Capital Budgeting

Instructor: Paruj Ratanaworabhan

Based on lecture materials from J. Weston, Rice University

Capital Budgeting

- Definition: the process a business undertakes to evaluate potential major projects or investments

- This process involves analyzing a project's cash inflows and outflows to determine whether the expected return meets a set benchmark

- Major tools and metrics:
  - Net Present Value (NPV)
  - Payback period
  - Internal rate of return (IRR)

Best Practices

- Arms-length
    - The parties involved (buyers, investors, lenders, borrowers, sellers) in an arm's length transactions have no pre-existing relationship with each other
        - No inside dealings
- Objective
- Transparent

Decisions Obtained

- Accept or reject
- Best of all the candidate projects
- Ranking of different projects

Foundation: cost vs benefit analysis

Net Present Value (NPV)

- Add up the PV of all future cash
- Compare with initial investment
- Decision rule: Invest if NPV > 0

$$NPV = \text{inital investment} + \frac{\text{Cash flow Year 1}}{(1+r)^1} + \ldots \frac{\text{Cash flow Year n}}{(1+r)^n}$$

Or,

$$NPV = \text{inital investment} + \sum_{t=1}^{t=\text{end of project}} \frac{(\text{Cash Flows at Year t})}{(1+r)^t}$$

Problem: Analyze the table of cash flows and compute the NPV if the discount rate is 10%?

Period	Cash Flow		Present Value
0	-$1,500	→	-$1,500
1	$900		$818.18
2	$750		$619.83
Total	$150		-$61.98

Main Drivers of NPV

- Cash flow (the more the better)
- Timing (the sooner the better)
- Discount rate (the lower the better)

Why NPV?

- Best capital budgeting tool
- Incorporates:
    - Timing
    - Opportunity cost
    - Risk
- Objective
- Arms-length
- Transparent

In-class Exercise

- What is the NPV of a project that requires an initial outlay of $1,000 and provides an annual income of $500 for 3 years? Assume a discount rate of 5%, and each annual income is paid at the end of each year

Payback Period

- How long it takes to earn back initial investment

- Decision rule: invest if payback less than a specified time (e.g., 1 year, 10 years, etc)

Payback Period Example

Project	Cash Flow				Payback
	0	1	2	3	
X	-$500	$500	$250	$0	1
Y	-$500	$100	$200	$600	3
Z	-$500	$300	$400	$400	1.5

Payback: Pros and Cons

- Pros:
    - Time is money; reflecting the opportunity cost
- Cons:
    - Neglects cash after the payback
    - Neglects timing for future cash flow
    - Neglects risk; no discount rate consideration
    - Arbitrary cut off
        - Non objective, not arms-length

Use Payback with NPV

Project	Cash Flow				Payback	NPV (10%)
	0	1	2	3		
X	-$500	$500	$250	$0	1	$161
Y	-$500	$100	$200	$600	3	$207
Z	-$500	$300	$400	$400	1.5	$404

Accounting Ratio

- Measure the ratio of A/B

- Decision rule: invest if the ratio > (some threshold)

Accounting Ratio Example: ROIC

$$\text{Return on invested capital (ROIC)} = \frac{\text{Net operating profit after tax (NOPAT)}}{\text{Invested capital (IC)}}$$

Exhibit 1: Calculation of NOPAT for Cisco Systems, Inc.

Operating approach

Description	2009	2010	2011	2012	2013
Net sales	36,117	40,040	43,218	46,061	48,607
- Cost of goods sold	13,023	14,397	16,682	17,852	19,167
Gross income	23,094	25,643	26,536	28,209	29,440
- R&D	5,208	5,273	5,823	5,488	5,942
- Sales and marketing	8,403	8,716	9,812	9,647	9,538
- General and administrative	1,565	1,999	1,908	2,322	2,264
- Amortization and in-process R&D	596	491	1,319	687	500
EBIT	7,322	9,164	7,674	10,065	11,196
+ Amortization and in-process R&D	596	491	1,319	687	500
EBITA	7,918	9,655	8,993	10,752	11,696
- Income tax provision	1,559	1,648	1,335	2,118	1,244
+ Deferred taxes	1,258	(654)	(162)	653	(96)
- Tax shield	(75)	(44)	(26)	(20)	(3)
NOPAT	**7,692**	**7,397**	**7,522**	**9,307**	**10,359**

Exhibit 3: Calculation of Invested Capital for Cisco Systems, Inc.

