

Chapter 10

The Basics of Capital Budgeting: Evaluating Cash Flows

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Capital Budgeting Basics - Capital Budgeting Decisions are the most important decisions that are made within a company. This chapter covers the basic methods of evaluating capital budgeting projects.

Need to absorb - How to calculate and interpret Payback method, Net Present Value, Internal Rate of Return, and Profitability Index. Know the difference between Independent and Mutually Exclusive projects. Pay particular attention to NPV and IRR, and know why they sometimes produce different choices. Know the Reinvestment Rate assumptions for all methods. Know the strengths and weaknesses of Payback method, Net Present Value, Internal Rate of Return, Modified Internal Rate of Return, and Profitability Index. You need to understand there are issues related to evaluating projects with Unequal Lives. While unlikely to be on the exam, you should know how to compute the Optimal Capital Budget. Be able to define Capital Rationing.

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Do not need to absorb - How to calculate Modified Internal Rate of Return or how to calculate and interpret Discounted Payback or Equivalent Annual Annuities.

Need to Read – Read the Chapter

Need to Do – Make 100 on the quiz. Questions and Problems that you should answer- Self Test 1, Questions - All, and all end of chapter Problems related to NPV, IRR, Payback, and Profitability Index. I consider Self-Test 1, and Problems 9-13, 15, 19 and 21 to be exam level problems.

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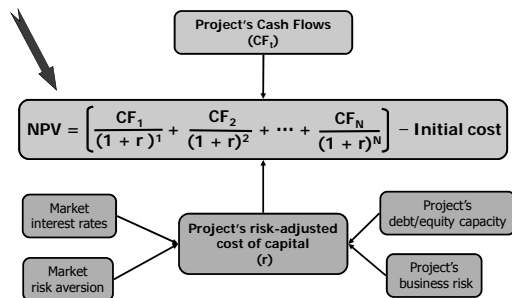
Topics

- Overview and “vocabulary”
- Methods
 - NPV
 - IRR, MIRR
 - Profitability Index
 - Payback, discounted payback
- Unequal lives
- Economic life
- Optimal capital budget

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The Big Picture: The Net Present Value of a Project



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What is capital budgeting?

- Analysis of potential projects.
- Long-term decisions; involve large expenditures.
- Very important to firm's future.

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Steps in Capital Budgeting

- Come up with a good idea
- Estimate cash flows (inflows & outflows).
- Assess risk of cash flows.
- Determine $r = \text{WACC}$ for project.
- Evaluate cash flows.

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Independent versus Mutually Exclusive Projects

- Projects are:
 - independent, if the cash flows of one are unaffected by the acceptance of the other.
 - mutually exclusive, if the cash flows of one can be adversely impacted by the acceptance of the other.

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Normal vs. Nonnormal Cash Flows

- Normal Cash Flow Project:
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 - One change of signs.
- Nonnormal Cash Flow Project:
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 - Most common: Cost (negative CF), then string of positive CFs, then cost to close project.
 - For example, nuclear power plant or strip mine.

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Rationale for the NPV Method

- $NPV = PV \text{ inflows} - \text{Cost}$
- This is net gain in wealth, so accept project if $NPV > 0$.
- Choose between mutually exclusive projects on basis of higher positive NPV. Adds most value.

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Rationale for the IRR Method

- If $IRR > r$, then the project's rate of return is greater than its cost-- some return is left over to boost stockholders' returns.
- Example:
 $r = 10\%$, $IRR = 15\%$.
- So this project adds extra return to shareholders.

