Return on Investment

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Last Time

Discounted Cash Flow (DCF)

- Decision making
- Free cash flow
- Forecast drivers
- Forecasting free cash flow
- Sensitivity analysis
- Decision criteria

This Time

Return on investment

- IRR versus NPV

IRR

RECALL...

The internal rate of return of an asset is the one discount rate such that the NPV of the asset's free cash flows equals zero.
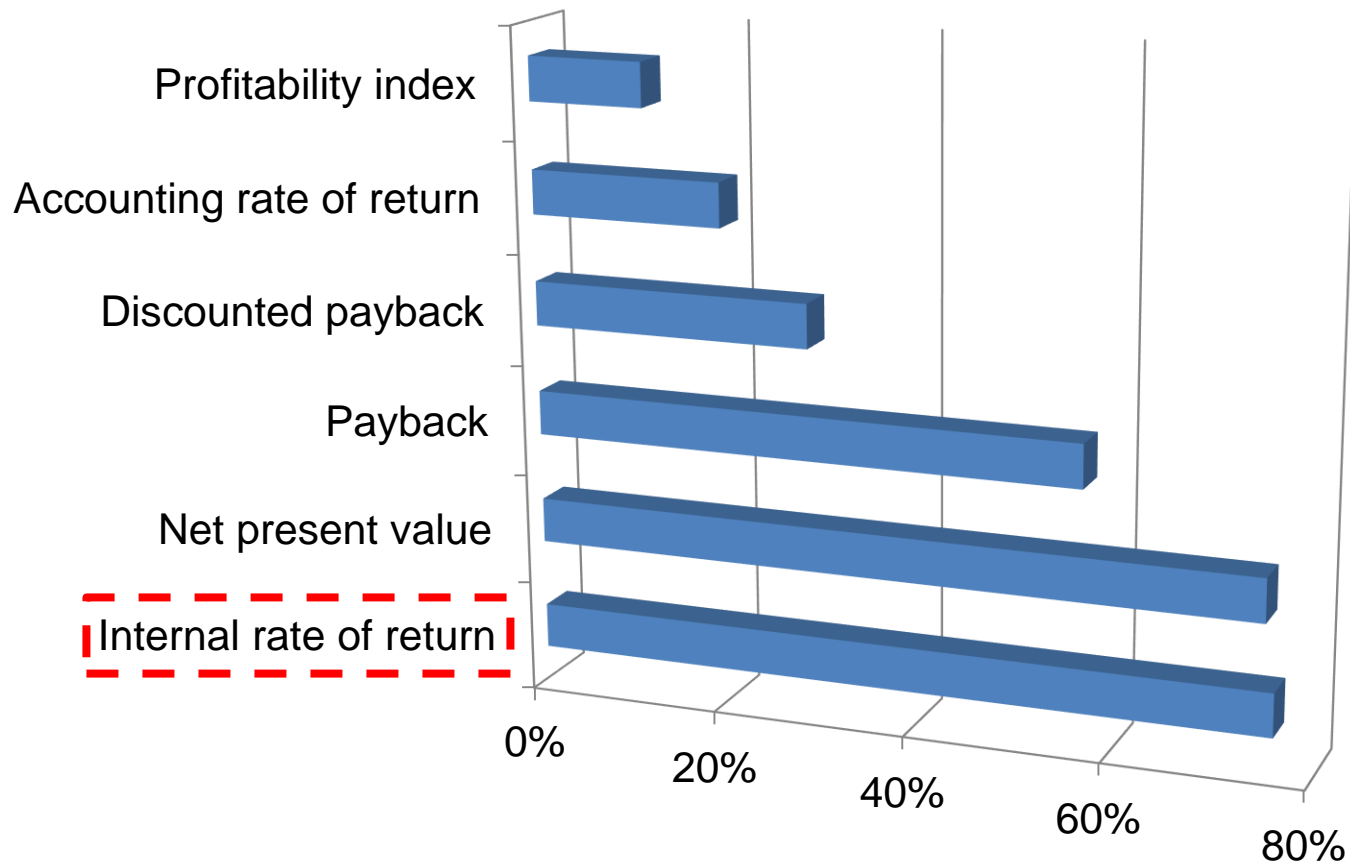
The internal rate of return of an asset is the one discount rate such that the NPV of the asset's free cash flows equals zero.

