Mini Case #1
Watertown, Inc.:
Capital Budgeting Decision Analysis

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Section 5, Group 6
September 6, 2015

Introduction

Watertown, Inc. is considering two alternative options for manufacturing inflatable tubes. The first process option has an initial investment of $1M with higher earnings over the next 5 years, while the second process will cost less at $0.8M but with slightly lower revenues. Several capital budgeting tools were used to determine the best option that would provide the most profitability for the firm; tools used include the payback period, discounted payback, internal rate of return (IRR), modified internal rate of return (MIRR), incremental IRR, profitability index (PI), and Net Present Value (NPV). The solutions to all of these tools are listed below in Figure 1, with evidence and calculations located in Figures 2-11 in the Appendix. Though some of the results of these tools pointed to Process 2 being the best choice, in the end NPV is the correct tool to use as it provides the right timing, scalability, risk, and all cash flows for each process. We first take a look at the payback period evaluation.

	Process 1	Process 2
NPV	$930,644.14	$595,654.42
IRR	36.91%	44.06%
Payback Period (years)	2.5	1.50
Discounted payback period (years)	2.92	1.76
Incremental IRR: 1 over 2	28.35%	
~~MIRR~~	~~25.18%~~	~~22.67%~~
Profitability Index	1.93	1.74

Figure 1: Results of Capital Budgeting Tools

Payback Period

The payback period tool utilizes a very simple calculation to determine the timing of when a project's cash flows will pay off the initial investment. For Watertown, Process 2 would be selected because it will repay its initial investment quicker at 1.5 years (Figure 3), as compared to Process 1 at 2.5 years (Figure 2). However, given the inherent risks and capital intensive nature of investing in inflatable tubes, the payback period and its perceived benefits of simplicity have a short-term oriented focus characterized by several drawbacks: 1) the timing of cash flows are ignored during the payback period; 2) cash flows are overlooked post initial investment recovery; and 3) identifying an acceptable payback term, or end date, is an arbitrary process void of capital market guidance. Essentially, it is a "flying-blind" approach when long-term quality investment analysis is warranted.

Discounted Payback

The discounted payback period tool discounts the cash flows during the payback period until they equal the initial investment. When using this tool in a capital budget selection process, Watertown management should select Process 2 at 1.76 years (Figure 3), as compared to Process 1 at 2.92 years (Figure 2). Unfortunately, the discounted payback period method is equally inadequate as a long-term capital intensive budgeting tool. Similar to the payback period tool, it assigns random cutoff dates to the payback period and entirely disregards cash flows afterward the initial pay-off. Thus, advantages and disadvantages are nearly identical as compared to the payback period making the need for another tool more applicable.

Internal Rate of Return (IRR) & Modified IRR

IRR looks at the firm's ability to generate cash flows internally by discounting these cash flows at a rate that makes net present value (NPV) equal to zero. For mutually exclusive projects, the IRR with the highest rate should be selected. For Watertown management, Process 2 has the highest IRR rate of 44.06% (Figure 2) over Process 1 at 36.91% (Figure 3).

Notwithstanding its popularity for "summarizing the merits of a project" with a single number and its basic rule to "accept the project if the IRR is greater than the discount rate," the IRR calculation has some inherent flaws (Ross, Westerfield, & Jaffe, 2013). For instance, because IRR ignores scalability and timing of cash flows, Process 1 is actually the optimal choice at the established discount rate of 9.75% because the NPV is greater (Figure 7). Above the crossover rate of 28.349%, the point where NPV of both projects are equal, Process 2 becomes the more attractive investment (Figure 4 & Figure 7). Regarding modified IRR, which addresses multiple IRR difficulties by combining cash flows until only one sign remains, is deemed irrelevant considering each process produces only positive cash flows post initial investment, resulting in a single IRR for each process.

Incremental IRR

One of the major problems with IRR for mutually exclusive projects is that it masks a great deal of overall value to a company due to differences in scale and timing of two projects. By calculating an incremental cash flow and then applying IRR, a crossover point can be determined. As seen in Figure 7, Processes 1 and 2 have a crossover point at 28.349%. For Watertown Inc. to make a selection solely on IRR would dictate Process 2 as the best choice; however, this would produce less value for Watertown Inc. because the real discount value is well below the crossover point. Incremental IRR clarifies whether there is a crossover point and its relative position to the discount rate. In this case, since there is one crossover point before both IRR's, the IRR selection needs to be scrutinized by using an NPV analysis.