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NPV and IRR may produce conflicting results

- Why? Different reinvestment rate assumptions
 - NPV at WACC, IRR at IRR
- When?
 - Size (scale) differences. Smaller projects have smaller investments. The higher the opportunity cost, the more costly the funds, so high WACC favors small projects.
 - Timing differences. Project with faster payback provides more CF in early years for reinvestment. If WACC is high, early CF especially good, $NPV_{\text{Short}} > NPV_{\text{Long}}$.
- When a conflict occurs, use NPV

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Capital Budgeting Project Categories

1. Replacement to continue profitable operations
2. Replacement to reduce costs
3. Expansion of existing products or markets
4. Expansion into new products/markets
5. Contraction decisions
6. Safety and/or environmental projects
7. Mergers
8. Other

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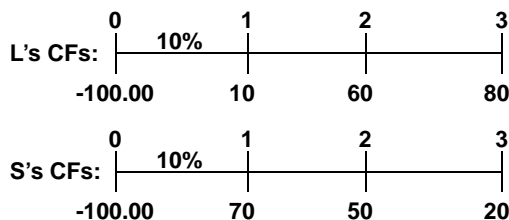
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Cash Flows for Franchises L and S



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NPV: Sum of the PVs of All Cash Flows

$$NPV = \sum_{t=0}^N \frac{CF_t}{(1+r)^t}$$

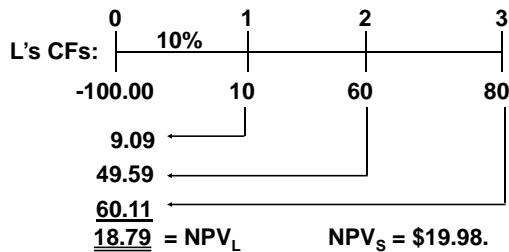
Cost often is CF_0 and is negative.

$$NPV = \sum_{t=1}^N \frac{CF_t}{(1+r)^t} - CF_0$$

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What's Franchise L's NPV?



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Calculator Solution: Enter Values in CFLO Register for L

-100

10

60

80

10 = 18.78 = NPV_L

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Rationale for the NPV Method

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Using the NPV measure, which franchise(s) should be accepted?

- If Franchises S and L are mutually exclusive, accept S because $NPV_S > NPV_L$.
- If S & L are independent, accept both; $NPV > 0$.
- NPV is dependent on cost of capital.

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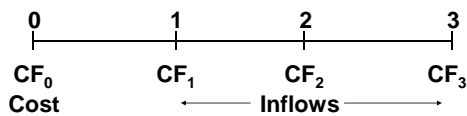
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Internal Rate of Return: IRR



IRR is the discount rate that forces PV inflows = cost. This is the same as forcing $NPV = 0$.

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NPV: Enter r , solve for NPV.

$$\sum_{t=0}^N \frac{CF_t}{(1+r)^t} = NPV$$

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IRR: Enter $NPV = 0$, Solve for IRR

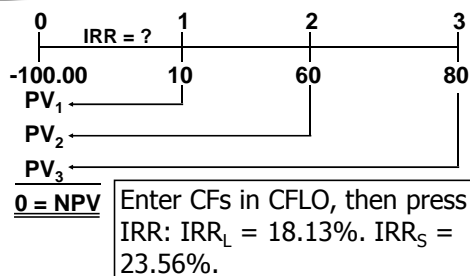
$$\sum_{t=0}^N \frac{CF_t}{(1+IRR)^t} = 0$$

IRR is an estimate of the project's rate of return, so it is comparable to the YTM on a bond.

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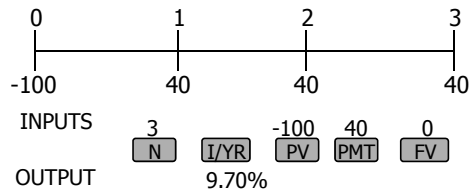
What's Franchise L's IRR?



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Finding IRR if CFs are Constant



Or, with CFLO, enter CFs and press
IRR = 9.70%.

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Rationale for the IRR Method

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- Example:
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- So this project adds extra return to shareholders.

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Decisions on Franchises S and L per IRR

- If S and L are independent, accept both: $IRR_S > r$ and $IRR_L > r$.
- If S and L are mutually exclusive, accept S because $IRR_S > IRR_L$.
- IRR is not dependent on the cost of capital used.

