Economic Evaluation

- Objective of Analysis
- Criteria
  - Nature
  - Peculiarities
- Comparison of Criteria
- Recommended Approach

Objectives of Economic Evaluation Analysis

- Is individual project worthwhile? Above minimum standards?
  - This is a "choice", is it better or not?
  - This is easier
- Is it best? Is it at top of ranking list?
  - This is a "judgment" about details
  - This is more difficult
- Note difference between "choice" and "judgment"

Principal Evaluation Criteria

- Net Present Value
- Benefit - Cost Ratio
- Internal Rate of Return
- Cost-Effectiveness Ratio
- Pay-Back Period

Net Present Value

- NPV = B - C (stated in present values)
- Objective: To Maximize
- Advantage: Focus on Result
- Disadvantages
  - Interpretation of NPV
  - No account for scale, thus difficult to use for ranking

Present Value and Net Present Value: Example Calculations

Activity:	Initial									Rehab			
Years:	0	1	2	3	4	5	6	7	8	9	10	11	12
Cash Flow	-100	5	10	20	40	50	40	30	20	-40	35	25	15

Use NPV function in Excel. Note carefully that it assumes you mean that all cash flows occur at the end of the relevant period, not at beginning.

Present Value of cash flows at end of year 1, 2,etc, at rate = NPV (rate,c9:n9) **$143.58**

Discount rate expressed either in percent or decimal: 10% or 0.1

Net Present Value is above plus cash flow at time zero= NPV(0.1,c9:n9) +b9 **$43.58**

Difficulty in Interpreting Meaning of NPV

- Suppose for example that a project
  - costs 1000
  - sells 4 years later for 1500
- The obvious profit is: 500 = 1500 - 1000
- From an NPV perspective, however, we get
  - NPV = [1500 / (1+r) exp 4]- 1000
  - This amount depends on discount rate, r
  - If r = 10%, NPV ~ [1500 / 1.47] - 1000 ~ 20
  - Try telling that to tax authorities -- or others!

Evaluation of Projects S and T

Project	Benefit $	Cost $	Net Value $	NPV as % of Cost
S	2,002,000	2,000,000	2,000	0.1
T	2,000	1,000	1,000	100

Which project has the highest Net Present Value?

Which would you choose?

When might NPV be a good method?

When you spend the same total budget !

Benefit - Cost

- Ratio = Σ B / Σ C (Present Values)
- Objective: To Maximize
- Advantage: Common Scale, Useful in Ranking
- Disadvantages:
  - Treatment of Recurring Costs
    Σ B / Σ C or Net Benefits/Investment
    = > Bias against operating projects
  - Ranking sensitive to r
    low r = > higher rank for long-term projects

A Comparison of a Capital Intensive and Operations Project (Benefits in Present Values)

Project	K	R
Investment, C_k	$1,000,000	$1,000,000
Annual Cost, C_r	$50,000	$500,000
Annual Benefits	$200,000	$700,000
Annual Return	$150,000	$200,000
Useful Life	10 Years	10 Years
Total Benefits	$2,000,000	$7,000,000
Total Cost, $C_k + C_r$	$1,500,000	$6,000,000
Benefit/Cost Ratio	1.34 better than	1.17
Annual Return	15% worse than	20%
Net Value Present	$500,000 worse than	$1,000,000

Note: Because B/C counts recurring costs as part of total costs,
It disadvantages projects with operating costs (ex: factories),
And favors capital intensive projects (hydropower dams)

Ranking of Projects by Benefit-Cost Criterion Can Depend on DR

Project	Investment C_k,$	Annual Benefits R, $	Project Life N Years	Benefit - cost at discount rate of 3%	10%
A	1000	200	10	1.73	1.23 (best)
B	1000	125	20	1.86 (best)	1.05

Note: Varying the DR changes the Relative value of projects

Internal Rate of Return

- IRR = r such that NPV = 0
- Objective: Maximize IRR
- Advantages:
  - No need to choose r
  - Manipulation by r impossible
- Disadvantages:
  - Calculations complex -- but easy in spreadsheet
  - Ambiguous
- Note: ranking by IRR and B/C ratio may differ

Data for calculation of IRR

Example:

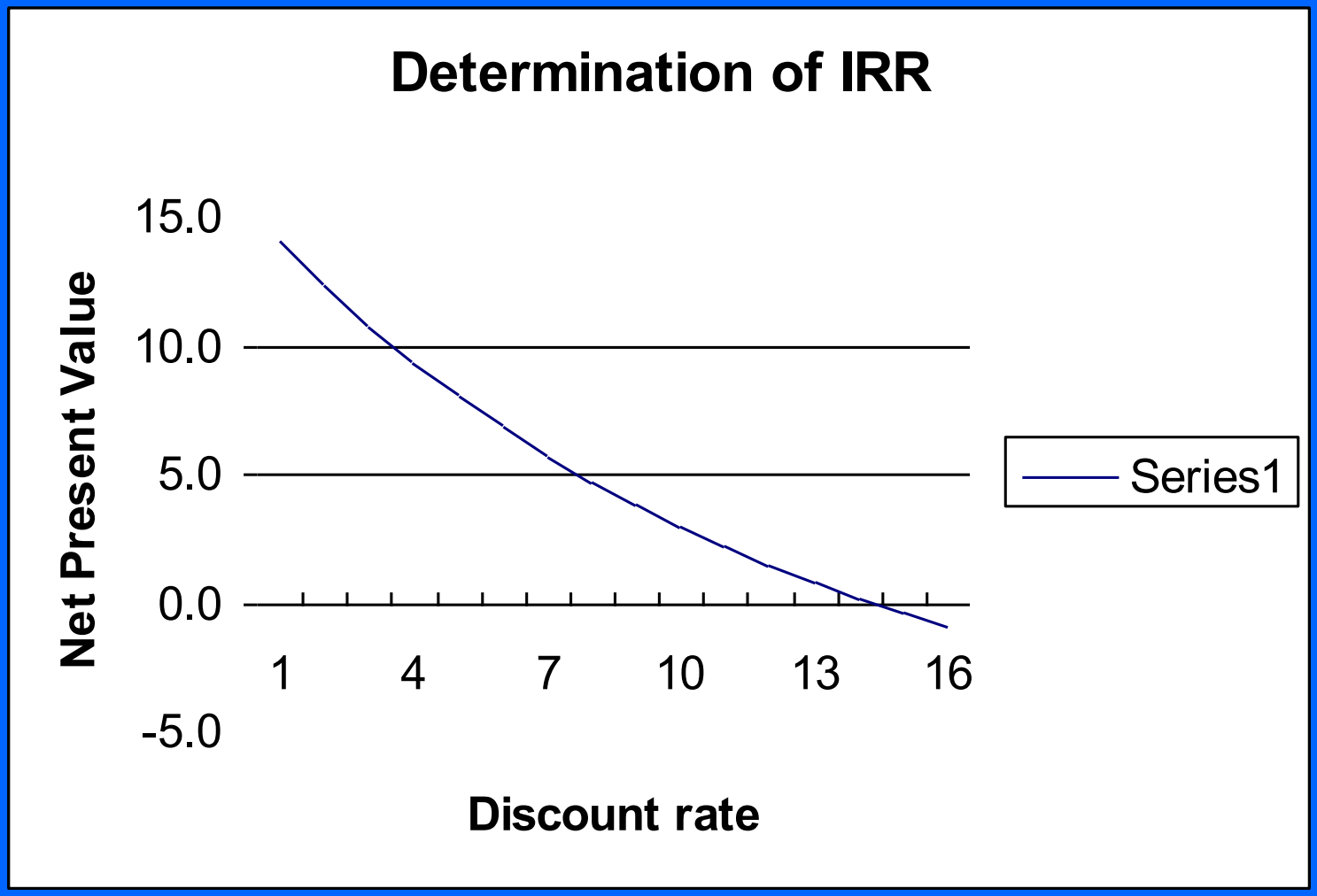
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Investment	15			3			5			
Net Income		2	3	4	5	5	3	4	5	6
Cash Flow	-15	2	3	1	5	5	-2	4	5	6

NPV at 12% $0.79 Formula: NPV(12%, B9:K9)

Spreadsheet Determination of IRR

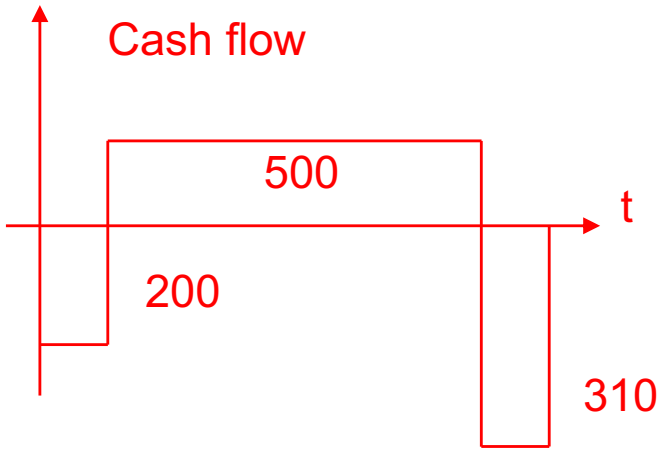
Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Investment	15			3			5			
Net Income		2	3	4	5	5	3	4	5	6
Cash Flow	-15	2	3	1	5	5	-2	4	5	6
IRR	13.33%			Formula: IRR(b9:k9)						

