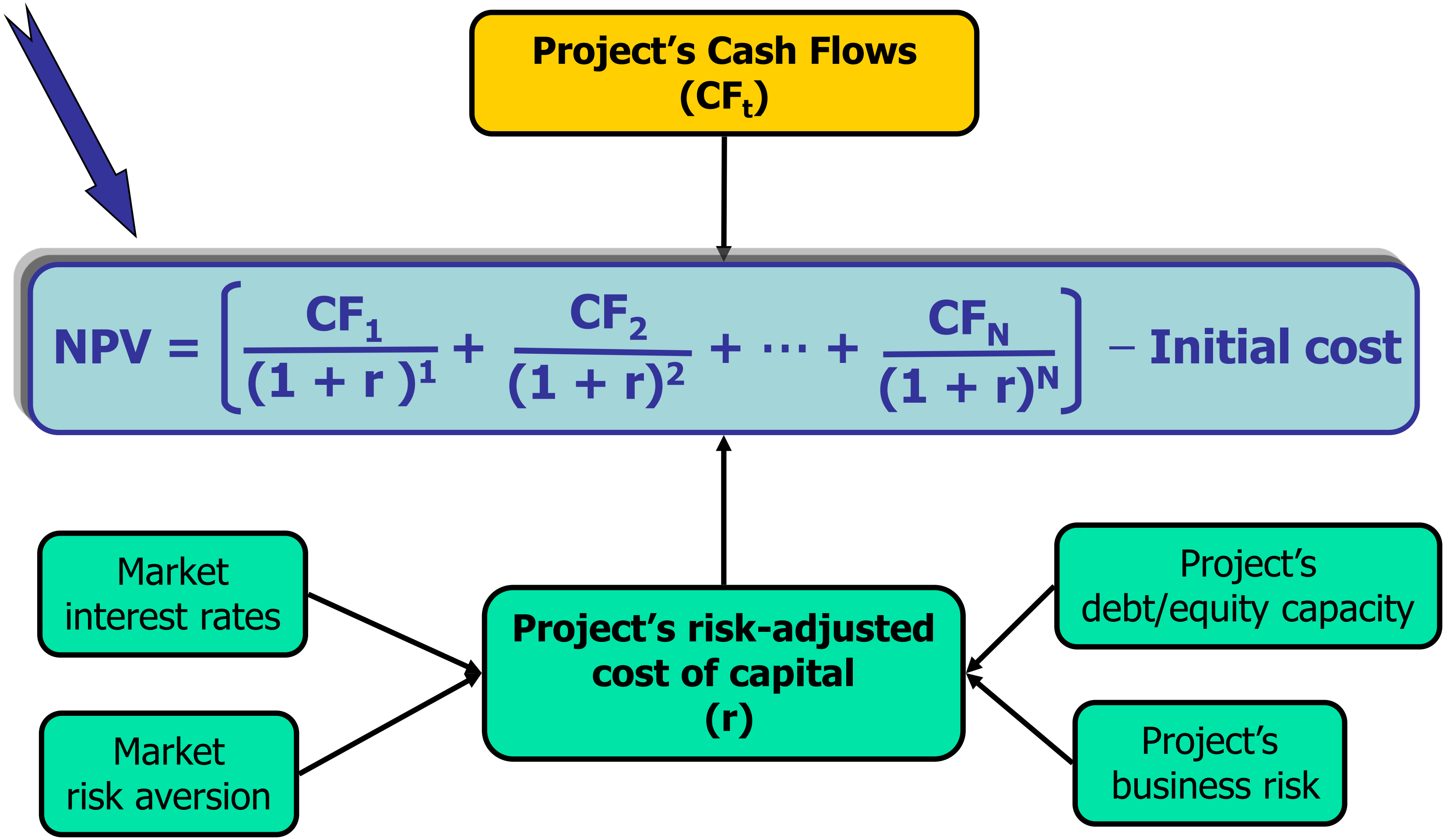
Chapter 10

The Basics of Capital Budgeting

Topics

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

The Big Picture: The Net Present Value of a Project



What is capital budgeting?

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

Steps in Capital Budgeting

- Estimate cash flows (inflows & outflows).
- Assess risk of cash flows.
- Determine r = WACC for project.
- Evaluate cash flows.

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

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.