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Construct NPV Profiles

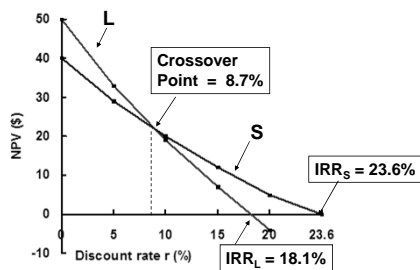
- Enter CFs in CFLO and find NPV_L and NPV_S at different discount rates:

r	NPV_L	NPV_S
0	50	40
5	33	29
10	19	20
15	7	12
20	(4)	5

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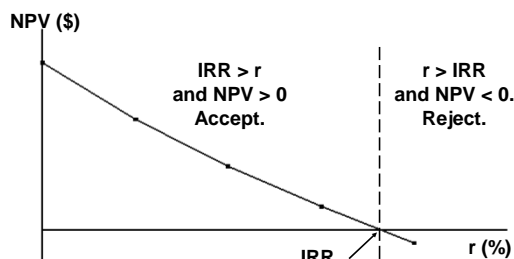
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NPV Profile



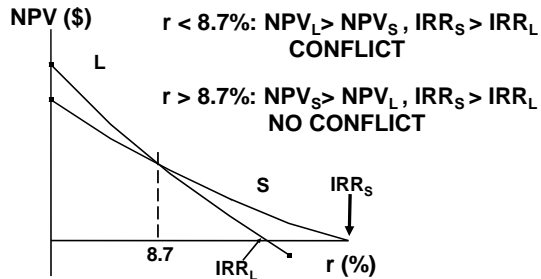
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NPV and IRR: No conflict for independent projects.



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Mutually Exclusive Projects



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To Find the Crossover Rate

- Find cash flow differences between the projects. See data at beginning of the case.
- Enter these differences in CFLO register, then press IRR. Crossover rate = 8.68%, rounded to 8.7%.
- Can subtract S from L or vice versa and consistently, but easier to have first CF negative.
- If profiles don't cross, one project dominates the other.

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Two Reasons NPV Profiles Cross

- Size (scale) differences. Smaller project frees up funds at $t = 0$ for investment. The higher the opportunity cost, the more valuable these funds, so high r favors small projects.
- Timing differences. Project with faster payback provides more CF in early years for reinvestment. If r is high, early CF especially good, $NPV_S > NPV_L$.

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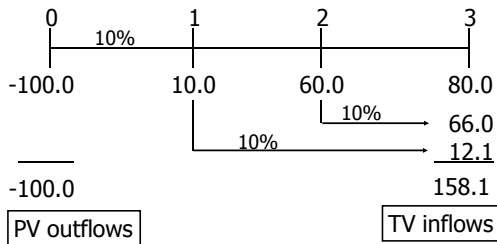
Modified Internal Rate of Return (MIRR)

- MIRR is the discount rate that causes the PV of a project's terminal value (TV) to equal the PV of costs.
- TV is found by compounding inflows at WACC.
- Thus, MIRR assumes cash inflows are reinvested at WACC.

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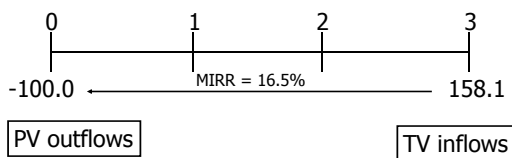
MIRR for Franchise L: First, find PV and TV ($r = 10\%$).



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Second, find discount rate that equates PV and TV.



$$\$100 = \frac{\$158.1}{(1 + \text{MIRR}_L)^3}$$

$$\text{MIRR}_L = 16.5\%$$

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To find TV with financial calculator:
Step 1, Find PV of inflows.

- First, enter cash inflows in CFLO register:
 $CF_0 = 0$, $CF_1 = 10$, $CF_2 = 60$, $CF_3 = 80$
- Second, enter $I/YR = 10$.
- Third, find PV of inflows:
Press NPV = 118.78

Step 2, Find TV of inflows.

- Enter PV = -118.78, $N = 3$, $I/YR = 10$,
PMT = 0.
- Press FV = 158.10 = FV of inflows.

Step 3, Find PV of outflows.