Net Present Value (NPV)

NPV will provide the best measure to select between mutually exclusive Process 1 and Process 2. Though Process 1 has higher start-up costs, future inflows of cash are greater than Process 2. Since present value of cash flow is dependent upon the discount rate, two curves can

be generated with different discount rates to determine which process would be more profitable for Watertown, Inc. As Figure 7 shows, Process 1 has a higher cash flow return for discount rates lower than 28.349%. Since the forecasted return of 9.75% is well below this, Process 1 is a better choice. NPV of Process 1 is $930,644, as compared to Process 2 of $595,654. At 9.75%, Process 1 provides $300K more in value.

As the discount rate grows, the NPV decreases due to the opportunity cost the company accepts by not making the same investment somewhere else. At the crossover rate where both NPV rates are identical, 28.349%, both processes would yield the same amount of present value given the different income streams. Between 0% and 28.349%, Process 1 is positive with higher NPV values then Process 2, and should be selected. For discount rates between 28.35% and 44.06%, Process 2 would be more profitable. Above 44.06%, neither Process 1 nor Process 2 would be more profitable than if invested somewhere else. However, since rates of return are typically much lower than the crossover rate of 28.349%, Process 1 is the clear answer for this analysis.

Profitability Index (PI)

The PI method shows the relative profitability, or the present value per dollar of initial cost, between Processes 1 and 2. Using PI as a method of selection, Process 1 should be selected since it has a higher value of 1.93 over Process 2 of 1.74. However, for mutually exclusive projects, PI ignores scaling and the initial investment, which could have huge discrepancy in actual value for Watertown Inc. Since the initial investments for the two projects are not overly different, this reduces the impact of the scaling flaw. Using the evaluation method of the PI here does not overturn the clear reasoning of the NPV calculation as a basis for choosing Process 1, but PI does not inform Watertown management the amount of profitability that can be gained with Process 1 over Process 2 since initial investment and scale are ignored.

Conclusion

Watertown, Inc. should choose Process 1 over Process 2; this decision is based on the mathematical analysis and comparisons of benefits between the payback period, discounted payback period, internal rate of return and modified internal rate of return, incremental internal rate of return, net present value, and the profitability index. While the payback period of Process 2 is shorter than Process 1, it is not the optimal choice when taking into consideration the inherent risks and capital needs of the investment. The discounted payback period is similarly ineffective, as it also indicates choosing Process 2 while disregarding cash flows. The IRR and incremental IRR are limited in that they ignore scalability and the timing of cash flows; choosing Process 2 based solely on a higher IRR or incremental IRR would have brought in $300K less than what Process 1 could. Finally, while the profitability index suggests that Process 1 would be the better choice, this metric also overlooks scaling and initial investment. This research shows that single analytical figures may be misleading, so it is important to analyze multiple factors in order to make the best, most profitable, decision.

Since all of the tools have some inherent flaws regarding scaling or ignoring certain cash flows, NPV analysis bridges the gap on these shortcomings. Watertown's management must rely on the NPV values as they provide a clear and accurate view of which process should be chosen. Process 1 promises higher revenues at a higher cost, while Process 2 sacrifices long-term profit for a lower initial cost. Process 1 at $930,644 is the better choice because it has a greater NPV for discount rates lower than 28.349%.