Cash Flows for Franchises L and S

	0	1	2	3
	10%			
L's CFs:	-100.00	10	60	80

	0	1	2	3
	10%			
S's CFs:	-100.00	70	50	20

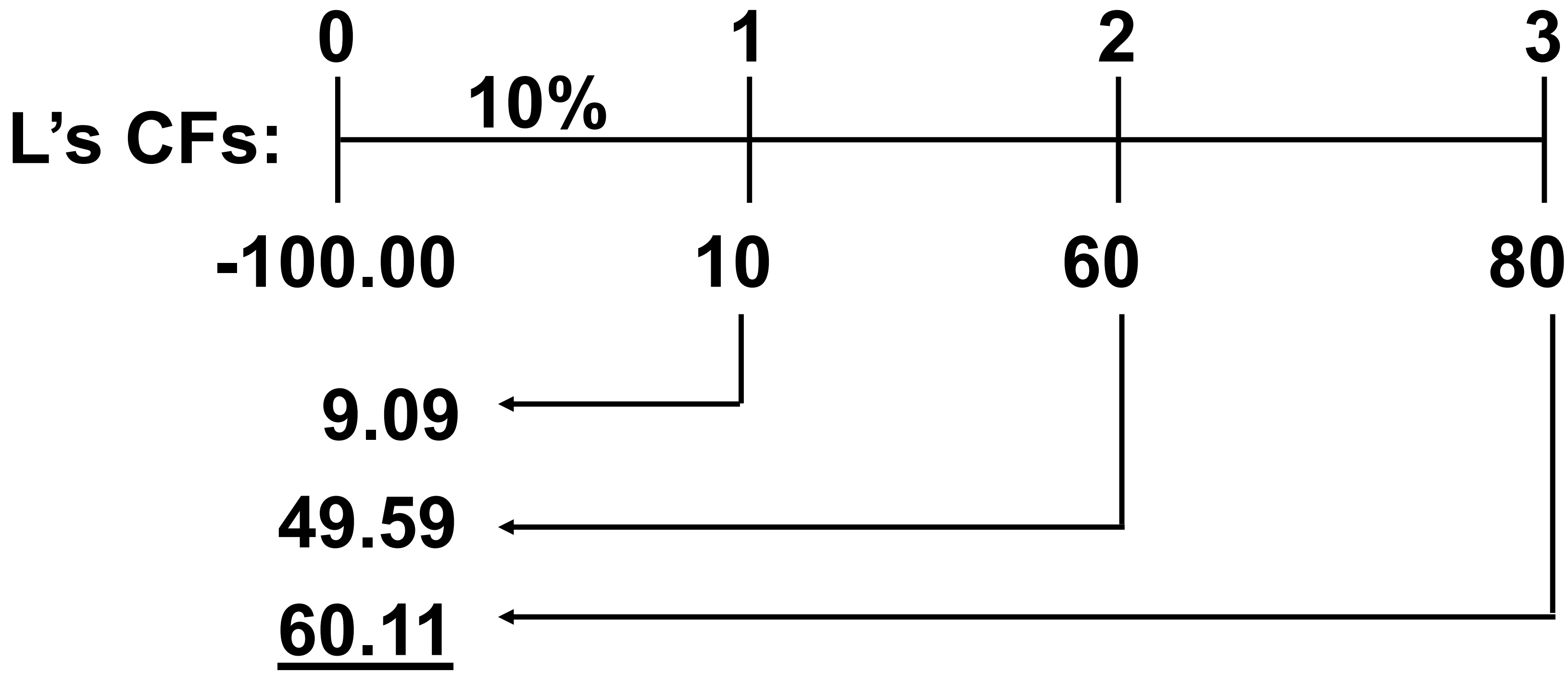
NPV: Sum of the PVs of All Cash Flows

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

Cost often is CF_0 and is negative.

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

What's Franchise L's NPV?



18.79 = NPV_L

NPV_S = $19.98.

Calculator Solution: Enter Values in CFLO Register for L

-100	CF_0		
10	CF_1		
60	CF_2		
80	CF_3		
10	I/YR	NPV	$= 18.78 = NPV_L$

Rationale for the NPV Method

- NPV = PV inflows – 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.

Using NPV method, 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.

Internal Rate of Return: IRR

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

NPV: Enter r, Solve for NPV

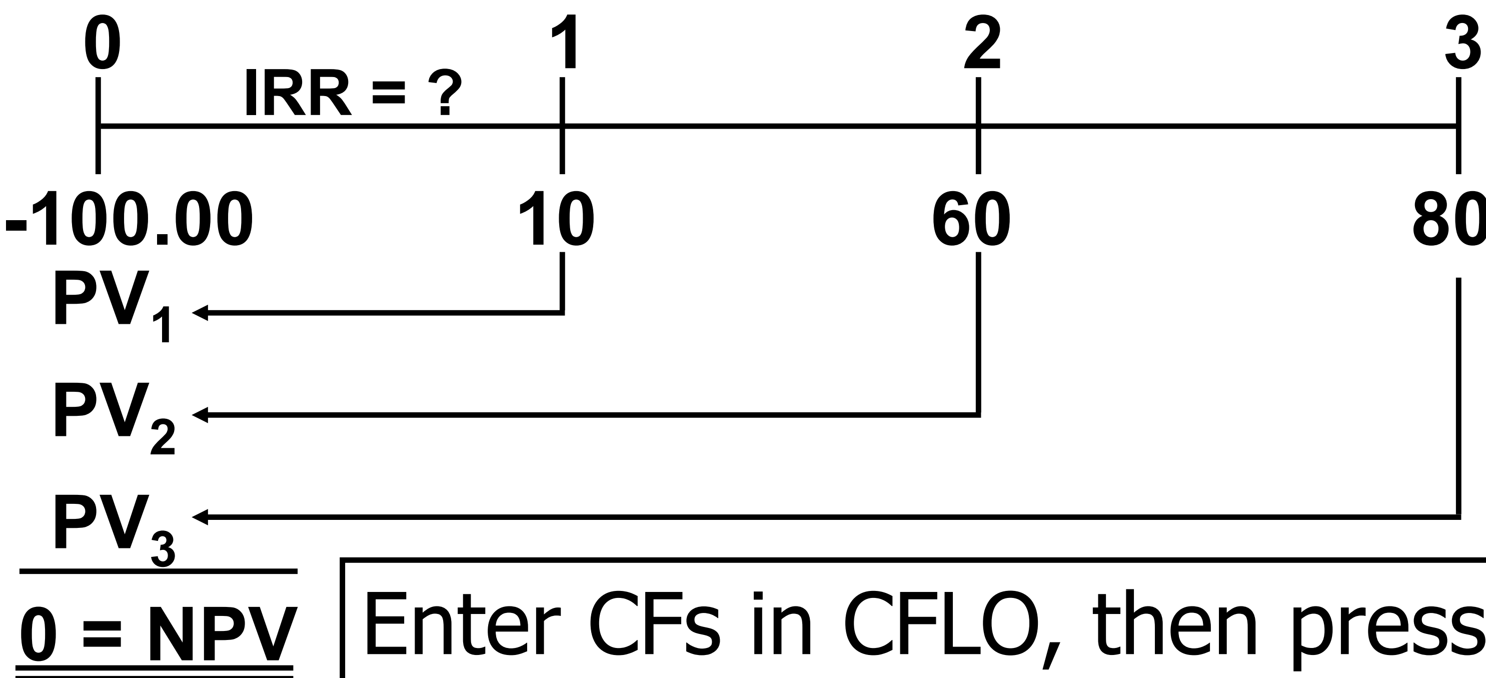
$$\sum_{t=0}^{N} \frac{CF_t}{(1+r)^t} = NPV$$

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.

