 through D9

CELL G9: =IF(COUNTIF($D$4:$D$9, "=1") > 0, "CF0 =", "")

CELL G10: =IF(COUNTIF($D$4:$D$9, "=1") > 0, "C01 =", "")

CELL G11: =IF(COUNTIF($D$4:$D$9, "=100") > 0, "F01 =", "")

CELL G12: =IF(COUNTIF($D$4:$D$9, "=100") > 0, "C02", "")

CELL G13: =IF(COUNTIF($D$4:$D$9, "=200") > 0, "F02 =", "")

CELL G14: =IF(COUNTIF($D$4:$D$9, "=200") > 0, "C03", "")

CELL G15: =IF(COUNTIF($D$4:$D$9, "=300") > 0, "F03 =", "")

CELL G16: =IF(COUNTIF($D$4:$D$9, “=300”) > 0, “C04” “”)

CELL G17: =IF(COUNTIF($D$4:$D$9, “=400”) > 0, “F04 =”, “”)

CELL G18: =IF(COUNTIF($D$4:$D$9, “=400”) > 0, “C05” “”)

CELL G19: =IF(COUNTIF($D$4:$D$9, “=500”) > 0, “F05 =”, “”)

CELL G20: =IF(COUNTIF($D$4:$D$9, “=500”) > 0, “C06” “”)

CELL I9: =IF(COUNTIF($D$4:$D$9, “=1”) > 0, B4, “”)

CELL I10: =IF(COUNTIF($D$4:$D$9, “=100”) > 0, B5, “”)

CELL I11: =IF(COUNTIF($D$4:$D$9, “=100”) > 0, COUNTIF($D$4:$D$9, “=100”), “”)

CELL I12: =IF(COUNTIF($D$4:$D$9, “=200”) > 0, XLOOKUP(200, $D$4:$D$9, $B4:$B$9, “” , 0, 1), “”)

CELL I13: =IF(COUNTIF($D$4:$D$9, “=200”) > 0, COUNTIF($D$4:$D$9, “=200”), “”)

CELL I14: =IF(COUNTIF($D$4:$D$9, “=300”) > 0, XLOOKUP(300, $D$4:$D$9, $B4:$B$9, “”, 0, 1), “”)

CELL I15: =IF(COUNTIF($D$4:$D$9, “=300”) > 0, COUNTIF($D$4:$D$9, “=300”), “”)

CELL I16: =IF(COUNTIF($D$4:$D$9, “=400”) > 0, XLOOKUP(400, $D$4:$D$9, $B4:$B$9, “”, 0, 1), “”)

CELL I17: =IF(COUNTIF($D$4:$D$9, “=400”) > 0, COUNTIF($D$4:$D$9, “=400”), “”)

CELL I18: =IF(COUNTIF($D$4:$D$9, “=500”) > 0, XLOOKUP(500, $D$4:$D$9, $B4:$B$9, “”, 0, 1), “”)

CELL I19: =IF(COUNTIF($D$4:$D$9, “=500”) > 0, COUNTIF($D$4:$D$9, “=500”), “”)

CELL I20: =IF(COUNTIF($D$4:$D$9, “=600”) > 0, XLOOKUP(600, $D$4:$D$9, $B4:$B$9, “”, 0, 1), “”)

CELL K9: =IF(I9 < > “”), “ENTER”, “”), copy this cell for cells K10 through K20

CELL M9: =IF(I9 < > “”, “↓”, “”), copy this cell for cells M10 through M20, the down arrow is a symbol from the “Insert” menu

CELL I23: = B11 * 100

CELL K23: =IF(I23 < > “”, “ENTER”, “”)

CELL M23: =IF(I23 < > “”, “↓”, “”)

CELL G25: =CONCATENATE(“NPV = “,TEXT(B12,”#,###,###,###,##0.00”)), note: could also use the =CONCAT function with newer versions of Excel

CELL G29: =CONCATENATE(“IRR = “,TEXT((B13 * 100),”#,###,###,###,##0.00”)), note: could also use the =CONCAT function with newer versions of Excel

References

Alexander, Maura, Tom Arnold, and Joseph Farizo. 2022. "Excel Templates for Illustrating TVM Calculations and a Financial Calculator with Associated Excel Functions." *Journal of Economics and Finance Education,* 21: 79-92.