Operating approach

Description	2009	2010	2011	2012	2013
Cash *	1,445	1,602	1,729	1,842	1,944
Accounts receivable	3,177	4,929	4,698	4,369	5,470
Inventories	1,074	1,327	1,486	1,663	1,476
Deferred tax assets	2,320	2,126	2,410	2,294	2,616
Prepaid and other	2,605	3,178	4,052	4,891	5,349
Total current assets	10,621	13,162	14,375	15,059	16,855
- NIBCLs	13,655	16,137	16,918	17,700	18,909
Net working capital	(3,034)	(2,975)	(2,543)	(2,641)	(2,054)
+Net PP&E	4,043	3,941	3,916	3,402	3,322
+Goodwill	12,925	16,674	16,818	16,998	21,919
+ Intangibles	1,702	3,274	2,541	1,959	3,403
+Other assets	5,281	5,820	6,589	7,467	7,026
Invested capital	**20,917**	**26,734**	**27,321**	**27,185**	**33,616**

Source: Credit Suisse report on "Calculating Return on Invested Capital", June, 2014

Other Accounting Ratios

- Return on investments (ROI)
- Return on assets (ROA)
- Return on equity (ROE)
- Gross margin (Gross Profit/Sales)
- Profit margin (Net profit/Net Sales)
- Profitability index

Accounting Ratios: Pros and Cons

- The good:
    - More money is better
    - Reflects the use of capital
- The bad:
    - Neglects timing
    - Includes accounting distortions (e.g., depreciation or some non-cash expenses)
    - Neglects risk
    - Arbitrary cut off

Internal Rate of Return (IRR)

- What discount rate makes NPV = 0?
- Decision rule: invest if that rate > current discount rate

IRR

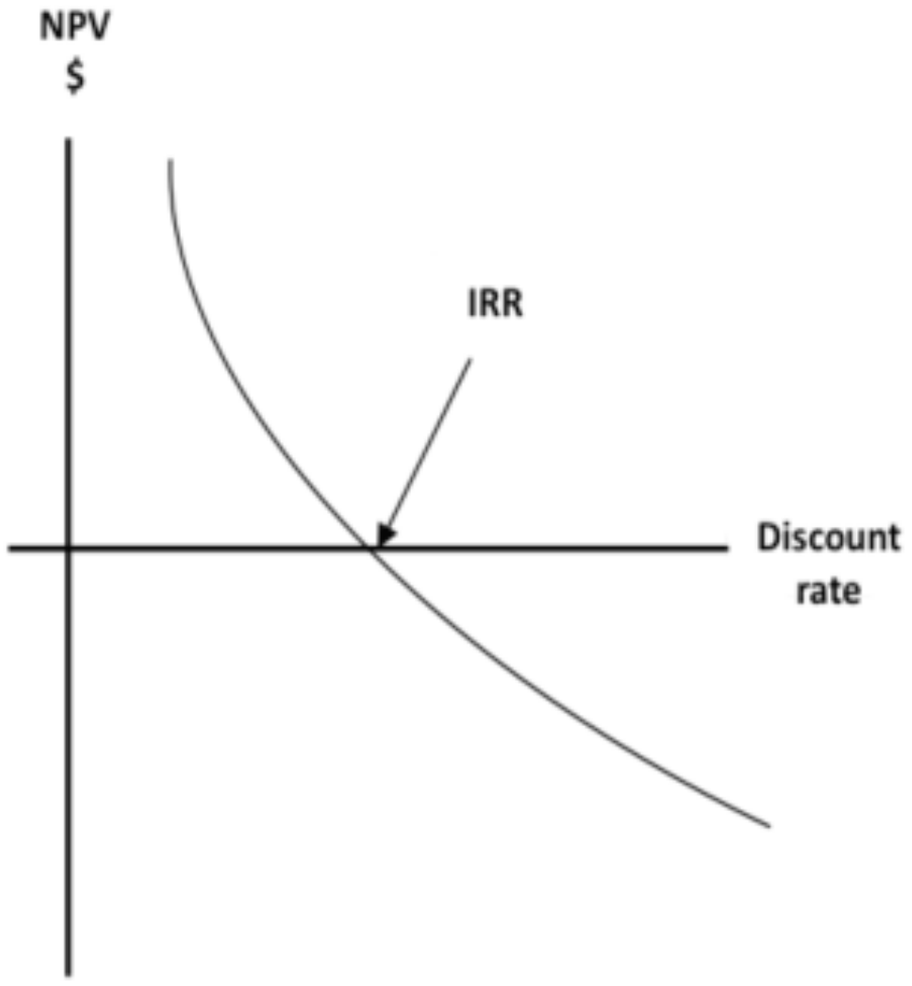
- Discounting more drives NPV down
- How hard can NPV get hit and stay > 0
- This decision rule is similar to NPV