What's Franchise L's IRR?



Enter CFs in CFLO, then press IRR: IRR_L = 18.13%. IRR_S = 23.56%.

Find IRR if CFs are Constant

0	1	2	3
-100	40	40	40

INPUTS	3		-100	40	0
	N	I/YR	PV	PMT	FV
OUTPUT		9.70%			

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

Rationale for the IRR Method

- If IRR > WACC, then the project's rate of return is greater than its cost-- some return is left over to boost stockholders' returns.
- Example:

  WACC = 10%, IRR = 15%.
- So this project adds extra return to shareholders.

Decisions on Franchises S and L per IRR

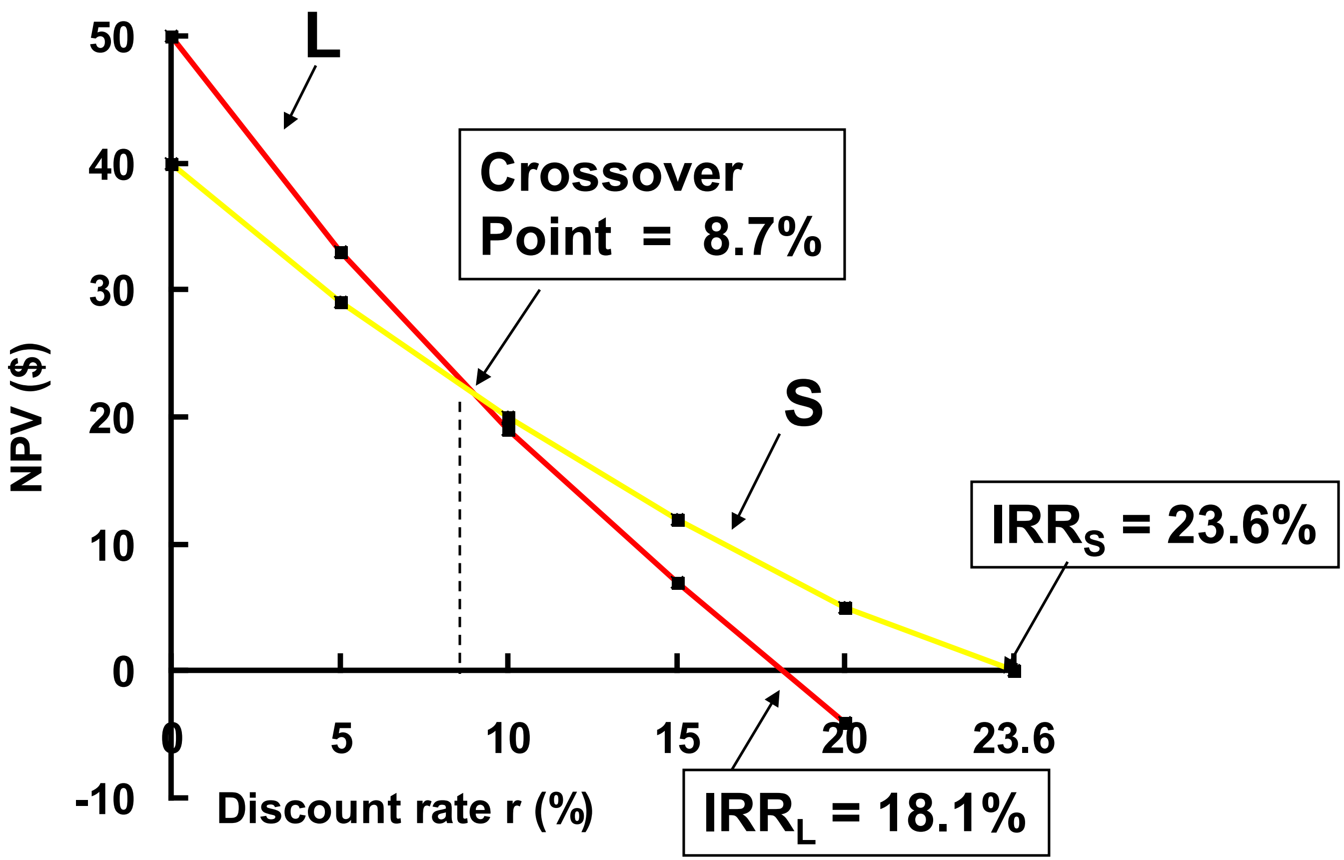
- If S and L are independent, accept both: $IRR_S > r$ and $IRR_L > r$.
- If S and L are mutually exclusive, accept S because $IRR_S > IRR_L$.
- IRR is not dependent on the cost of capital used.