$$NPV = \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_3}{(1+IRR)^3} + ... + \frac{CF_T}{(1+IRR)^T} = 0$$
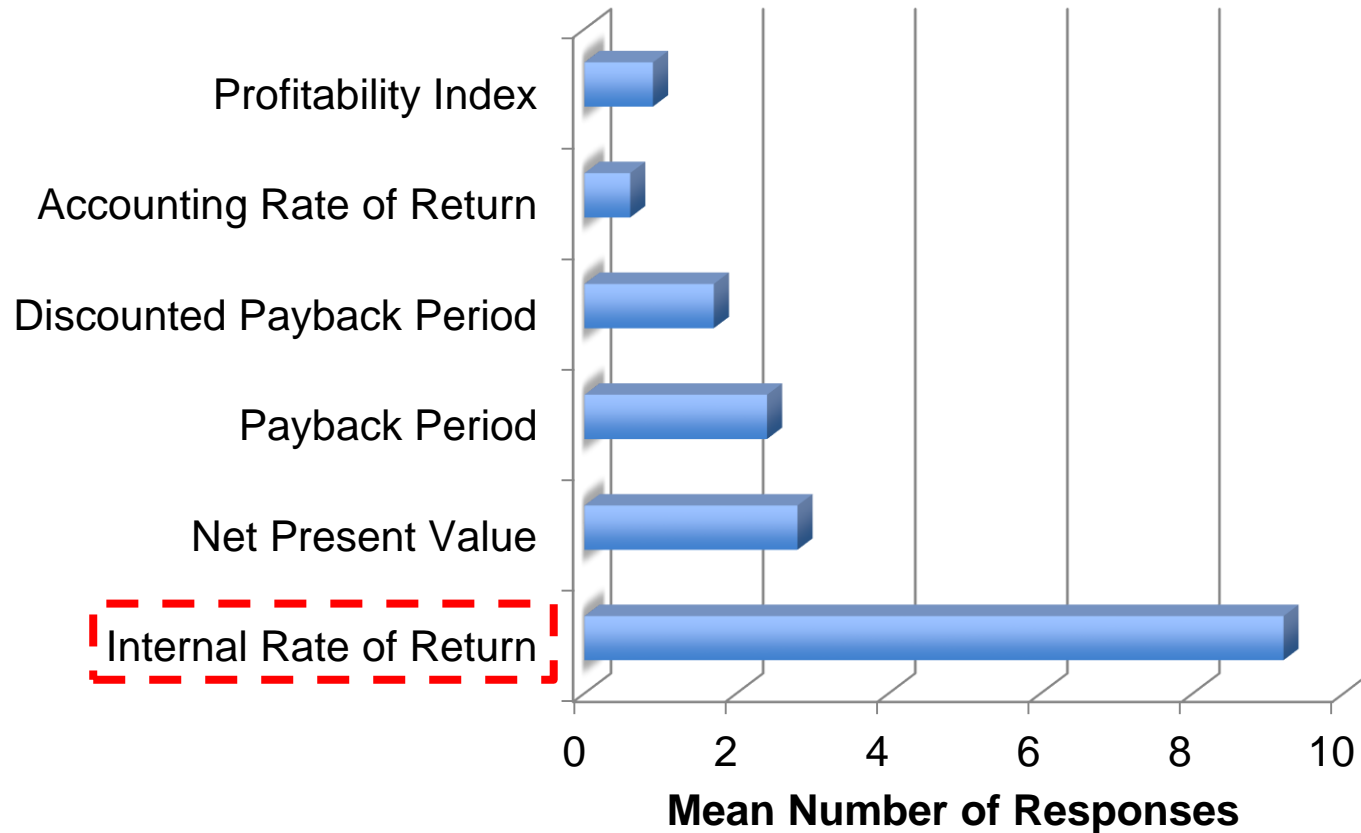
The IRR Decision Rule says accept all projects whose $IRR > R$, reject all projects whose $IRR < R$ where R is the hurdle rate

