CAPITAL BUDGETING

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CAPITAL BUDGETING

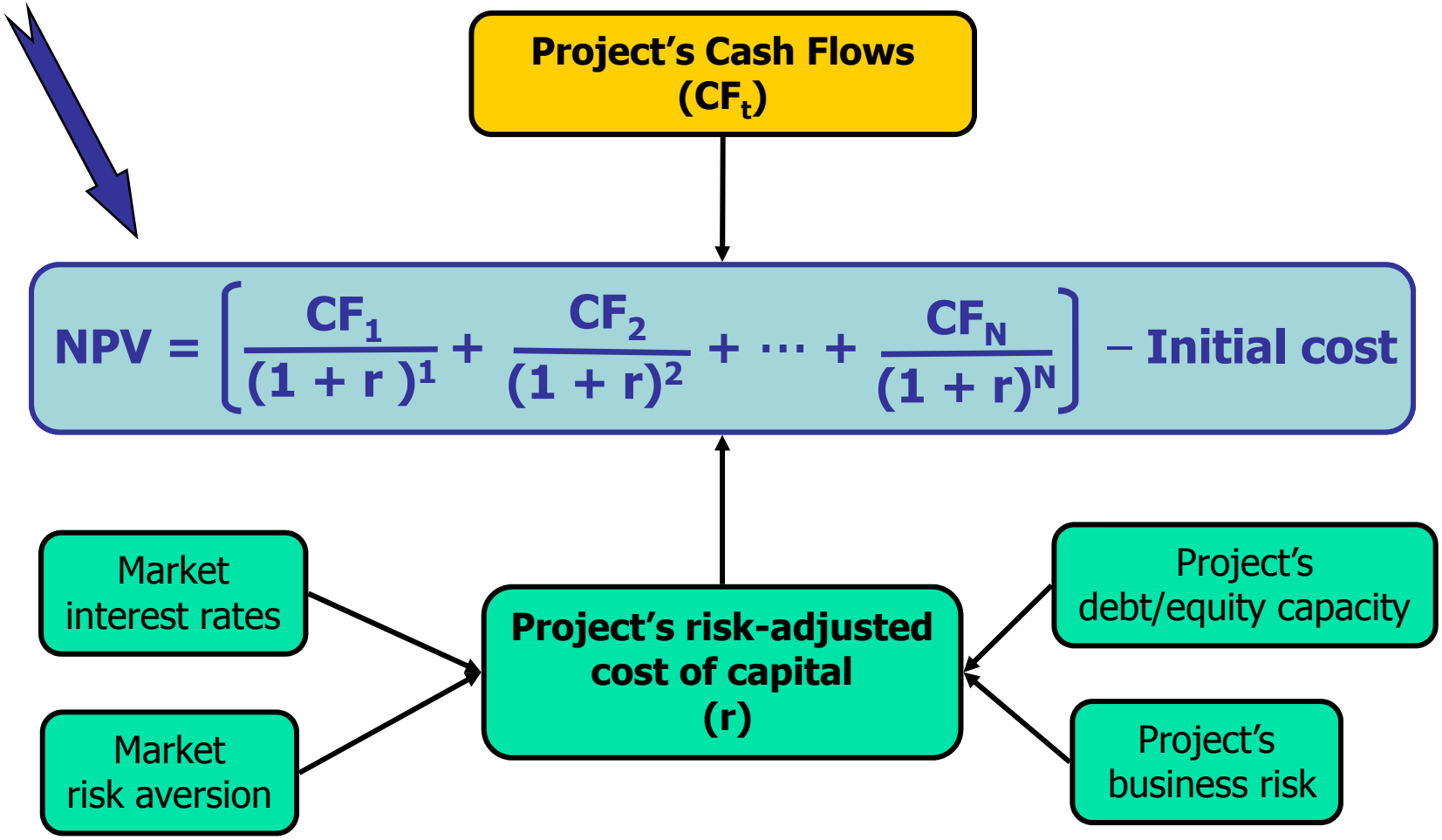
Why?

- Perhaps most impt. function financial managers must perform
  - Results of Cap Budgeting decisions continue for many future years, so firm loses some flexibility
  - Cap Budgeting decisions define firm's strategic direction.
  - Timing key since Cap Assets must be put in place when needed

Business Application

- Valuing projects that affect firm's strategic direction
- Methods of valuation used in business
- Parallels to valuing financial assets (securities)

The Big Picture:
The Net Present Value of a Project



VALUE OF ASSET TODAY

- =
- Sum of PVs of future CFs

Capital Budgeting

- Is to a company what buying stocks or bonds is to individuals:
  - An investment decision where each want a return > cost
- CFs are key for each

Cap. Budgeting & CFs

COMPANY

- **CFs**
  - generated by a project & returned to company . costs

INDIVIDUAL

- **CFs**
  - generated by stocks or bonds & returned to individual > costs

Cap Budgeting Evaluation Methods

- Payback
- Discounted Payback
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Modified Internal Rate of Return (MIRR)
- Profitability Index (PI)
- Equivalent Annual Annuity (EAA)
- Replacement Chain

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 appropriate discount rate (r = WACC) for project.
- Evaluate cash flows. (Find NPV or IRR etc.)
- Make Accept/Reject Decision

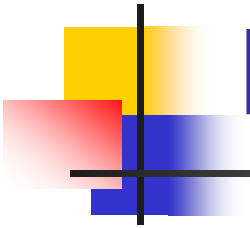
Capital Budgeting Project Categories

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.