Construct NPV Profiles

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

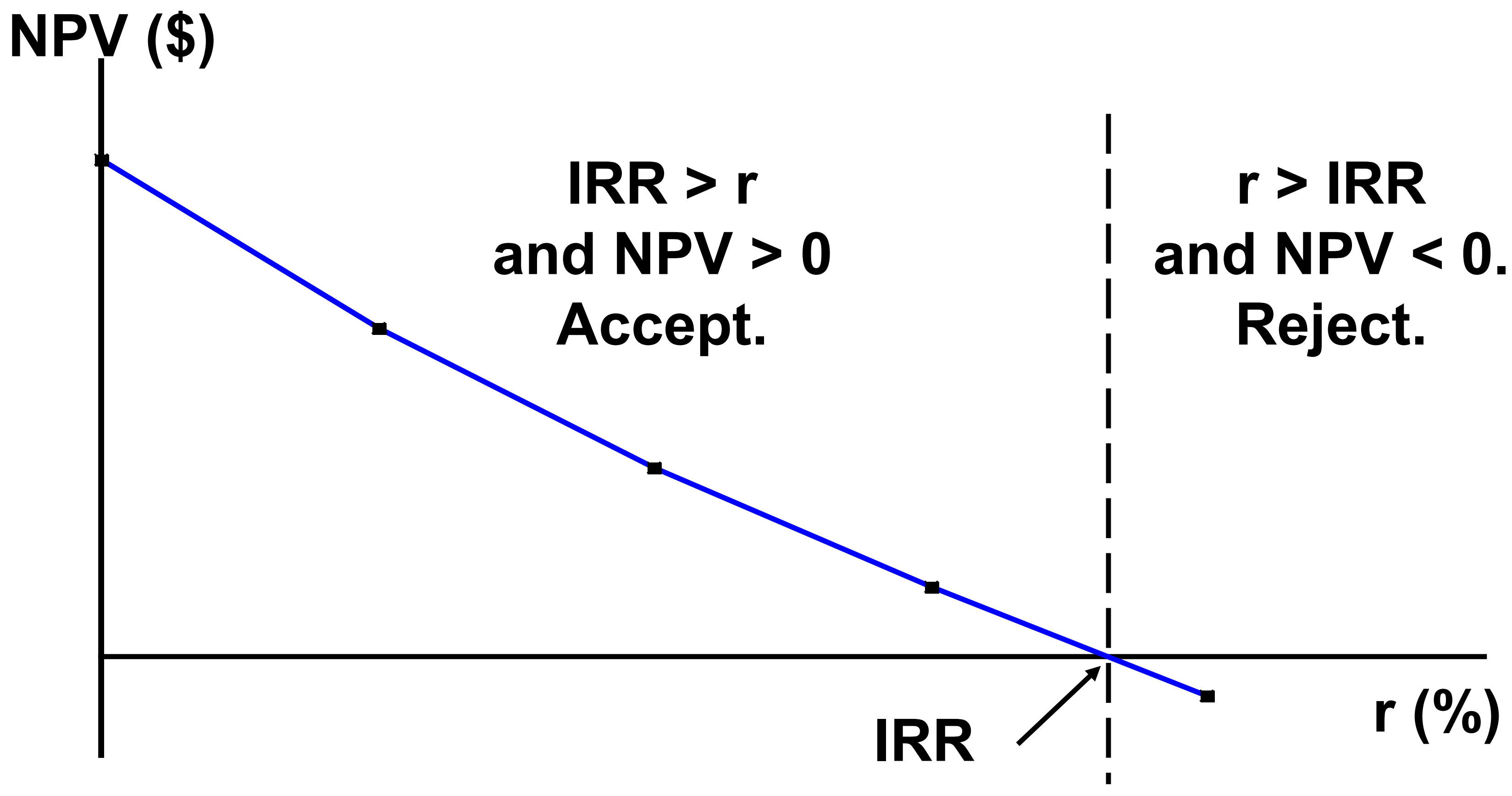
r	NPV_L	NPV_S
0	50	40
5	33	29
10	19	20
15	7	12
20	(4)	5

NPV Profile



L
Crossover Point = 8.7%
S
IRR$_S$ = 23.6%
IRR$_L$ = 18.1%
NPV ($)
50
40
30
20
10
0
-10
0
5
10
15
20
23.6
Discount rate r (%)

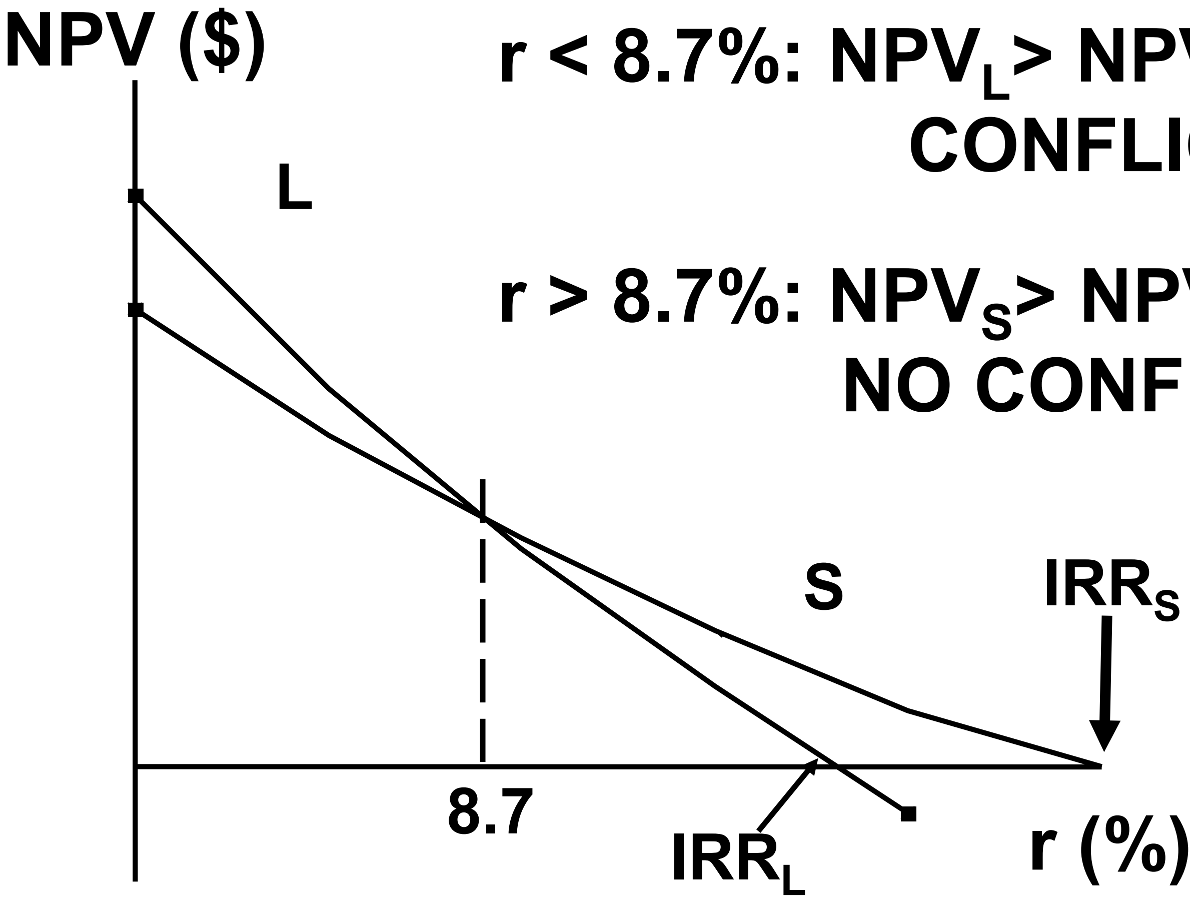
NPV and IRR: No conflict for independent projects.