Rates of return are popular measures used for making decisions

Graham and Harvey, 2001, The theory and practice of corporate finance: Evidence from the field, *Journal of Financial Economics*

What do Private Equity Firms Say they Do? (Paul Gompers, Steve Kaplan, and Vladimir Mukharlyamov)

IRR V NPV

Lesson: The IRR rule leads to the same decisions – accept or reject – as the NPV rule if all negative cash flows precede all positive cash flows

Examples of CF sequences where IRR and NPV rules will coincide:

-, +, +, +, +

-, -, -, +, +, +, +, +, +

-, -, -, -, - , +

Examples of CF sequences where IRR and NPV rules may not coincide:

-, +, -, +, -, +

+, +, +, +, +, +, -, -, -, -

-, +, +, +, +, -

Can we compare projects using IRR?

Comparing Projects

Wharton wants to upgrade IT system and overhaul network infrastructure

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Puts out request for proposals (RFP)

Bid #1 from Cisco

Generate $60 million in cost savings over three years for up front cost of $100 million

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If Wharton's cost of capital is 12%, what is your assessment of this bid?

Bid #1 from Cisco

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Cash flows first:

	Year			
	0	1	2	3
Bid #1: Cisco	-100	60	60	60

Bid #1 from Cisco

Generate $60 million in cost savings over three years for up front cost of $100 million

	Year					IRR
	0	1	2	3		
Bid #1: Cisco	-100	60	60	60		36%

$$0 = -100 + \frac{60}{(1+IRR)} + \frac{60}{(1+IRR)^2} + \frac{60}{(1+IRR)^3}$$

Bid #1 from Cisco

Generate $60 million in cost savings over three years for up front cost of $100 million

	Year				IRR
	0	1	2	3	
Bid #1: Cisco	-100	60	60	60	36%

IRR > R **and** CFs signs proper $\rightarrow$ Looks good!

Bid #1 from Cisco

Generate $60 million in cost savings over three years for up front cost of $100 million

	Year				IRR	NPV
	0	1	2	3		
Bid #1: Cisco	-100	60	60	60	36%	44.11

$$NPV = -100 + \frac{60}{(1+0.12)} + \frac{60}{(1+0.12)^2} + \frac{60}{(1+0.12)^3}$$

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NVP > 0 → Looks good!

Bid #1a from Cisco

Same cost savings ($60 mil over three years) but costs spread over time: $20 mil today, $35 mil over three years

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Cash flows first:

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Bid #1a: Cisco (Costs)	-20	-35	-35	-35
Bid #1a: Cisco (Savings)	0	60	60	60

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Same cost savings ($60 mil over three years) but costs spread over time: $20 mil today, $35 mil over three years

Cash flows first:

	Year			
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Bid #1a: Cisco (Costs)	-20	-35	-35	-35
Bid #1a: Cisco (Savings)	0	60	60	60
Bid #1a: Cisco (Net)	-20	25	25	25

Bid #1a from Cisco

Same cost savings ($60 mil over three years) but costs spread over time: $20 mil today, $35 mil over three years

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	0	1	2	3	
Bid #1a: Cisco (Costs)	-20	-35	-35	-35	
Bid #1a: Cisco (Savings)	0	60	60	60	
Bid #1a: Cisco (Net)	-20	25	25	25	112%

$$0 = -20 + \frac{25}{(1+IRR)} + \frac{25}{(1+IRR)^2} + \frac{25}{(1+IRR)^3}$$

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Bid #1a: Cisco (Net)	-20	25	25	25	112%

Bid #1a IRR (112%) > Bid #1 IRR (36%)