Calculating IRR

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} - I_0 = 0$$

CF = cash flow
I_0 = initial investment

NPV VS IRR



If IRR = 10% then any discount rate below that, e.g. 5%, generates a positive NPV

IRR Calculation with Multiple Trials

Time	Cash Flow	Trial 1 (10%)	Trial 2 (20%)	Trial 3 (16%)
0	(9,364)	(9,364)	(9,364)	(9,364)
1	10,000	9,091	8,333	8,621
2	1,000	826	694	743
NPV	1,636	553	-336	0

NPV and IRR with Google Sheet

	A	B	C	D	E	F
1				interest	10%	
2	Time	Cash Flow	PV			
3	0	-9364	-9364			
4	1	10000	9090.909091			
5	2	1000	826.446281			
6						
7			553.3553719	NPV = SUM(C3:C5)		
8			$553.3553719	NPV (formula) = npv($E$1, B4:B5) + C3		
9			15.998308%	IRR =irr(B3:B5)		

IRR Properties

- Similar to NPV
- Scales NPV into a %
- More intuitive
- Accounts for timing, opportunity cost, and risk

IRR Caution: Loan-Type Flow

Project	CF_0	CF_1	IRR	NPV at 10%
X	(400)	500	25%	54.54
Y	400	(500)	25%	(54.54)

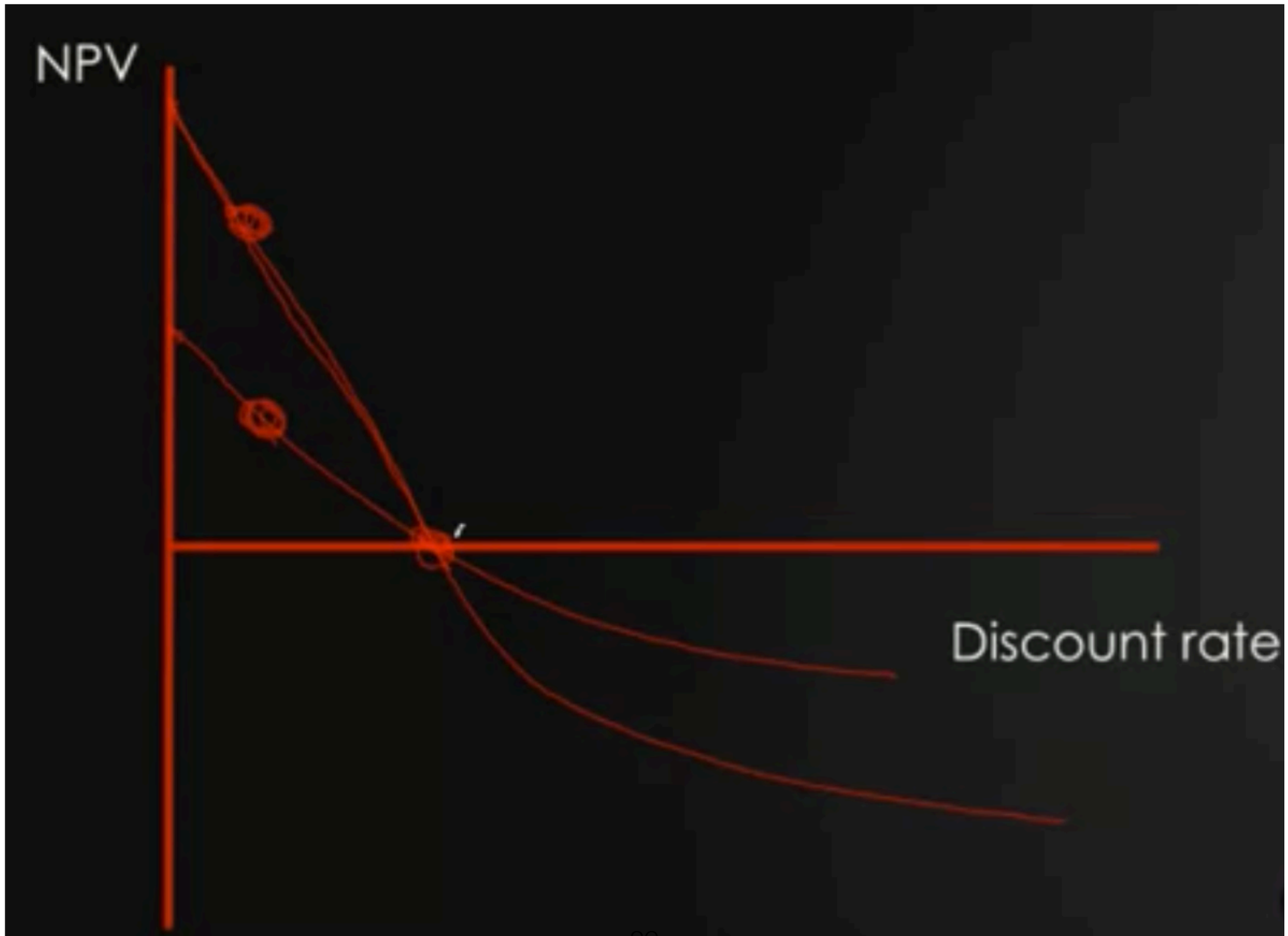
When the cash flow switches sign in loan-type flow