Mutually Exclusive Projects

$r < 8.7\%$: $NPV_L > NPV_S$, $IRR_S > IRR_L$
CONFLICT

$r > 8.7\%$: $NPV_S > NPV_L$, $IRR_S > IRR_L$
NO CONFLICT



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.

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, $NPV_S > NPV_L$.

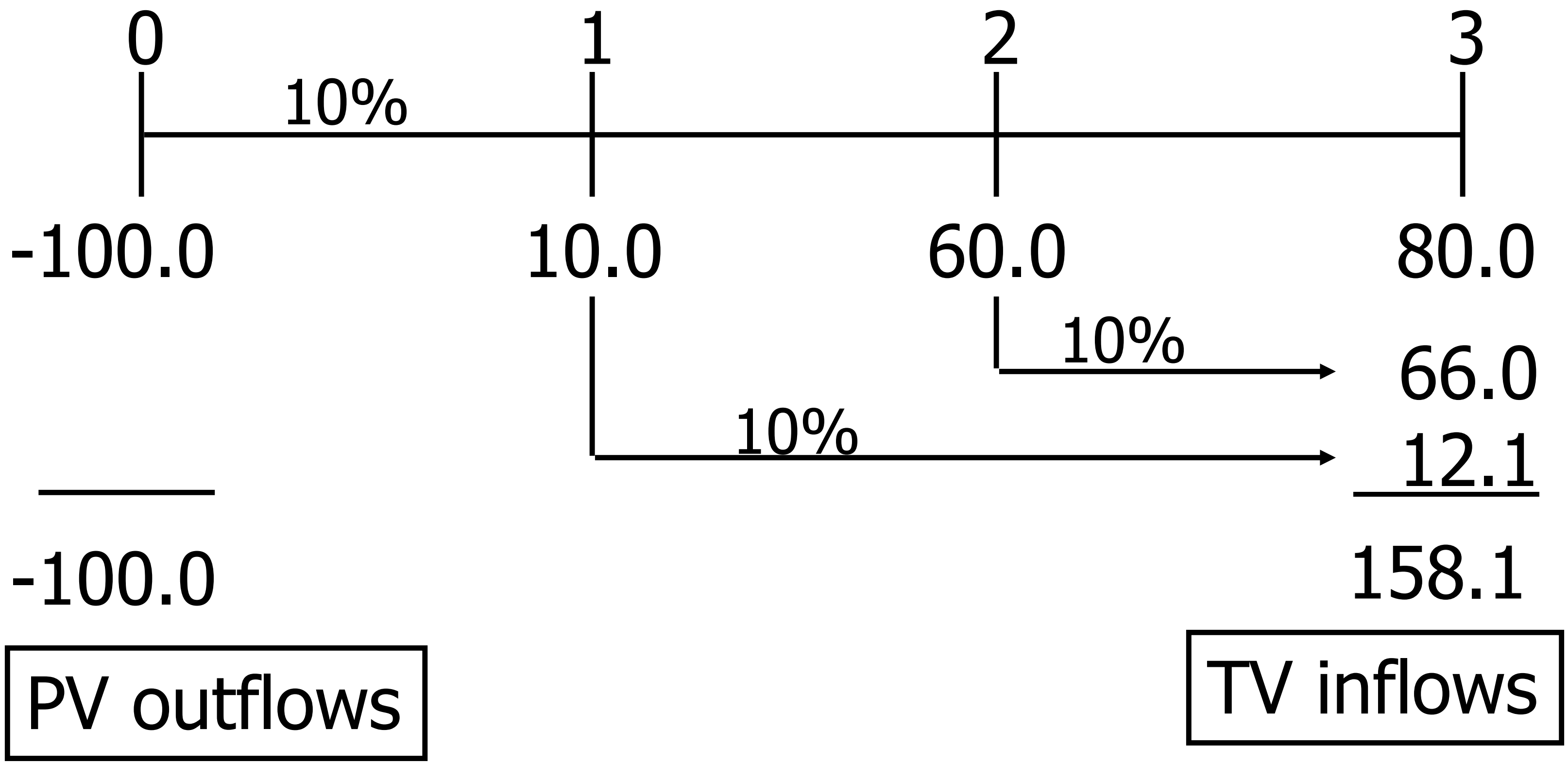
Reinvestment Rate Assumptions

- NPV assumes reinvest at r (opportunity cost of capital).
- IRR assumes reinvest at IRR.
- Reinvest at opportunity cost, r, is more realistic, so NPV method is best. NPV should be used to choose between mutually exclusive projects.