Bid #1a from Cisco

Same cost savings ($60 mil over three years) but costs spread over time: $20 mil today, $35 mil over three years

	Year					IRR	NPV
	0	1	2	3			
Bid #1a: Cisco (Costs)	-20	-35	-35	-35			
Bid #1a: Cisco (Savings)	0	60	60	60			
Bid #1a: Cisco (Net)	-20	25	25	25		112%	40.05

$$NPV = -20 + \frac{25}{(1+0.12)} + \frac{25}{(1+0.12)^2} + \frac{25}{(1+0.12)^3}$$
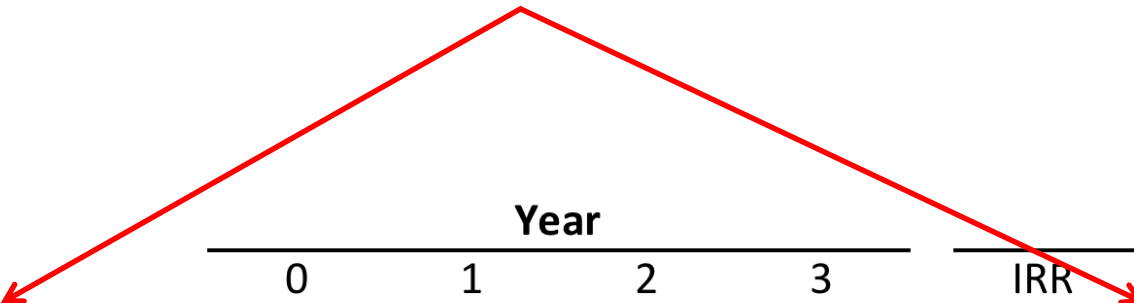
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Bid #1a: Cisco (Savings)	0	60	60	60			
Bid #1a: Cisco (Net)	-20	25	25	25		112%	40.05

Bid #1 NPV ($44.11) > Bid #1a NPV ($40.05)

What is going on?

NPV → Bid #1 is better

	Year					IRR	NPV
	0	1	2	3			
Bid #1: Cisco	-100	60	60	60		36%	44.11
Bid #1a: Cisco (Costs)	-20	-35	-35	-35			
Bid #1a: Cisco (Savings)	0	60	60	60			
Bid #1a: Cisco (Net)	-20	25	25	25		112%	40.05

NPV → Bid #1 is better

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Bid #1a: Cisco (Net)	-20	25	25	25		112%	40.05

IRR → Bid #1a is better

A closer look

	Year			
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
Bid #1a: Cisco (Costs)	-20	-35	-35	-35

A closer look

	Year			
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
Bid #1a: Cisco (Costs)	-20	-35	-35	-35
Bid #1a: Cisco (Implicit Loan)	80	-35	-35	-35

Bid 1a incorporates a loan from Cisco

A closer look

	Year			
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
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Bid 1a incorporates a loan from Cisco
What is the interest rate?

A closer look

	Year			
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
Bid #1a: Cisco (Costs)	-20	-35	-35	-35
Bid #1a: Cisco (Implicit Loan)	80	-35	-35	-35

$$80 = \frac{35}{(1+R)} + \frac{35}{(1+R)^2} + \frac{35}{(1+R)^3} \Rightarrow R = 15\%$$

A closer look

	Year			
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
Bid #1a: Cisco (Costs)	-20	-35	-35	-35
Bid #1a: Cisco (Implicit Loan)	80	-35	-35	-35

$$0 = -80 + \frac{35}{(1+IRR)} + \frac{35}{(1+IRR)^2} + \frac{35}{(1+IRR)^3} \Rightarrow IRR = 15\%$$

Note: This is also the IRR of the loan

A closer look

	Year			
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
Bid #1a: Cisco (Costs)	-20	-35	-35	-35
Bid #1a: Cisco (Implicit Loan)	80	-35	-35	-35

$$80 = \frac{35}{(1+YTM)} + \frac{35}{(1+YTM)^2} + \frac{35}{(1+YTM)^3} \Rightarrow YTM = 15\%$$

Note: This is also the Yield-to-Maturity of the loan

A closer look

	Year			
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
Bid #1a: Cisco (Costs)	-20	-35	-35	-35
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$$80 = \frac{35}{(1+YTM)} + \frac{35}{(1+YTM)^2} + \frac{35}{(1+YTM)^3} \Rightarrow YTM = 15\%$$

Is this high or low?