IRR Caution: Scale VS Percentage

Project	CF_0	CF_1	IRR	NPV at 10%
X	-1	2	100%	0.82
Y	-100	120	20%	9.1

- Hard to compare mutually exclusive projects
- Higher IRR might not imply higher NPV

Same IRR Different NPV



IRR Caution:Multiple or No IRR

- Different rates might set NPV = 0
- There could be no rate that sets NPV = 0

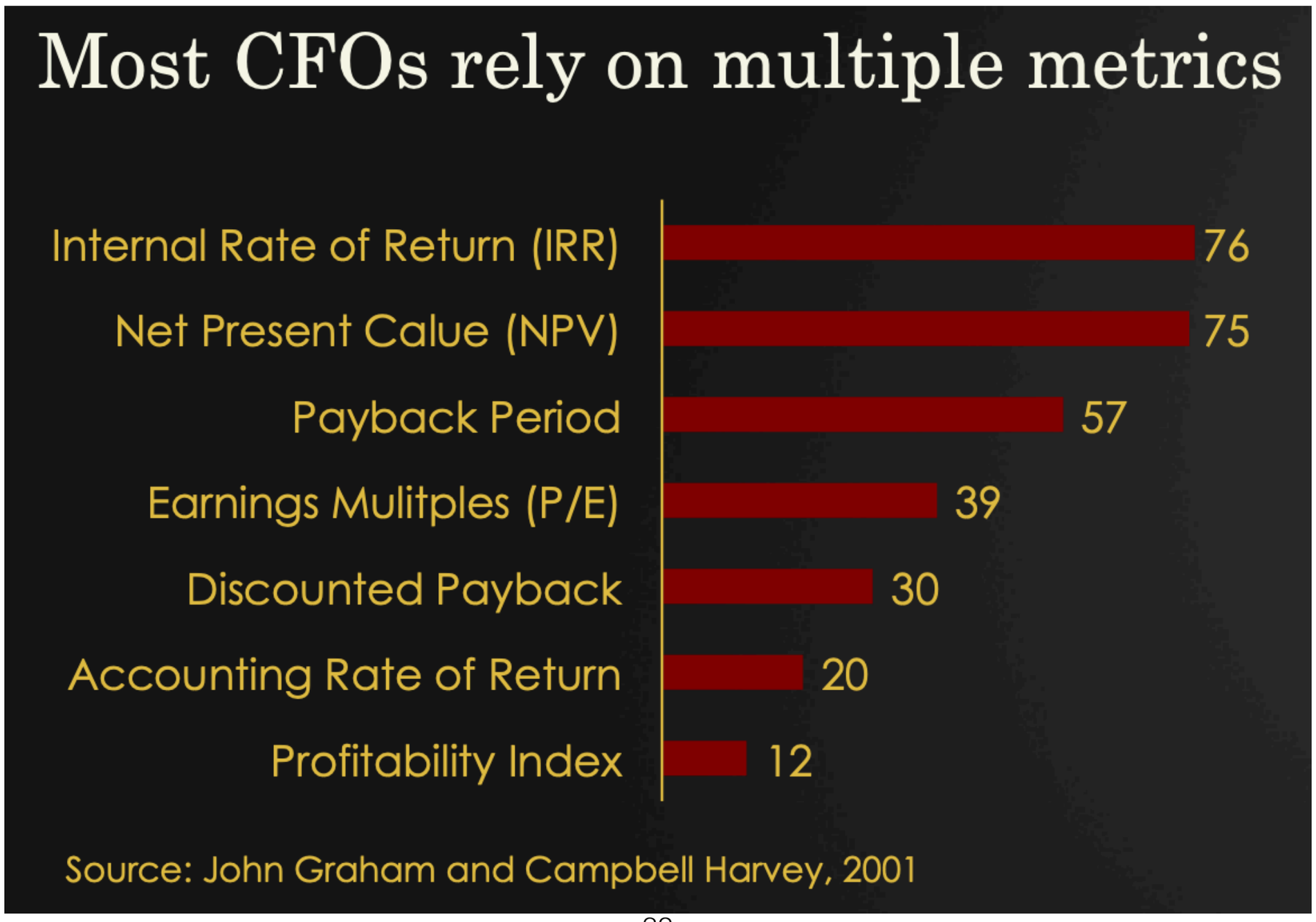
51	Time	Cash Flow		
52	0	-50000		
53	1	28125		
54	2	28125		
55	3	28125		
56	4	28125		
57	5	28125		
58	6	-93750		
59				
60	IRR (guess 5%)	3%	5%	=irr($B$52:$B$58,C60)
61	IRR (guess 10%	3%	10%	=irr($B$52:$B$58,C61)
62	IRR (guess 15%	28%	15%	=irr($B$52:$B$58,C62)
63	IRR (guess 20%	28%	20%	=irr($B$52:$B$58,C63)