Normal vs. Nonnormal Cash Flows

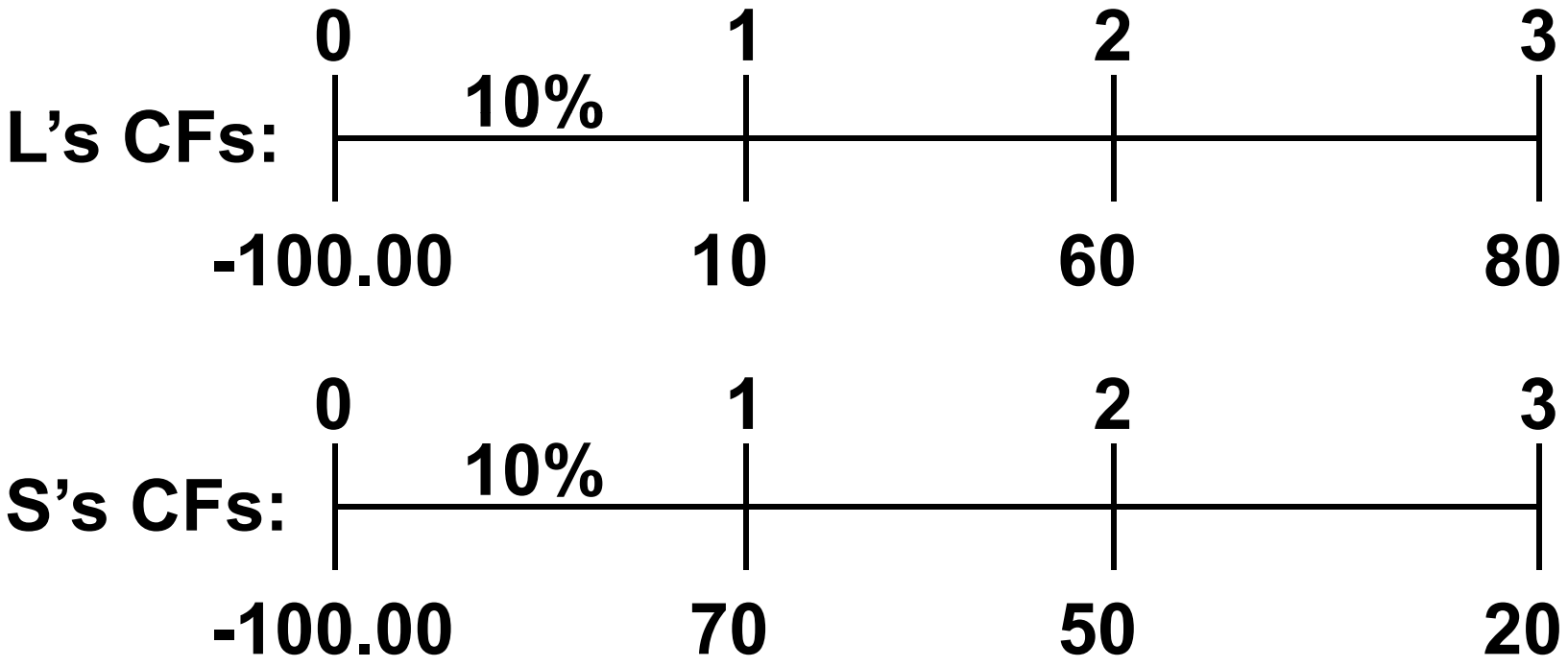


- Normal Cash Flow Project:
  - Cost (negative CF) followed by a series of positive cash inflows.
  - One change of signs.
- Nonnormal Cash Flow Project:
  - Two or more changes of signs.
  - Most common: Cost (negative CF), then string of positive CFs, then cost to close project.
  - For example, nuclear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

Inflow (+) or Outflow (-) in Year

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

Cash Flows for Franchises L and S



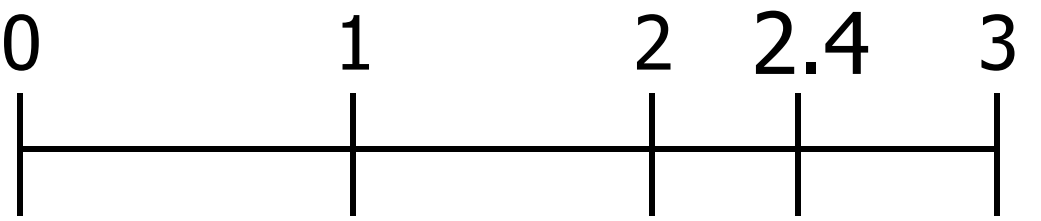
Expected Net Cash Flows

Year	Project L	Project S
0	<$100>	<$100>
1	10	70
2	60	50
3	80	20

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?

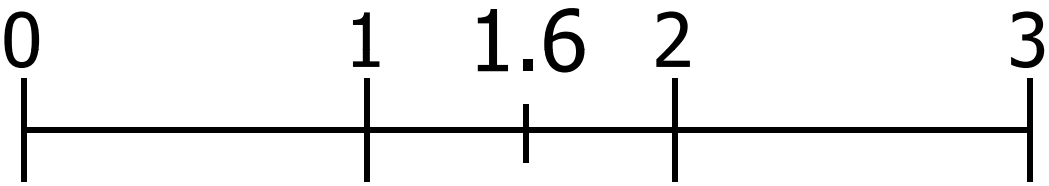
Payback for Franchise L



CF_t	-100	10	60		80
Cumulative	-100	-90	-30	0	50

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

Payback for Franchise S



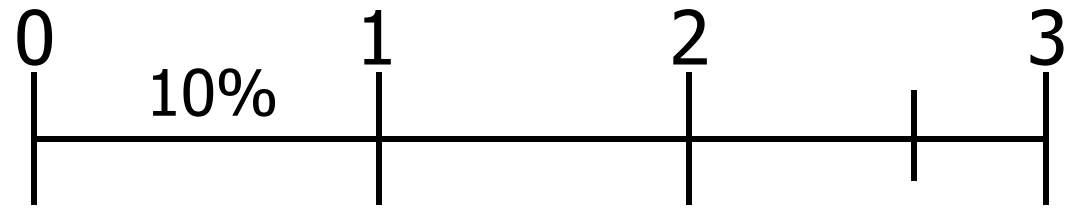
CF_t	-100	70	50	20
Cumulative	-100	-30	0	20	40

$Payback_S$ = 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 payback period.
  - No specification of acceptable payback.
  - CFs uniform??

Discounted Payback: Uses Discounted CFs



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.

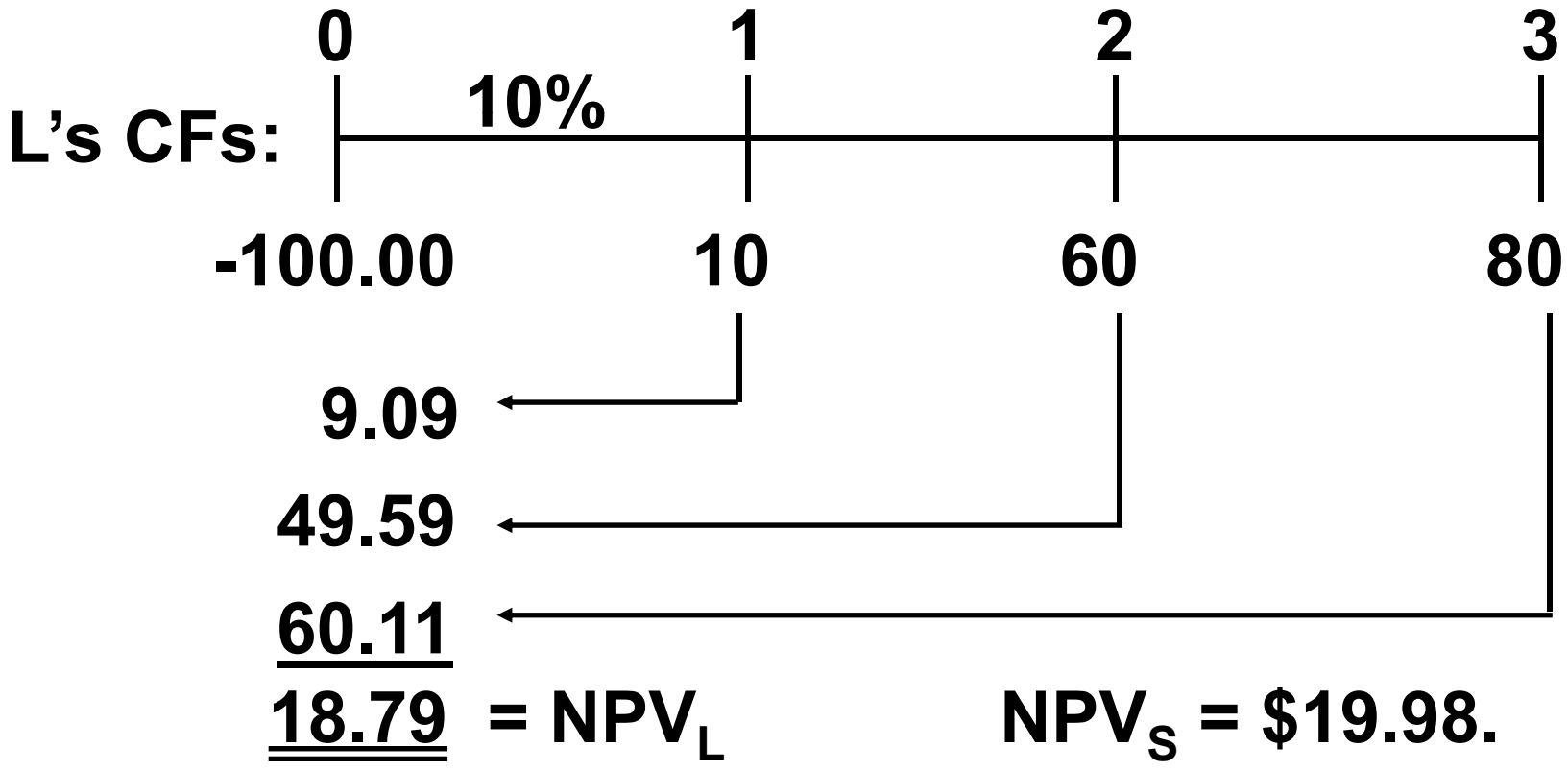
NPV: Sum of the PVs of All Cash Flows

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

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?