Appendix

	A	B	C	D	E	F	G	H
1	**Process 1**							
2	**Year**	**0**	**1**	**2**	**3**	**4**	**5**	
3	Rate	0.0975						
4	Initial Investment	1,000,000						
5	Depreciation		200,000	200,000	200,000	200,000	200,000	
6	EBIAT		150,000	200,000	300,000	470,000	500,000	
7	Net Cash Flow	-1,000,000	350,000	400,000	500,000	670,000	700,000	NCF=EBIAT+Depreciation
8	Discounted Cash Flow	-1,000,000	318,907	332,086	378,230	461,803	439,618	$DCF = \frac{CF_t}{(1+r)^t}$
9	Balance with discounted cash flows	-1,000,000	-681,093	-349,007	29,223	491,026	930,644	
10	NPV	930,644	=B7+NPV(B3,C7:G7)		$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$			
11	IRR	36.91%	=IRR(B7:G7)		$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t} = 0$			
12	Payback Period	2.500	years=2+(B4-C7-D7)/E7		determine the year net cash flow repays investment			
13	Discounted payback period	2.923	years=2+(B4-C8-D8)/E8		determine the year discounted cash flow repays investment			
14	Incremetal Cash Flows: Project 1 incremental to Project 2	-200,000	-250,000	0	165,000	470,000	500,000	choose higher first cost over lower first cost
15	Incremental IRR: 1 over 2	28.35%	=IRR(B14:G14)		IRR of incremental cash flows			
16	~~MIRR~~	~~25.18%~~	~~=MIRR(B7:G7,B3,B3)~~		$\sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} = \frac{\sum_{t=0}^{n} CIF_t(1+r)^{n-t}}{(1+MIRR)^n}$			Not applicable as noted.
17	Profitability Index	1.93	=SUM(C8:G8)/-B8		$PI = \frac{\sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}}{CF_0}$			

Figure 2: Process 1 Capital Budgeting Calculations and Results

Note: The same calculation methods were used for Process 2

Process 2						
Year	0	1	2	3	4	5
Rate	0.0975					
Initial Investment	800,000					
Depreciation		160,000	160,000	160,000	160,000	160,000
EBIAT		440,000	240,000	175,000	40,000	40,000
Net Cash Flow	-800,000	600,000	400,000	335,000	200,000	200,000
Discounted Cash Flow	-800,000	546,697	332,086	253,414	137,852	125,605
Balance with discounted cash flows	-800,000	-253,303	78,783	332,198	470,049	595,654
NPV	595,654					
IRR	44.06%					
Payback Period	1.500	years				
Discounted payback period	1.763	years				
~~MIRR~~	~~22.67%~~	Not applicable as noted.				
Profitability Index	1.74					

Figure 3: Process 2 Capital Budgeting Calculations and Results

Discount Rate	NPV: Process 1	NPV: Process 2	Notes
0.0%	1,620,000	935,000	
5.0%	1,227,743	744,872	
9.75%	930,644	595,654	IRR general rule = accept project when IRR is greater than discount rate
10.0%	916,682	588,510	
15.0%	666,662	458,251	
20.0%	463,220	348,470	
25.0%	295,808	254,976	
28.0%	209,318	205,345	3,973
28.349%	199,850	199,850	0 Crossover Rate = 28.349%
28.5%	195,791	197,490	(1,700)
30.0%	156,616	174,597	
35.0%	39,784	104,898	
36.9143%	(0)	80,628	NPV general rule: accept project when NPV is greater than 0
40.0%	(59,142)	43,986	
44.0556%	(128,615)	(0)	NPV general rule: accept project when NPV is greater than 0
45.0%	(143,587)	(9,625)	
50.0%	(216,214)	(57,119)	