- For this problem, there is only one outflow, $CF_0 = -100$, so the PV of outflows is -100.
- For other problems there may be negative cash flows for several years, and you must find the present value for all negative cash flows.

Step 4, Find "IRR" of TV of inflows and PV of outflows.

- Enter $FV = 158.10$, $PV = -100$, $PMT = 0$, $N = 3$.
- Press $I/YR = 16.50\% = MIRR$.

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Profitability Index

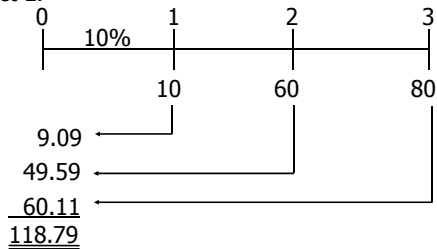
- The profitability index (PI) is the present value of future cash flows divided by the initial cost.
- It measures the "bang for the buck."

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Franchise L's PV of Future Cash Flows

Project L:



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Franchise L's Profitability Index

$$PI_L = \frac{\text{PV future CF}}{\text{Initial cost}} = \frac{\$118.79}{\$100}$$

$$PI_L = 1.1879$$

$$PI_S = 1.1998$$

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What is the payback period?

- The number of years required to recover a project's cost,
- or how long does it take to get the business's money back?

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Payback for Franchise L

	0	1	2	2.4	3
CF_t	-100	10	60		80
Cumulative	-100	-90	-30	0	50

Payback_L = 2 + \$30/\$80 = 2.375 years

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Payback for Franchise S

	0	1	1.6	2	3
CF_t	-100	70		50	20
Cumulative	-100	-30	0	20	40

Payback_S = 1 + \$30/\$50 = 1.6 years

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Strengths and Weaknesses of Payback

- Strengths:
 - Provides an indication of a project's risk and liquidity.
 - Easy to calculate and understand.
- Weaknesses:
 - Ignores the TVM.
 - Ignores CFs occurring after the payback period.
 - No specification of acceptable payback.

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Discounted Payback: Uses Discounted CFs

	0	1	2	3
	10%			
CF_t	-100	10	60	80
$PVCF_t$	-100	9.09	49.59	60.11
Cumulative	-100	-90.91	-41.32	18.79
Discounted payback	$= 2 + \$41.32/\$60.11 = 2.7 \text{ yrs}$			

Recover investment + capital costs in 2.7 yrs.

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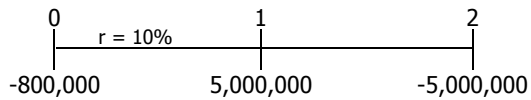
Inflow (+) or Outflow (-) in Year

0	1	2	3	4	5	N	NN
-	+	+	+	+	+	N	
-	+	+	+	+	-		NN
-	-	-	+	+	+	N	
+	+	+	-	-	-	N	
-	+	+	-	+	-		NN

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Pavilion Project: NPV and IRR?



Enter CFs in CFLO, enter I/YR = 10.

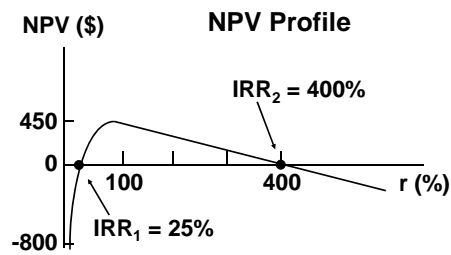
NPV = -386,777

IRR = ERROR. Why?

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Nonnormal CFs—Two Sign Changes, Two IRRs



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Logic of Multiple IRRs

- At very low discount rates, the PV of CF_2 is large & negative, so $NPV < 0$.
- At very high discount rates, the PV of both CF_1 and CF_2 are low, so CF_0 dominates and again $NPV < 0$.
- In between, the discount rate hits CF_2 harder than CF_1 , so $NPV > 0$.
- Result: 2 IRRs.