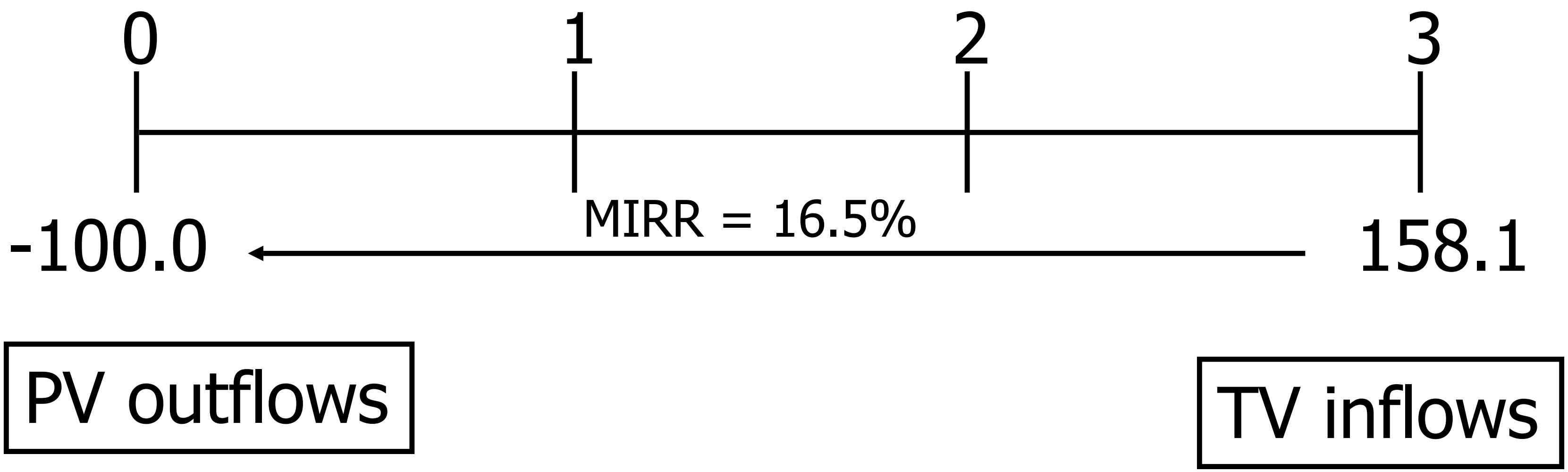
Modified Internal Rate of Return (MIRR)

- 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.

MIRR for Franchise L: First, Find PV and TV (r = 10%)



Second, Find Discount Rate that Equates PV and TV



$$\$100 = \frac{\$158.1}{(1+MIRR_L)^3}$$

$$MIRR_L = 16.5\%$$

Why use MIRR versus IRR?

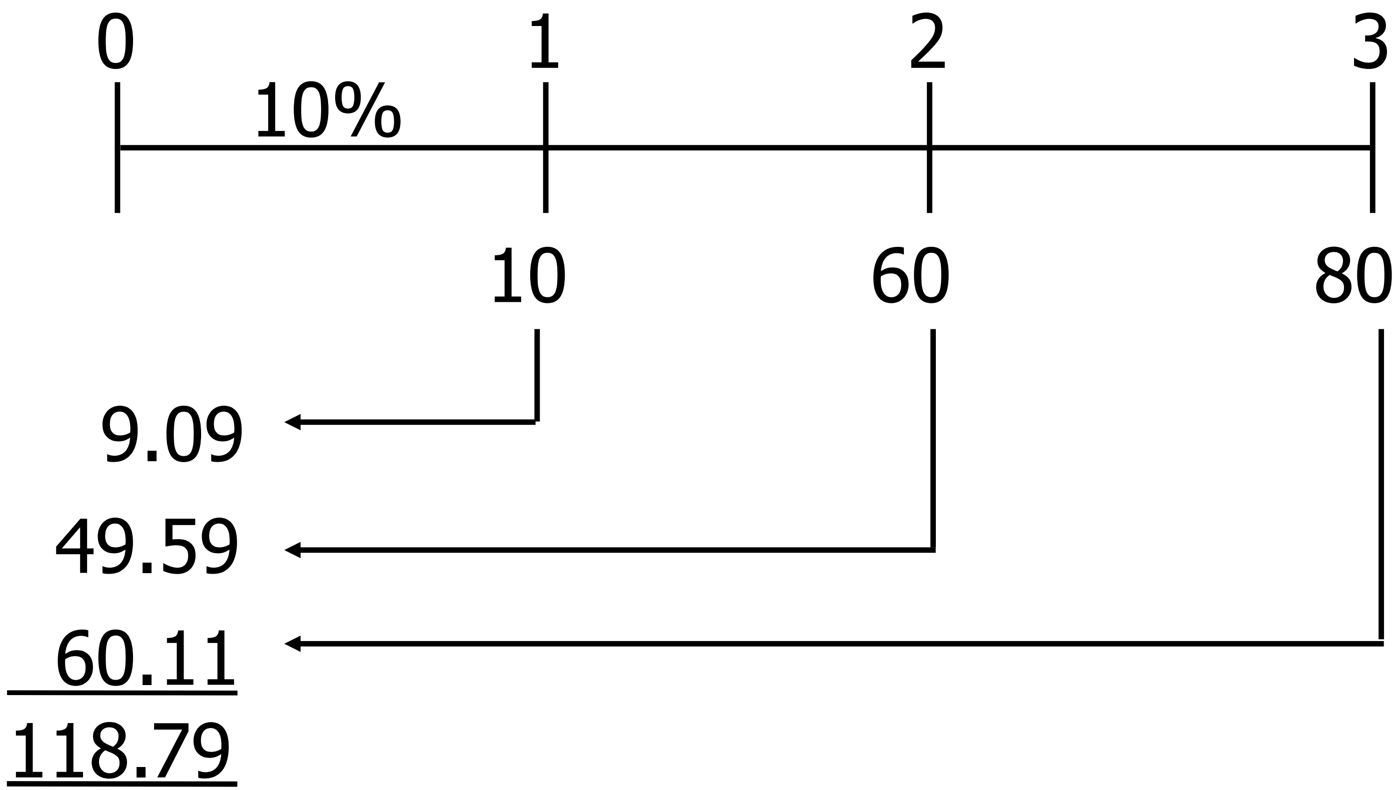
- MIRR correctly assumes reinvestment at opportunity cost = WACC. MIRR also avoids the problem of multiple IRRs.
- Managers like rate of return comparisons, and MIRR is better for this than IRR.

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.”

Franchise L's PV of Future Cash Flows

Project L:



Franchise L's Profitability Index

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

$$PI_L = 1.1879$$

$$PI_S = 1.1998$$

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?

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

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

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.

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 yrs

Recover investment + capital costs in 2.7 yrs.