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

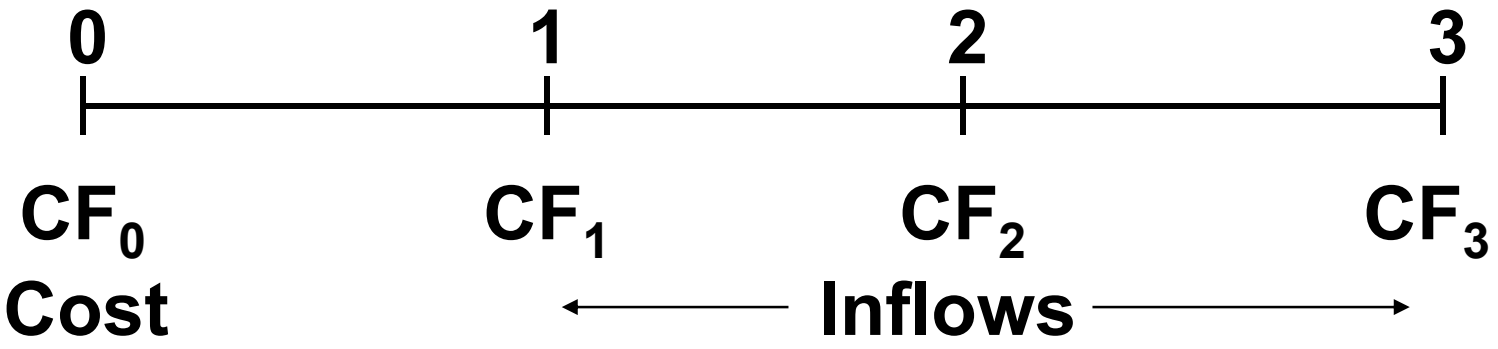
Rationale for the NPV Method

- 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.
- Risk Adjustment: higher risk, higher cost of cap, lower NPV

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 = PV costs. Same as i that creates NPV= 0.

::i.e., project's breakeven interest rate.

NPV: Enter r, Solve for NPV

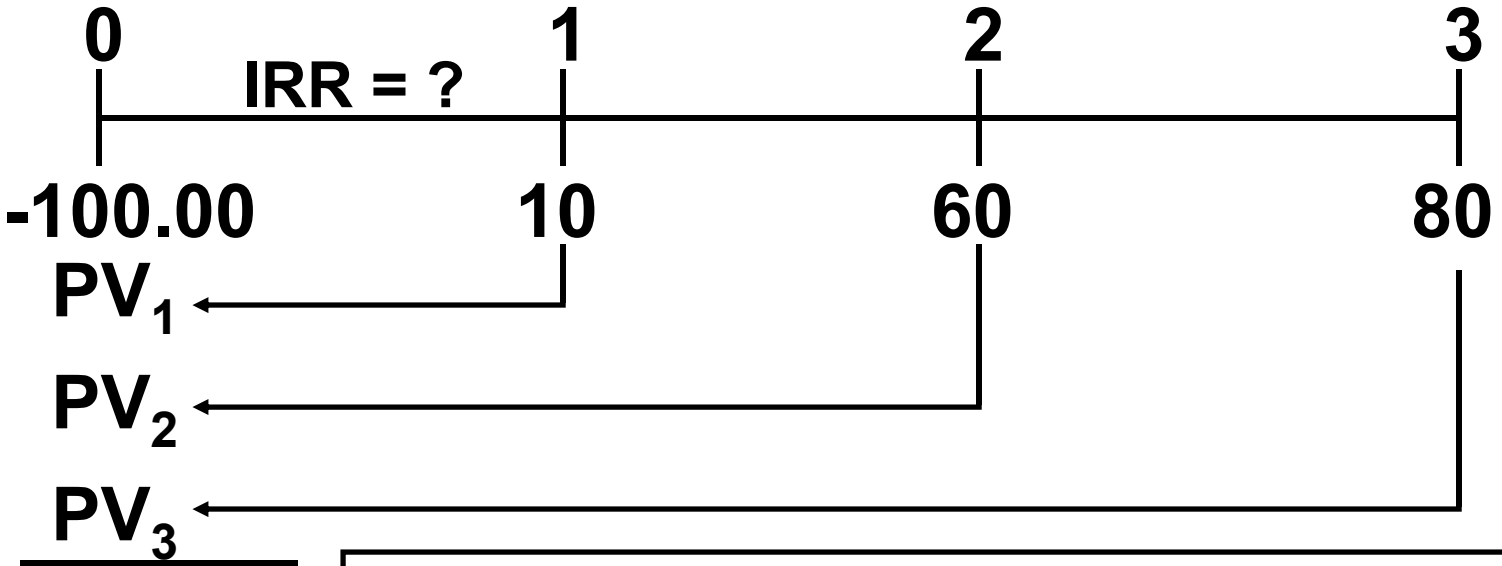
$$\sum_{t=0}^{N} \frac{CF_t}{(1+r)^t} = NPV$$

IRR: Enter NPV = 0, Solve for IRR

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

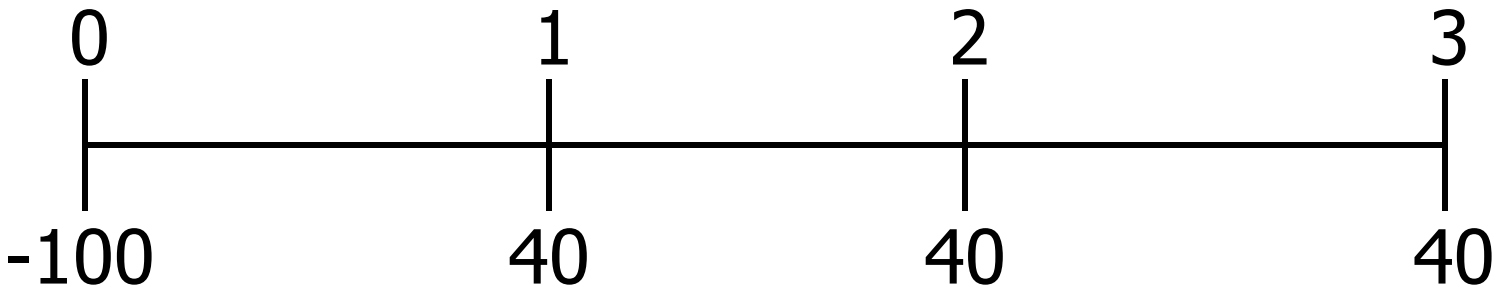
IRR is an estimate of the project's rate of return, so it is comparable to the YTM on a bond.