In Summary IRR

- A good metric
- But, always used with NPV
- Watch out for:
  - Sign changes
  - Percentage vs scale (or volume)
  - Multiple IRRs

What Do CFOs Use?

- CFO = Chief Financial Officer



In Summary: Tools and Metrics

- NPV always first best approach
- IRR puts NPV in perspective
- Payback can be useful
- Ratios are informative and easy

Cash Flow Forecast

- However, all these tools and metrics depend on forecasting the future earnings
- How accurate can our forecast be?
- How sensitive are our decisions?
- What are the main value drivers?

Scenario Analysis

Time	Cash Flows		
	(Pessimistic)	(Expected)	(Optimistic)
0	-$6,000	-$5,000	-$5,000
1	$2,500	$3,200	$4,000
2	$2,000	$2,500	$3,000
3	$1,000	$1,200	$2,000
4	$1,000	$1,200	$1,500
5	$1,000	$1,200	$1,500
NPV (@15%)	-$587	$1,745	$3,665

Sensitivity Analysis

- Expand scenarios
- Calculate sensitivities, tweaking more parameters like discount rate
- Spreadsheets make this easy

	A	B	C	D	E	F	G	H
1								
2								
3	Assumptions							
4	Discount rate	7%						
5	Initial investment	-$5,000						
6	Yearly Cash inflows	$1,500						
7								
8	Time	0	1	2	3	4	5	6
9	Cash Flows	-$5,000	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
10	Present Value [CF]	-5000	1401.87	1310.16	1224.45	1144.34	1069.48	999.513
11								
12	Net Present Value	2149.81						
13	Net Present Value (using formula)	$2,149.81						
14								
15	IRR	19.91%						
16								
17	Payback analysis							
18	Cumulative Cash Flow	-5000	-3598.13	-2287.97	-1063.53	80.8169		
19								

In Summary: Sensitivity Analysis

- Assumptions matter
- Forecasting is an art
- There is no 100% right answer
- Understand the limitations

What We Have Learned

- Tools and metrics for capital budgeting
  - NPV
  - Payback period
  - Accounting ratios
  - IRR
- Sensitivity analysis