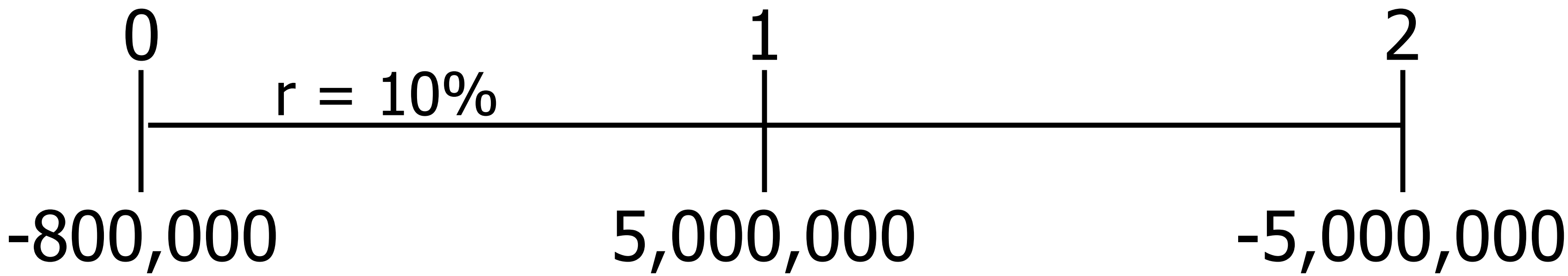
Normal vs. Nonnormal Cash Flows

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

Inflow (+) or Outflow (-) in Year

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

Pavilion Project: NPV and IRR?

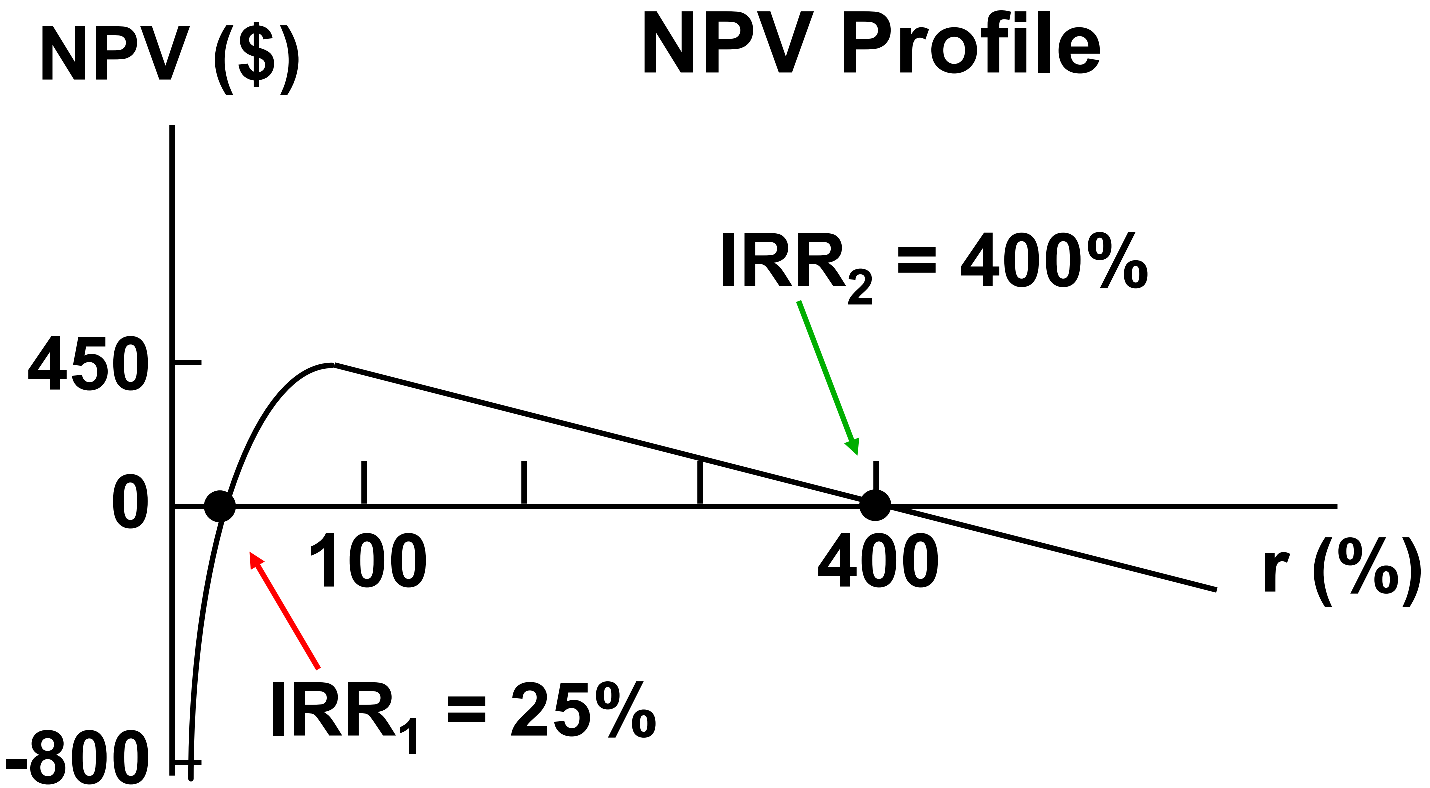


Enter CFs in CFLO, enter I/YR = 10.

NPV = -386,777

IRR = ERROR. Why?