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



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 <u>not</u> dependent on the cost of capital used.

Calculating IRR in Excel

- $CF_0 = -\$100$; $CF_1 = \$40$; $CF_2 = \$40$; $CF_3 = \$40$

	A	B	C	D	E
1	CF0	-100			
2	CF1-3	40			
3					
4	IRR	**=IRR(values, [guess])**			

	A	B	C	D	E
1	CF0	-100			
2	CF1-3	40			
3					
4	IRR	**9.70%**			

NPV = $-\$100 + \$40/1.097 + \$40/1.097^2 + \$40/1.097^3 = 0$

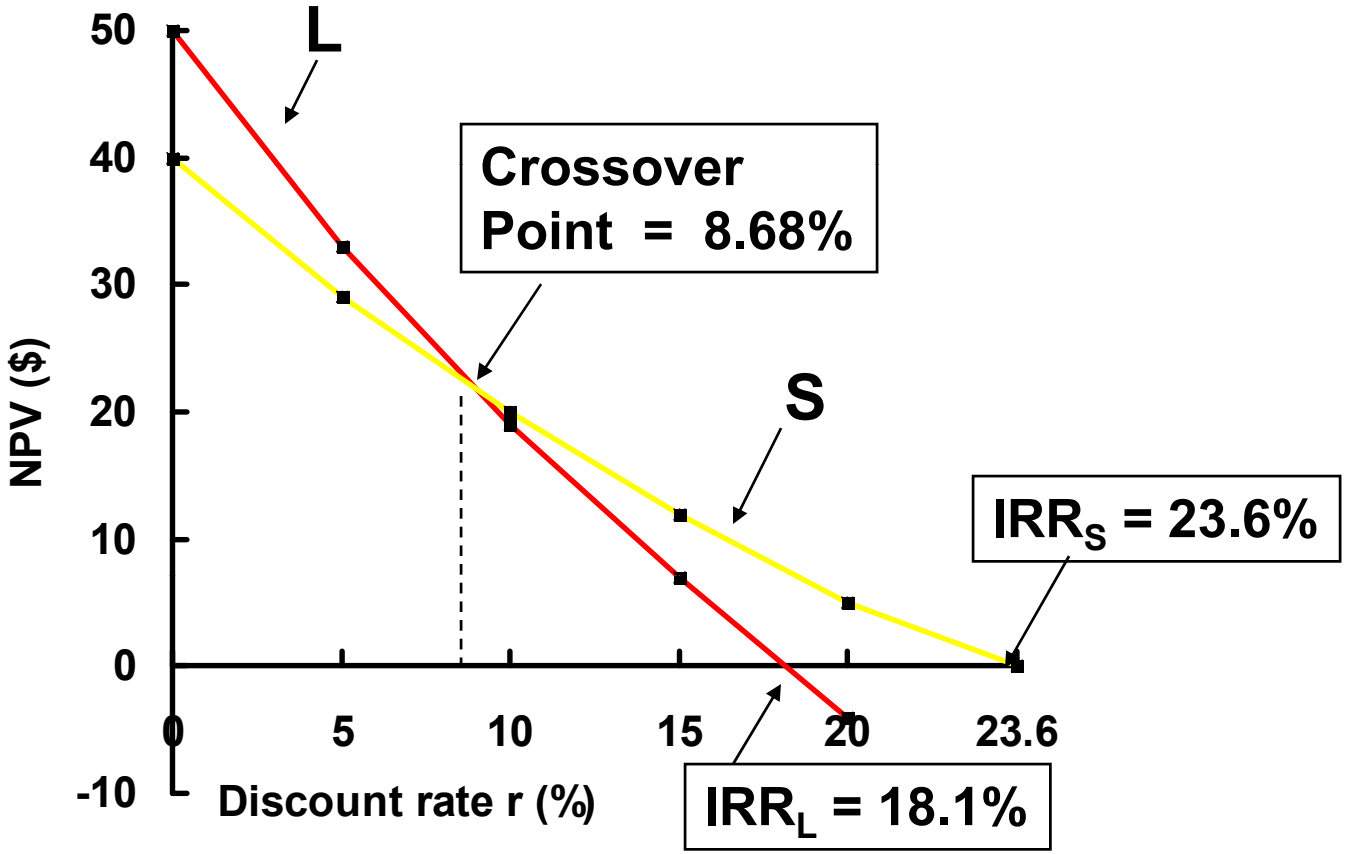
So the IRR = 9.70%

Construct NPV Profiles

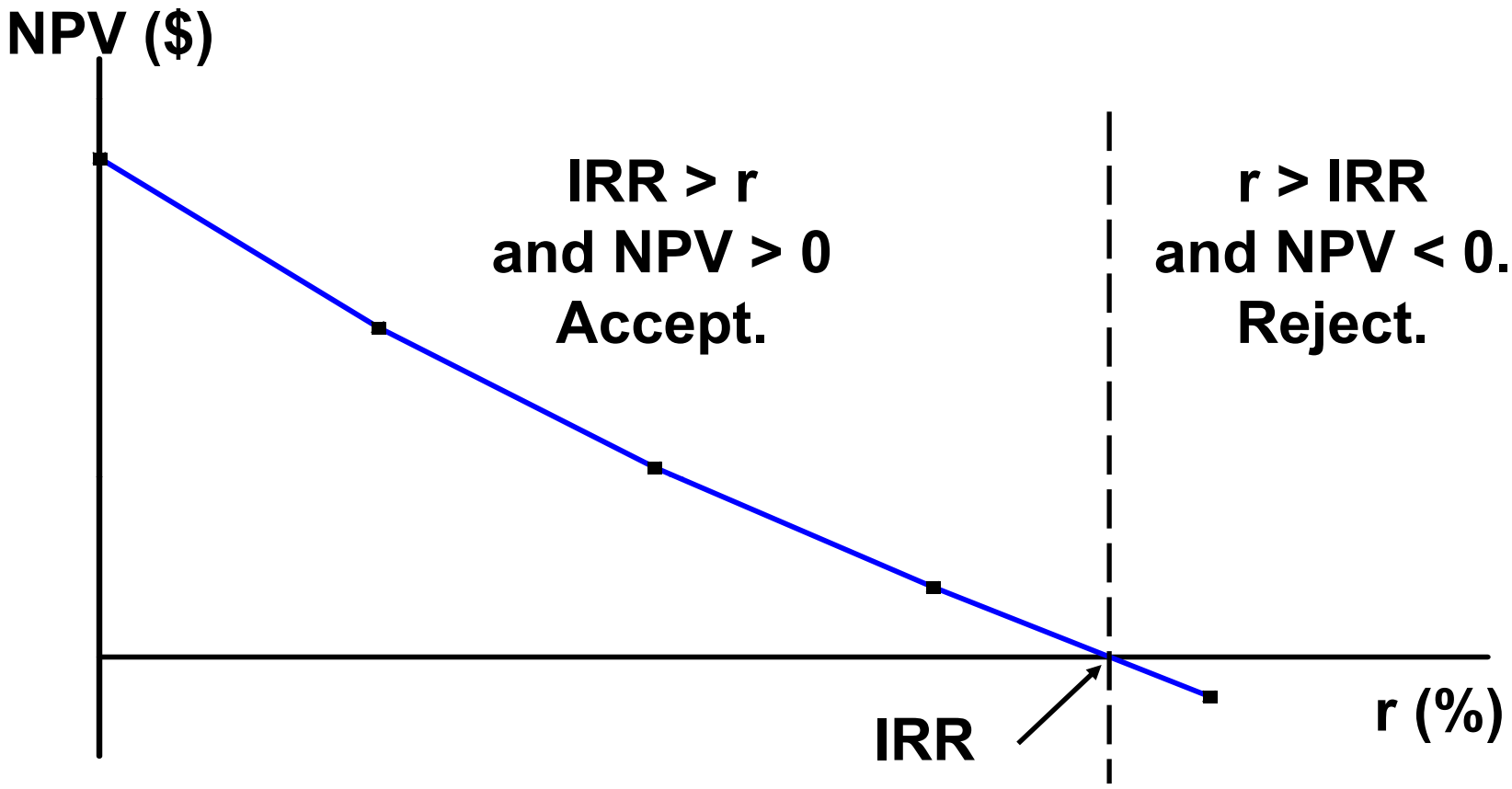
- Enter CFs in CFLO and find NPV_L and NPV_S at different discount rates:

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

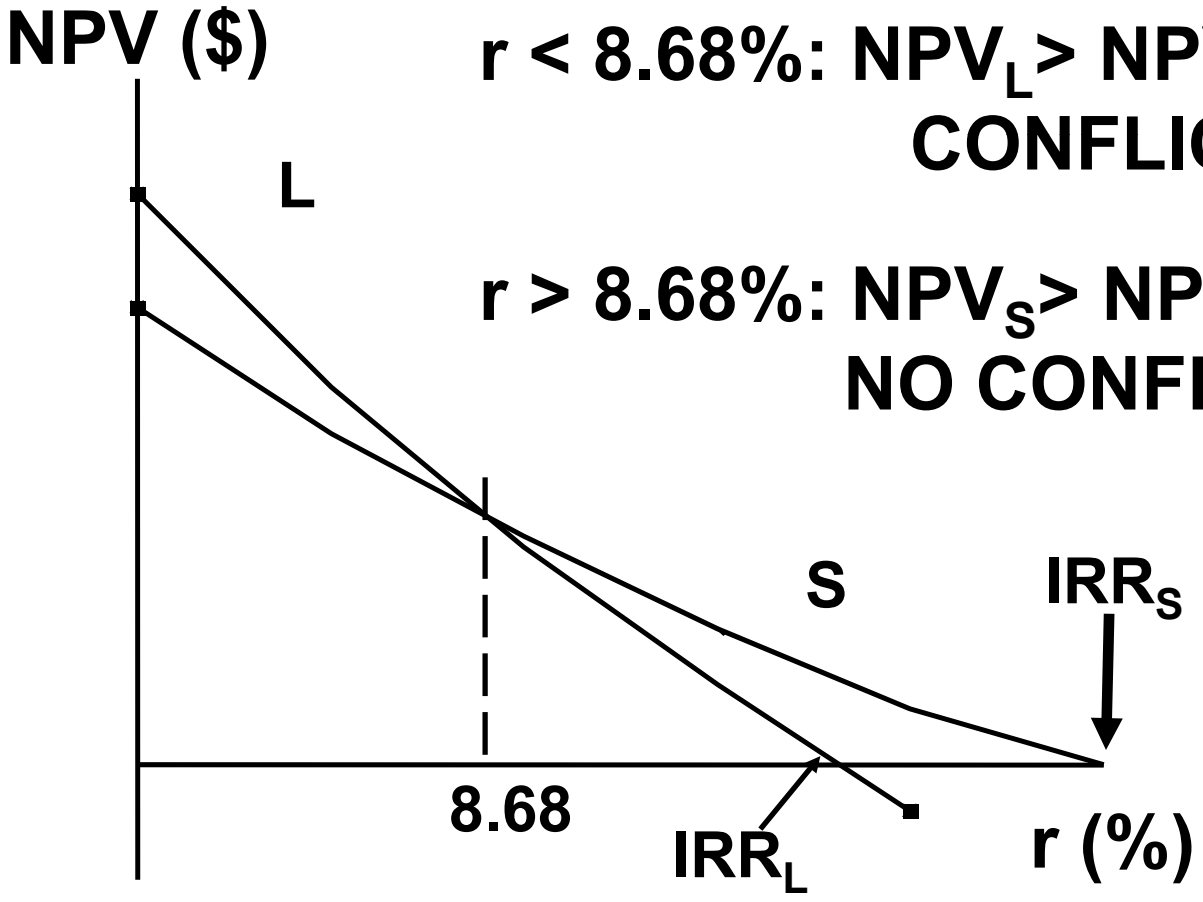
NPV Profile


L
Crossover
Point = 8.68%
S
IRR$_S$ = 23.6%
IRR$_L$ = 18.1%
NPV ($)
Discount rate r (%)
50
40
30
20
10
0
-10
0
5
10
15
20
23.6

NPV and IRR: No conflict for independent projects.



Mutually Exclusive Projects



r < 8.68%: $NPV_L > NPV_S$, $IRR_S > IRR_L$
CONFLICT

r > 8.68%: $NPV_S > NPV_L$, $IRR_S > IRR_L$
NO CONFLICT

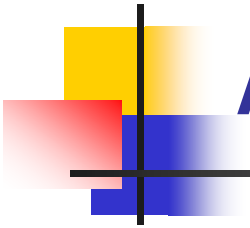
To Find the Crossover Rate

- 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
- 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