A closer look

		Year		
	0	1	2	3
Bid #1: Cisco (Costs)	-100	0	0	0
Bid #1a: Cisco (Costs)	-20	-35	-35	-35
Bid #1a: Cisco (Implicit Loan)	80	-35	-35	-35

$$80 = \frac{35}{(1+YTM)} + \frac{35}{(1+YTM)^2} + \frac{35}{(1+YTM)^3} \Rightarrow YTM = 15\%$$

Loan interest rate (15%) > Cost of Capital (12%)

Lesson: IRR increased because initial investment fell more than future cash flows.

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(Intuition: Small payoffs on a smaller investment can generate very large returns because of division by small numbers.)

Lesson: NPV fell because Cisco is lending you money at an interest rate that is greater than your cost of capital.

Lesson: IRR can mislead when deciding among projects.

Lesson: NPV will not mislead in comparisons. The larger the NPV, the greater the value

ADDITIONAL BIDS

	Year			
	0	1	2	3
Bid #1: Cisco	-100	60	60	60
Bid #2: Juniper	-100	90	70	5
Bid #3: Huawei	-20	20	20	20

	Year			
	0	1	2	3
Bid #1: Cisco	-100	60	60	60
Bid #2: Juniper	-100	90	70	5
Bid #3: Huawei	-20	20	20	20

How would you rank the bids according to the IRR and the NPV criterion?

	Year					IRR	NPV
	0	1	2	3			
Bid #1: Cisco	-100	60	60	60		36%	44.11
Bid #2: Juniper	-100	90	70	5		42%	39.72
Bid #3: Huawei	-20	20	20	20		84%	28.04

	Year					IRR	NPV
	0	1	2	3			
Bid #1: Cisco	-100	60	60	60		36%	44.11
Bid #2: Juniper	-100	90	70	5		42%	39.72
Bid #3: Huawei	-20	20	20	20		84%	28.04