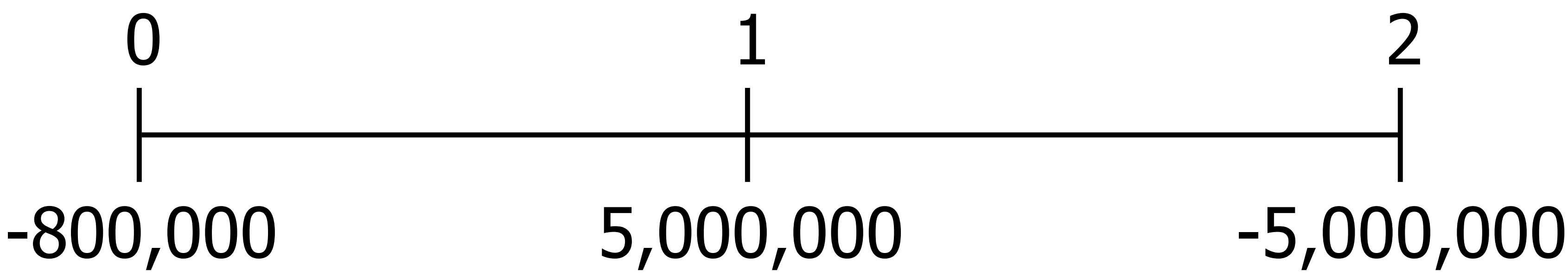
Nonnormal CFs—Two Sign Changes, Two IRRs



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.

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%

Accept Project P?

- NO. Reject because
  MIRR = 5.6% < r = 10%.

- Also, if MIRR < r, NPV will be negative:
  NPV = -$386,777.

S and L are Mutually Exclusive and Will Be Repeated, r = 10%

	0	1	2	3	4
S:	-100	60	60		
L:	-100	33.5	33.5	33.5	33.5

Note: CFs shown in $ Thousands

$NPV_L > NPV_S$, but is L better?

	S	L
CF_0	-100	-100
CF_1	60	33.5
N_J	2	4
I/YR	10	10
NPV	4.132	6.190

Equivalent Annual Annuity Approach (EAA)

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

Put Projects on Common Basis

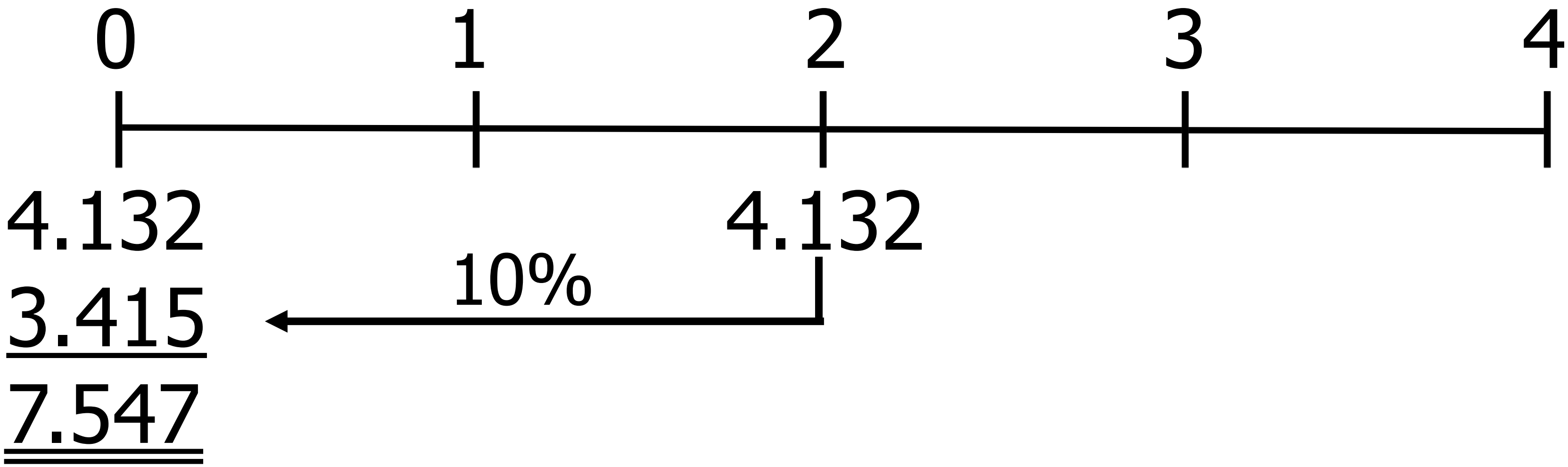
- Note that Franchise S could be repeated after 2 years to generate additional profits.
- Use replacement chain to put on common life.
- Note: equivalent annual annuity analysis is alternative method.

Replacement Chain Approach (000s) Franchise S with Replication

	0	1	2	3	4
S:	-100	60	60		
			-100	60	60
	-100	60	-40	60	60

NPV = $7.547.

Or, Use NPVs



Compare to Franchise L NPV = $6.190.

Suppose Cost to Repeat S in Two Years Rises to $105,000

	0	1	2	3	4
	10%				
S:	-100	60	60		
			-105	60	60
			-45		

$NPV_S = \$3.415 < NPV_L = \$6.190.$
Now choose L.

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.

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

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		

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.

Choosing the Optimal Capital Budget

- Finance theory says to accept all positive NPV projects.
- Two problems can occur when there is not enough internally generated cash to fund all positive NPV projects:
  - An increasing marginal cost of capital.
  - Capital rationing

Increasing Marginal Cost of Capital

- Externally raised capital can have large flotation costs, which increase the cost of capital.
- Investors often perceive large capital budgets as being risky, which drives up the cost of capital.

(More...)

- If external funds will be raised, then the NPV of all projects should be estimated using this higher marginal cost of capital.

Capital Rationing

- Capital rationing occurs when a company chooses not to fund all positive NPV projects.
- The company typically sets an upper limit on the total amount of capital expenditures that it will make in the upcoming year.

(More...)

- Reason: Companies want to avoid the direct costs (i.e., flotation costs) and the indirect costs of issuing new capital.
- Solution: Increase the cost of capital by enough to reflect all of these costs, and then accept all projects that still have a positive NPV with the higher cost of capital.

(More...)

- Reason: Companies don't have enough managerial, marketing, or engineering staff to implement all positive NPV projects.
- Solution: Use linear programming to maximize NPV subject to not exceeding the constraints on staffing.

(More...)

- Reason: Companies believe that the project's managers forecast unreasonably high cash flow estimates, so companies "filter" out the worst projects by limiting the total amount of projects that can be accepted.
- Solution: Implement a post-audit process and tie the managers' compensation to the subsequent performance of the project.