Figure 4: Comparison of NPV versus Discount Rates for Processes 1 and 2

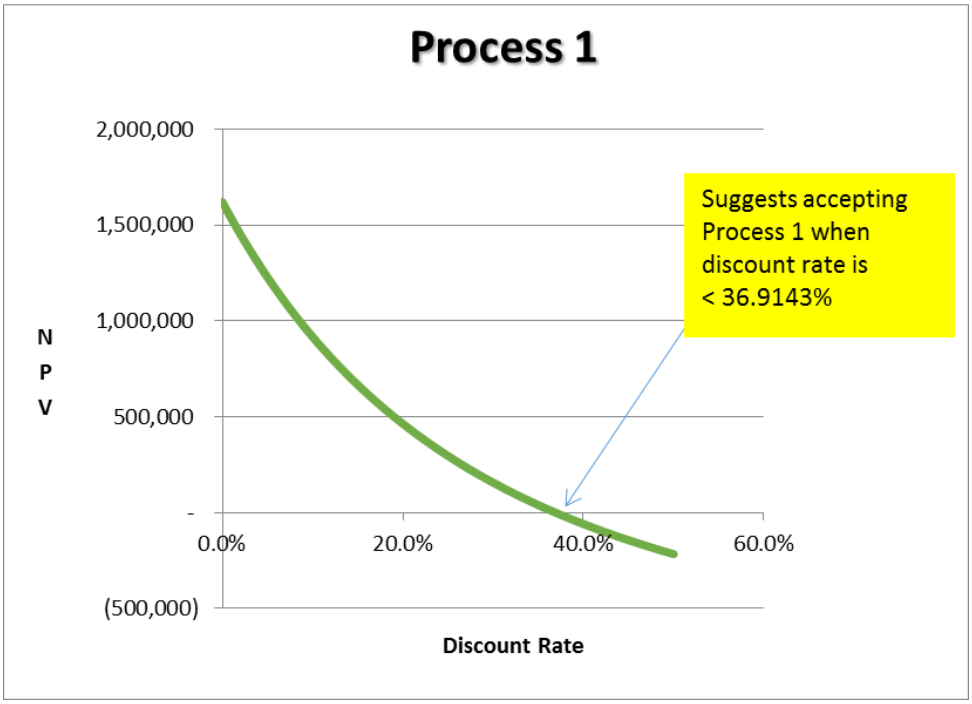

Figure 5: Process 1 NPV versus Discount Rate

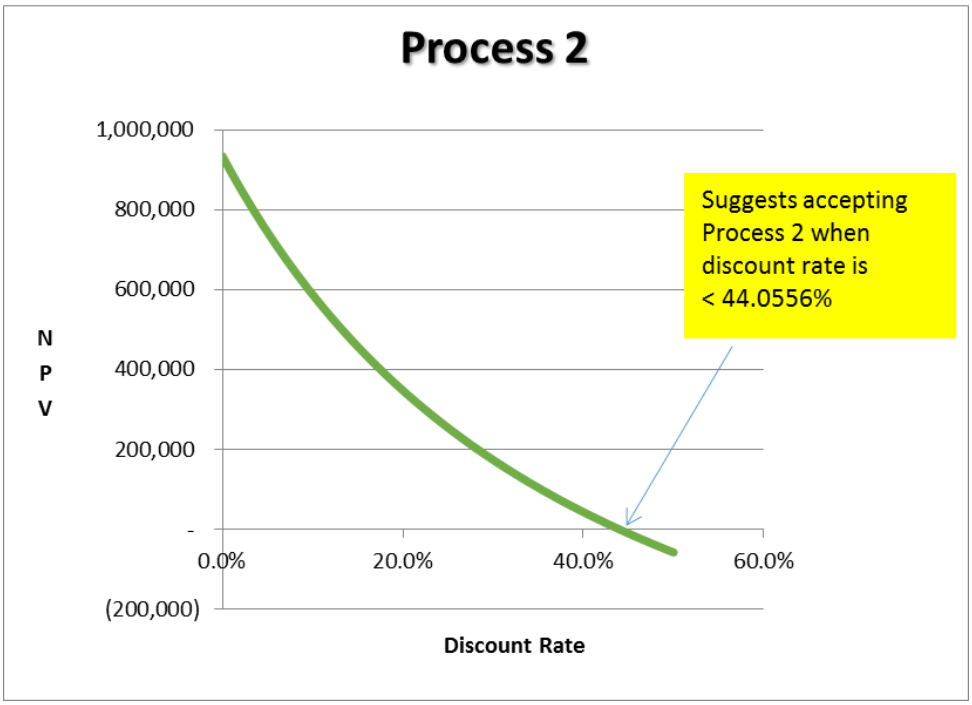

Figure 6: Process 2 NPV versus Discount Rate

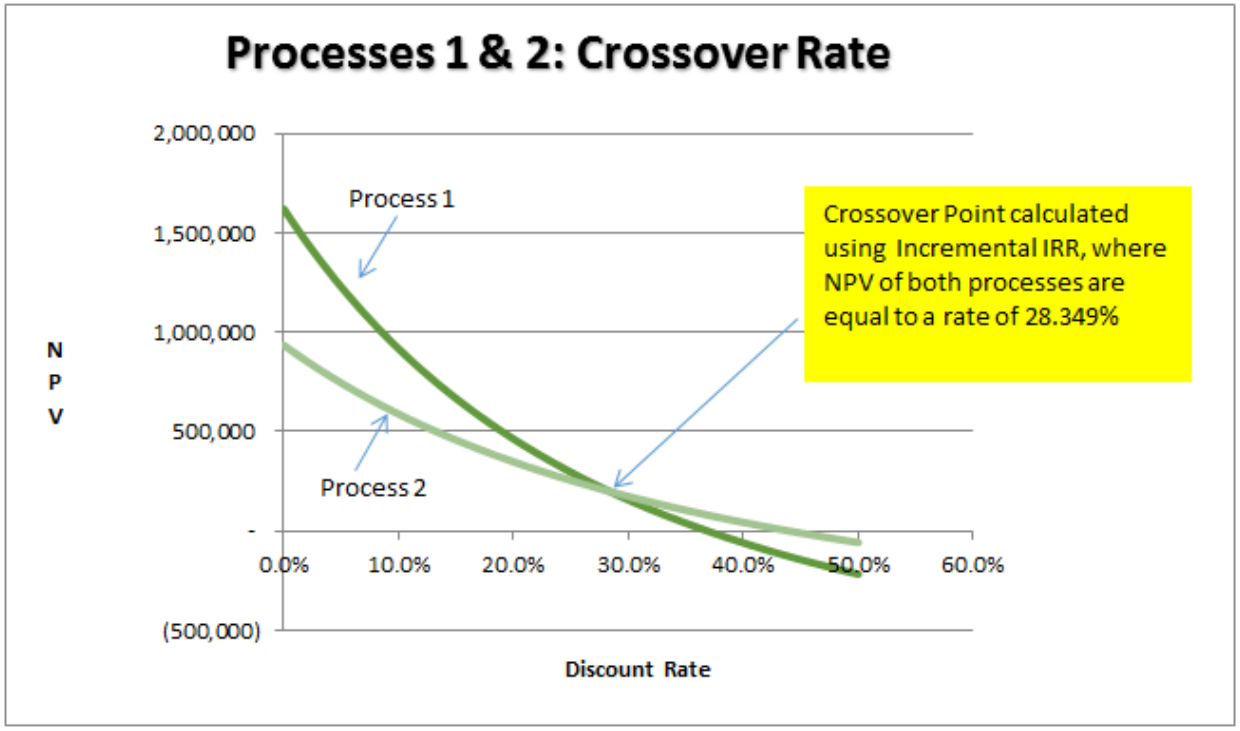

Figure 7: Processes 1 and 2 Crossover Rate

	Process 1					
Dates	0	1	2	3	4	5
Cash flows	-1,000,000	350,000	400,000	500,000	670,000	700,000
IRR	36.91%					
NPV@ 9.75%	930,644.14					
Accept if market rate	< 36.9143%					
Finance or investing	Investing					

Figure 8: Process 1 NPV versus IRR

	Process 2					
Dates	0	1	2	3	4	5
Cash flows	-800,000	600,000	400,000	335,000	200,000	200,000
IRR	44.06%					
NPV@ 9.75%	595,654.42					
Accept if market rate	< 44.0556%					
Finance or investing	Investing					

Figure 9: Process 2 NPV versus IRR

Year	0	1	2	3	4	5
Process 1: Net cash flow	-1,000,000	350,000	400,000	500,000	670,000	700,000
Process 2: Net cash flow	-800,000	600,000	400,000	335,000	200,000	200,000

	NPV	
Discount Rate	Process 1	Process 2
15%	666,662	458,251
30%	156,616	174,597
45%	-143,587	-9,625

Figure 10: Processes 1 and 2 Cash Flows and NPV

	Cash Flows						PV@9.75% of CF after	Profitability	NPV@9.75
Process	C0	C1	C2	C3	C4	C5	Initial Invest.	Index	%
1	-1,000,000	350,000	400,000	500,000	670,000	700,000	$1,930,644	1.93	$930,644
2	-800,000	600,000	400,000	335,000	200,000	200,000	$1,395,654	1.75	$595,654

Profitability Index Watertown Inc. applies a 9.75% percent discount rate to two investment opportunities.

$$\text{Profitability index (PI)} = \frac{\text{PV of cash flows } \textit{subsequent} \text{ to initial investment}}{\text{Initial investment}}$$

Figure 11: Processes 1 and 2 PI Calculations

References

Ross, S. A., Westerfield, R. W., & Jaffe, J. F. (2013). *Corporate Finance (10th ed.).* New York, NY: McGraw-Hill.