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Finding Multiple IRRs with Calculator

1. Enter CFs as before.
2. Enter a "guess" as to IRR by storing the guess. Try 10%:
10 STO
IRR = 25% = lower IRR
(See next slide for upper IRR)

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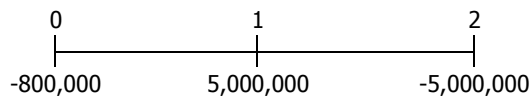
Finding Upper IRR with Calculator

Now guess large IRR, say, 200:
200 STO
IRR = 400% = upper IRR

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When there are nonnormal CFs and more than one IRR, use MIRR.



PV outflows @ 10% = -4,932,231.40.

TV inflows @ 10% = 5,500,000.00.

MIRR = 5.6%

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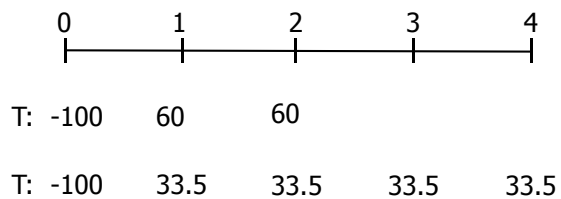
Accept Project P?

- NO. Reject because
MIRR = 5.6% < r = 10%.
- Also, if MIRR < r , NPV will be negative:
NPV = -\$386,777.

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Projects T (for two years) and F (for four years) are mutually exclusive and will be repeated; r = 10%.



Note: CFs shown in \$ Thousands

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$NPV_F > NPV_T$, but which is better? T can be repeated!

	T	F
CF_0	-100	-100
CF_1	60	33.5
N_j	2	4
I/YR	10	10
NPV	4.132	6.190

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Equivalent Annual Annuity Approach (EAA)

- Convert the PV into a stream of annuity payments with the same PV.
- T: $N=2$, $I/YR=10$, $PV=-4.132$, $FV = 0$.
Solve for $PMT = EAA_T = \$2.38$.
- F: $N=4$, $I/YR=10$, $PV=-6.190$, $FV = 0$.
Solve for $PMT = EAA_F = \$1.95$.
- T has higher EAA, so it is a better project.

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Replacement Chain

- Note that Project T could be repeated after 2 years to generate additional profits.
- Use replacement chain to put on common life.

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Replacement Chain Approach: f with Replication (\$ thousands)

0	1	2	3	4
T: -100	60	60		
<u>-100</u>	<u>60</u>	<u>-100</u>	<u>60</u>	<u>60</u>
		-40	60	60

NPV = \$7.547.

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Or, Use NPVs

0	1	2	3	4
4.132		4.132		
3.415	← 10%			
<u>7.547</u>				

The repeated NPV of Project T is bigger than F's NPV (\$7.514 > \$6.190).

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Suppose the cost to repeat T in two years rises to \$105,000?

0	1	2	3	4
T: -100	60	60		
		<u>-105</u>	60	60
		-45		

NPV_T = \$3.415 < NPV_T = \$6.190.
Now choose T.

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Economic Life versus Physical Life

- Consider another project with a 3-year life.
- If terminated prior to Year 3, the machinery will have positive salvage value.
- Should you always operate for the full physical life?
- See next slide for cash flows.

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Economic Life versus Physical Life (Continued)

Year	CF	Salvage Value
0	-\$5,000	\$5,000
1	2,100	3,100
2	2,000	2,000
3	1,750	0

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CFs Under Each Alternative (000s)

	Years: 0	1	2	3
1. No termination	-5	2.1	2	1.75
2. Terminate 2 years	-5	2.1	4	
3. Terminate 1 year	-5	5.2		

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NPVs under Alternative Lives (Cost of Capital = 10%)

- NPV(3 years) = -\$123.
- NPV(2 years) = \$215.
- NPV(1 year) = -\$273.

Conclusions

- The project is acceptable only if operated for 2 years.
- A project's engineering life does not always equal its economic life.

Contact Charles Hodges

- Email in D2L or email listed in Syllabus
- Chat Sessions
- Skype (bufordshighway), LinkedIn and Facebook (Charles Hodges).
- Office Phone (678)839-4816 and Cell Phone (770)301-8648, target is under 24 hours