IRR: #3 > #2 > #1

NPV: #1 > #2 > #3
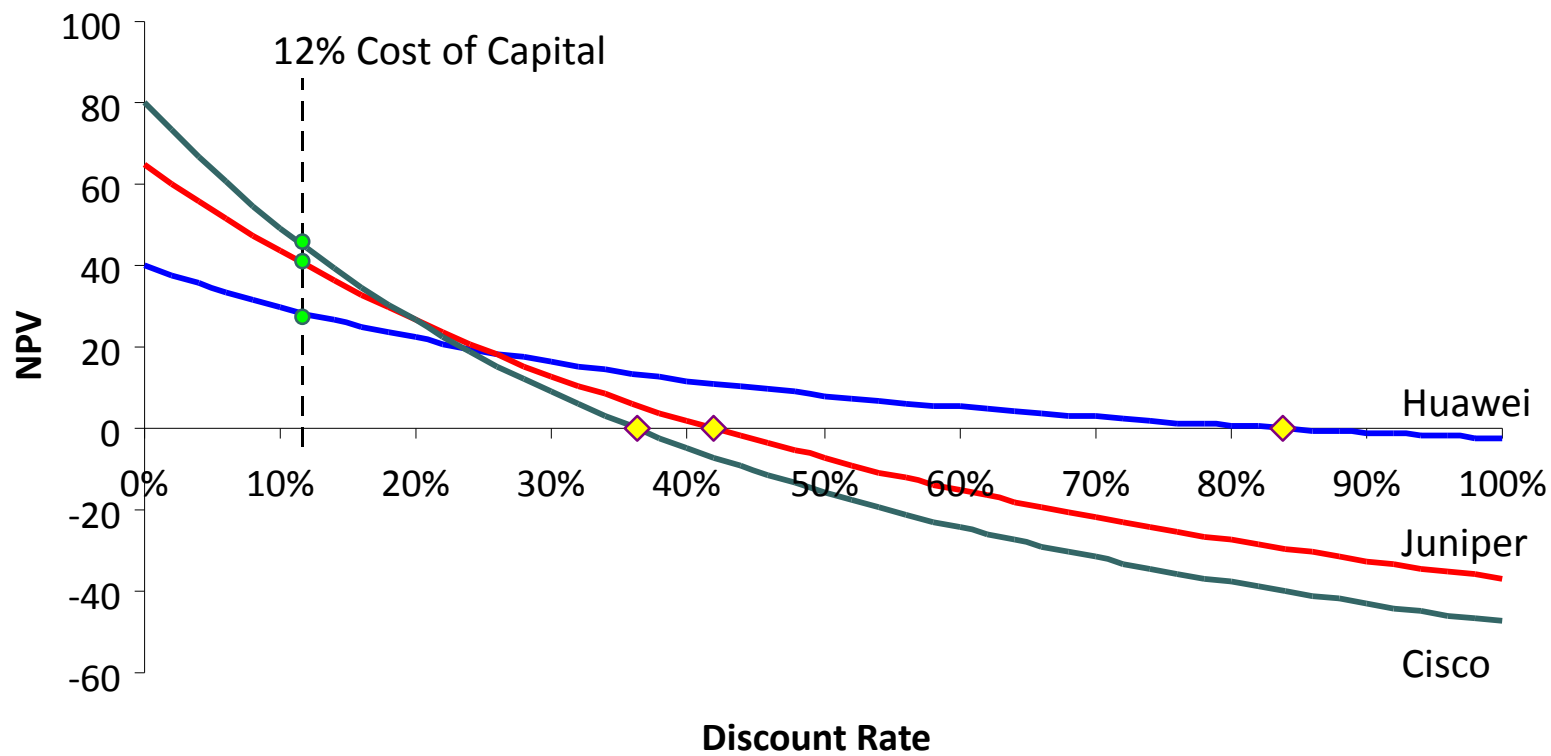
Intuition:

Huawei has small upfront cost → IRR ↑

Juniper has front-loaded CFs → IRR ↑

Lesson: IRR does not address differences in scale.

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Would you rather earn 100% on a $1 investment or 10% on a $1,000,000 investment?

Intuition:
Juniper's bid is like Cisco's with an embedded loan…

	Year			
	0	1	2	3
Bid #1: Cisco	-100	60	60	60
Bid #3: Huawei	-20	20	20	20
Bid #3: Huawei (Implicit Loan)	80	-40	-40	-40

Intuition:
Juniper's bid is like Cisco's with an embedded loan…with a 23% interest rate!

	Year				IRR
	0	1	2	3	
Bid #1: Cisco	-100	60	60	60	
Bid #3: Huawei	-20	20	20	20	
Bid #3: Huawei (Implicit Loan)	80	-40	-40	-40	23%

Summary

Lessons

- The internal rate of return of an asset is the one discount rate such that the NPV of the asset's free cash flows equals zero.

$$NPV = \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_3}{(1+IRR)^3} + ... + \frac{CF_T}{(1+IRR)^T} = 0$$

- The IRR Decision Rule says accept all projects whose $IRR > R$, reject all projects whose $IRR < R$ where R is the hurdle rate

Lessons

- IRR Rule can mislead decision making when cash flow signs are anything other than all negatives before all positives

- IRR Rule can mislead decision making when comparing projects even when cash flow signs are proper.
  - IRR does not account for differences in scale

Lessons

- IRR should be used in conjunction with NPV analysis

Coming up next

- Fixed Income Securities
  - Institutional environment
  - Valuation
  - Risk analysis