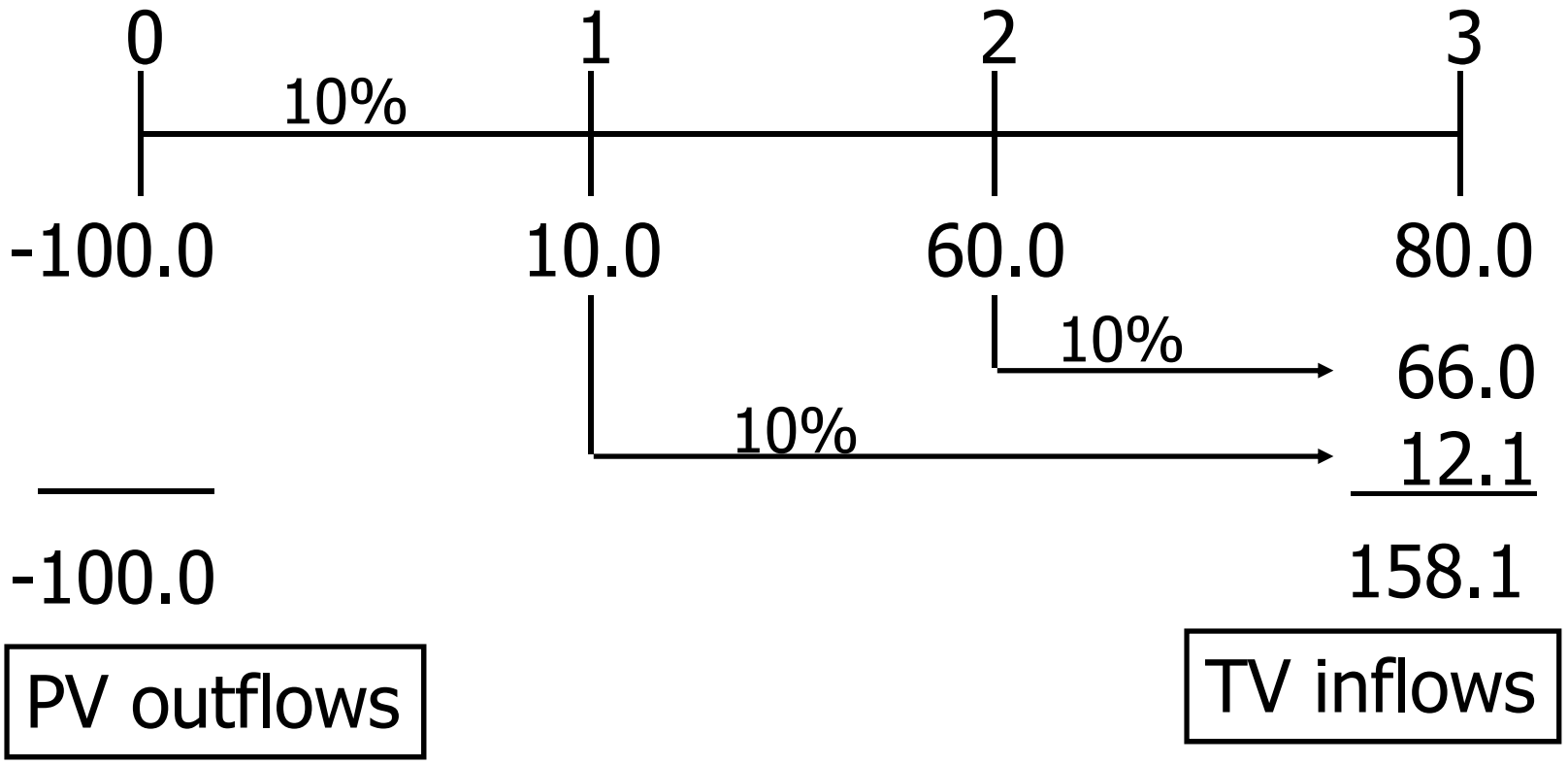


- NPV assumes reinvest at r (opportunity cost of capital).
- IRR assumes reinvest at IRR.
- Reinvest at opportunity cost, r, is more realistic, so NPV method is best. NPV should be used to choose between mutually exclusive projects.

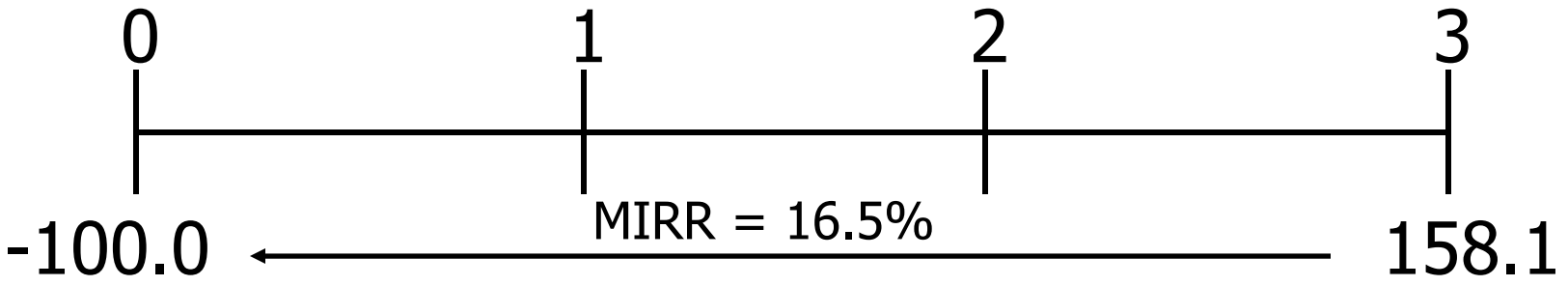
Modified Internal Rate of Return (MIRR)

- 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



PV outflows

TV inflows

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

$$MIRR_L = 16.5\%$$

To find TV with 12B: 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.

Why use MIRR versus IRR?

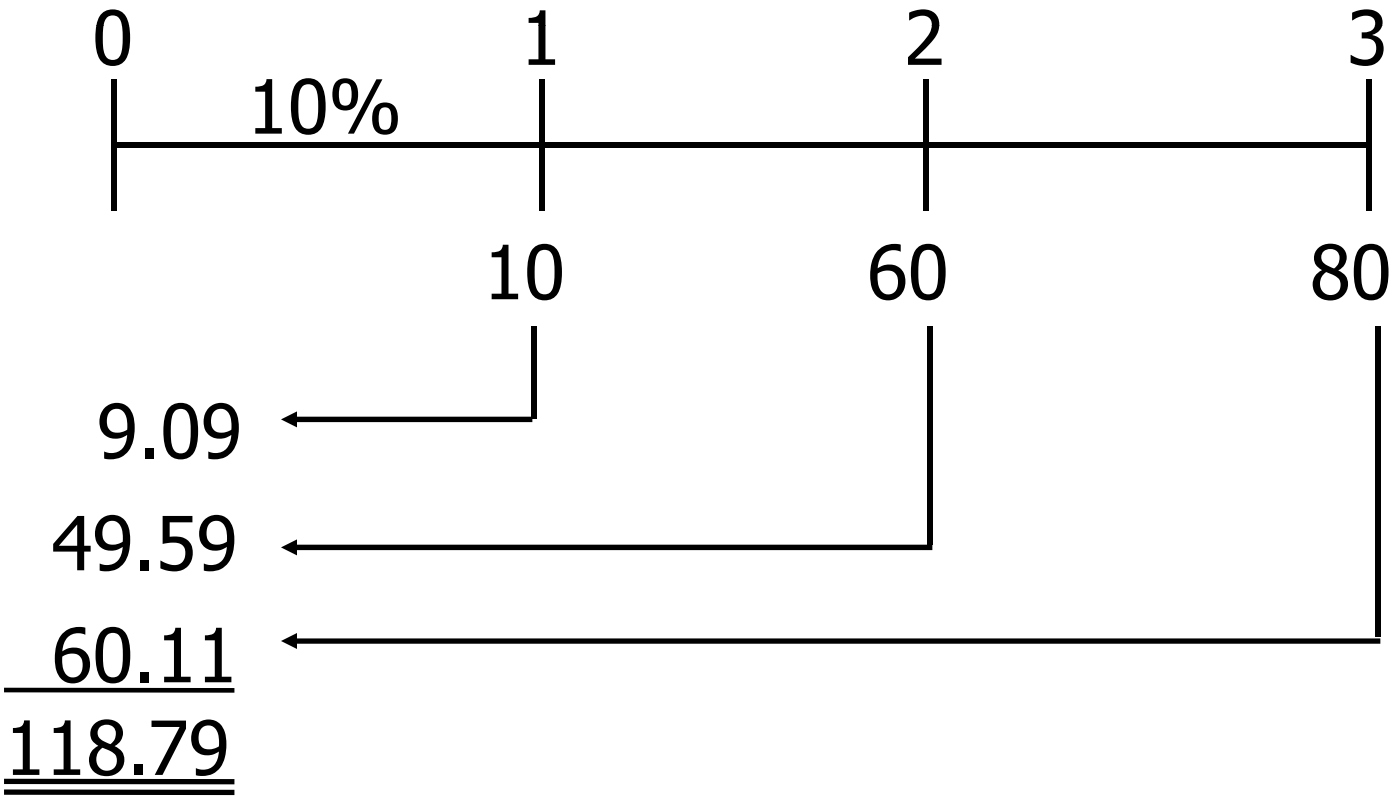
- MIRR correctly assumes reinvestment at opportunity cost = WACC. MIRR also avoids the problem of multiple IRRs.
- Managers like rate of return comparisons, and MIRR is better for this than IRR.

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."
- PV of Benefits / PV of Costs or
- PV of Inflows / PV Outflows
- PI > 1.0 :: Accept

Franchise L's PV of Future Cash Flows

Project L:



Franchise L's Profitability Index

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

$$PI_L = 1.1879$$

$$PI_S = 1.1998$$

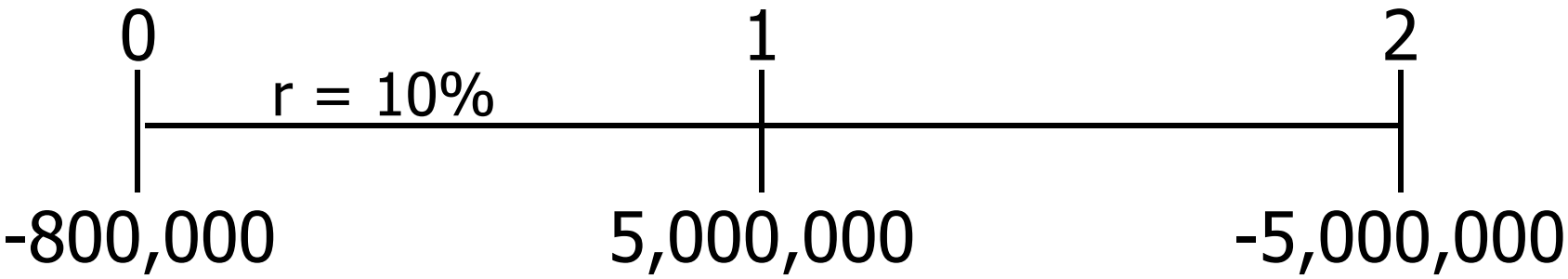
Normal vs. Nonnormal Cash Flows

- 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?

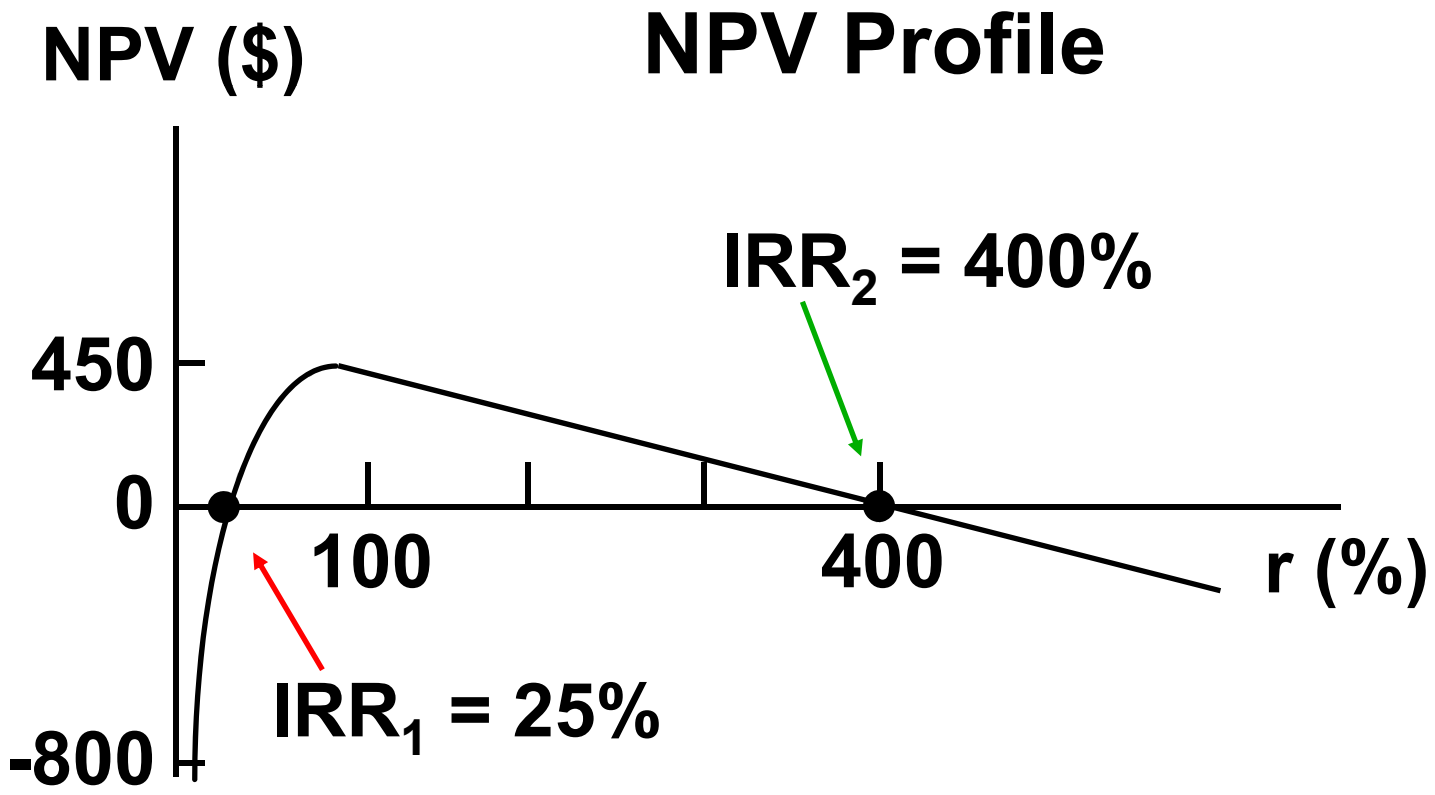


Enter CFs in CFLO, enter I/YR = 10.

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.

Finding Multiple IRRs with Calculator

1. Enter CFs as before.
2. Enter a "guess" as to IRR by storing the guess. Try 10%:

   10 [redacted] STO

   IRR = 25% = lower IRR

   (See next slide for upper IRR)

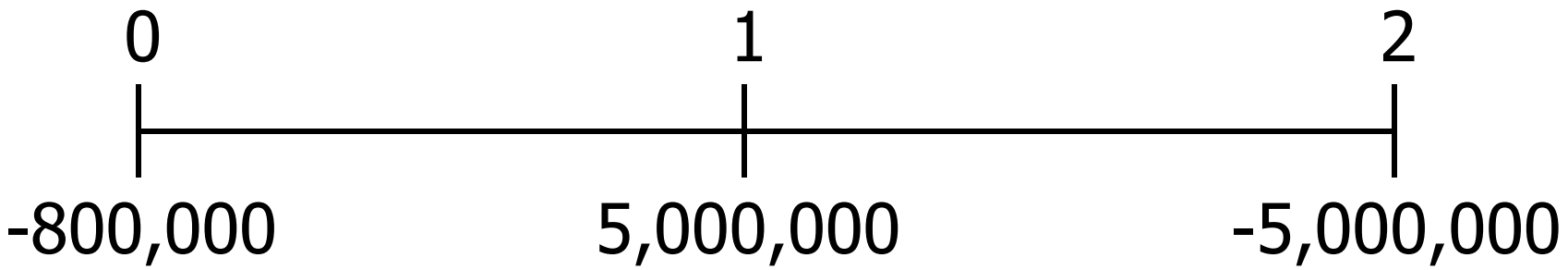
Finding Upper IRR with Calculator

Now guess large IRR, say, 200:

200 [redacted] STO

IRR = 400% = upper IRR

When There are Nonnormal CFs and More than One IRR, Use MIRR



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

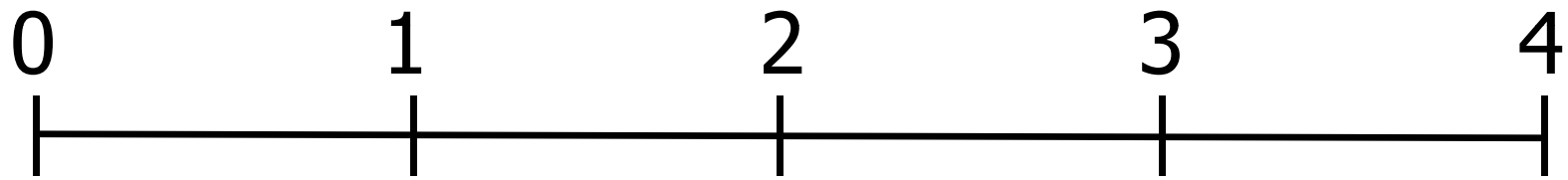
TV inflows @ 10% = 5,500,000.00.

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%



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

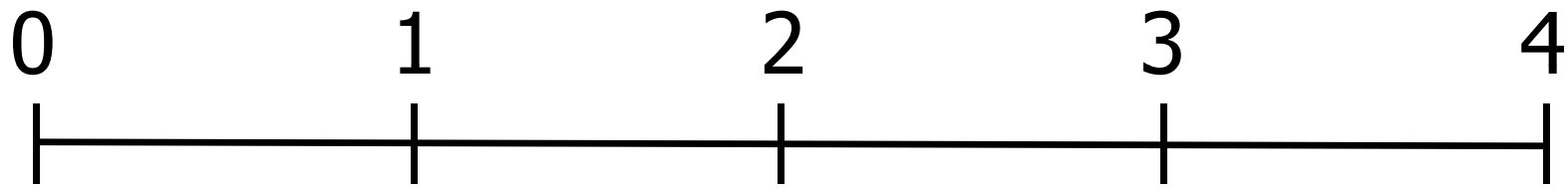
Equivalent Annual Annuity Approach (EAA)

- 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.

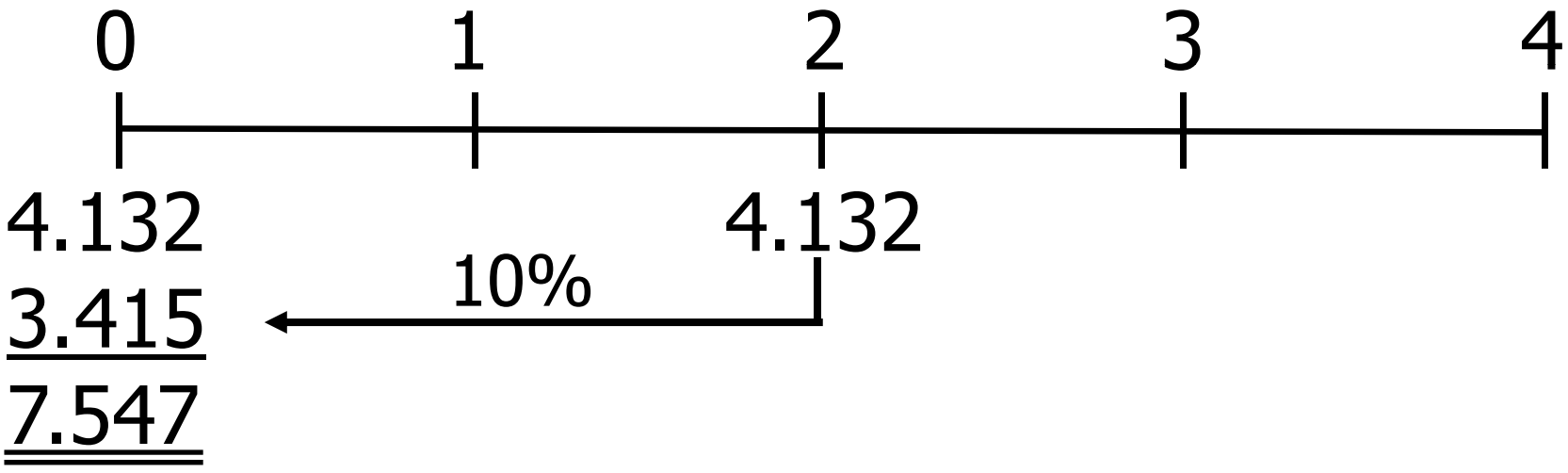
Replacement Chain Approach (000s) Franchise S with Replication



S:	-100	60	60		
			-100	60	60
	-100	60	-40	60	60

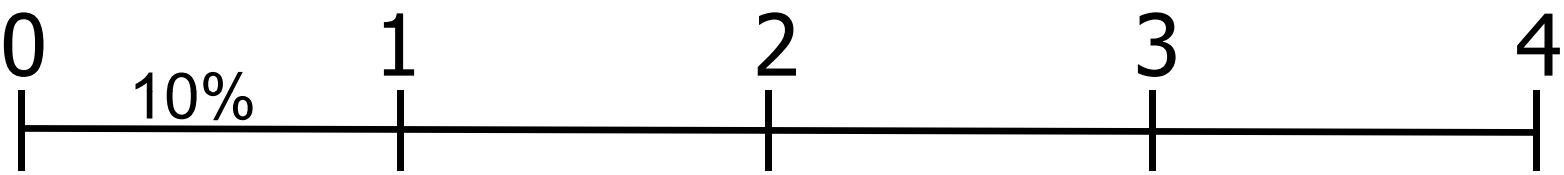
NPV = $7.547.

Or, Use NPVs



Compare to Franchise L NPV = $6.190.

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



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.

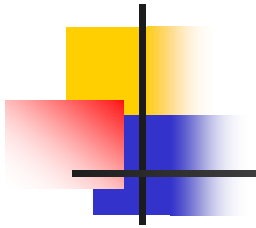
Choosing the Optimal Capital Budget

- 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.

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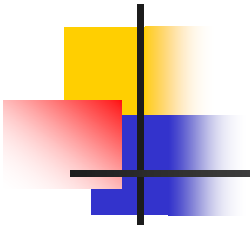

- Reason: Companies want to avoid the direct costs (i.e., flotation costs) and the indirect costs of issuing new capital.
- Solution: Increase the cost of capital by enough to reflect all of these costs, and then accept all projects that still have a positive NPV with the higher cost of capital.

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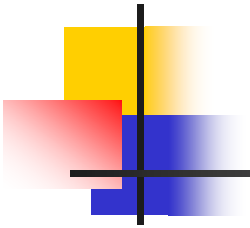

- Reason: Companies don't have enough managerial, marketing, or engineering staff to implement all positive NPV projects.
- Solution: Use linear programming to maximize NPV subject to not exceeding the constraints on staffing.

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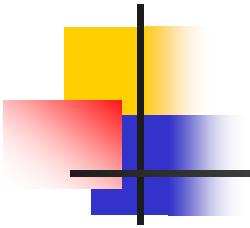

- Reason: Companies believe that the project's managers forecast unreasonably high cash flow estimates, so companies "filter" out the worst projects by limiting the total amount of projects that can be accepted.
- Solution: Implement a post-audit process and tie the managers' compensation to the subsequent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