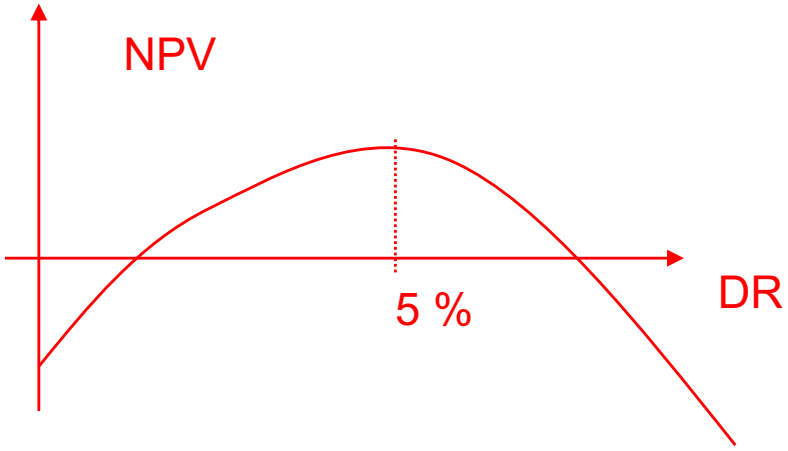
Graphical Determination of IRR



Projects can have Ambiguous Solutions for the Internal Rate of Return

Project	Investment, $	Annual Benefits $	Project Life Years	Closure cost at Year N-1 $
P	C_k	R	N	$C_c > RN - C_k$
Q	200	100	5	310





Ranking of Projects by Internal Rate of Return and Benefit-Cost Ratio Can Differ

Project	Investment, C_k, $	Annual Benefits R, $	Project Life N Years	Benefit - Cost r = 3%	Internal Rate of Return, 0%
A	1000	200	10	1.71	15.10 (best)
B	1000	125	20	1.86 (best)	10.93

Why is this? Because Relative value of project in B/C depends on DR

Pay-Back Period

- PBP = Number of periods needed for net benefits to sum up to initial investment
  - Note: undiscounted !!!
- Objective: To minimize
- Advantages: Really simple; No choice of r
- Disadvantages
  - Difficult to rank correctly projects with different useful lives or uneven cash flows

Evaluation of Projects V and W

Project	Investment, C_k, $	1	2	3	4	5	6	Payback Period Years	NPV at 10%	IRR
V	2000	1000	1000	1000				2	487	23.4%
W	2000	800	800	800	800	800	800	2.5	1484	32.7%

Note: Although Pay-back period gives "wrong" results, many Managers prefer it, because they do not trust forecasts!

Cost- Effectiveness Ratio

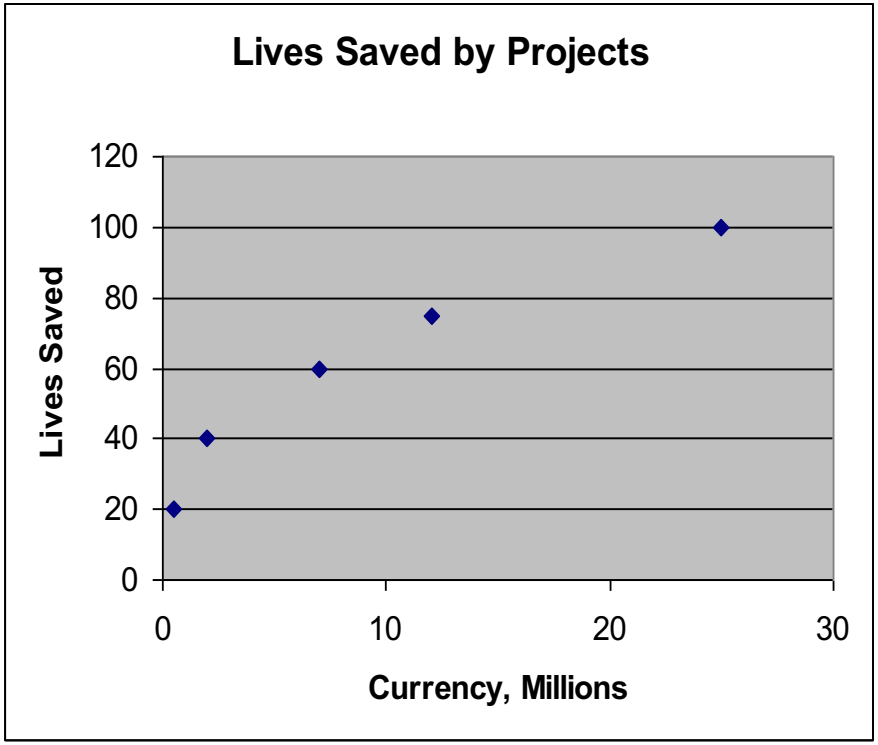
- Ratio = (Units of Benefit) / Cost
  - example: "lives saved/million dollars"
- Objective: To Maximize
- Advantage: Avoids problem of trying to assign money (example, $) values to "intangibles" such as a "life", "ton of pollution", etc.
- Disadvantage: No sense for minimum standard or limits

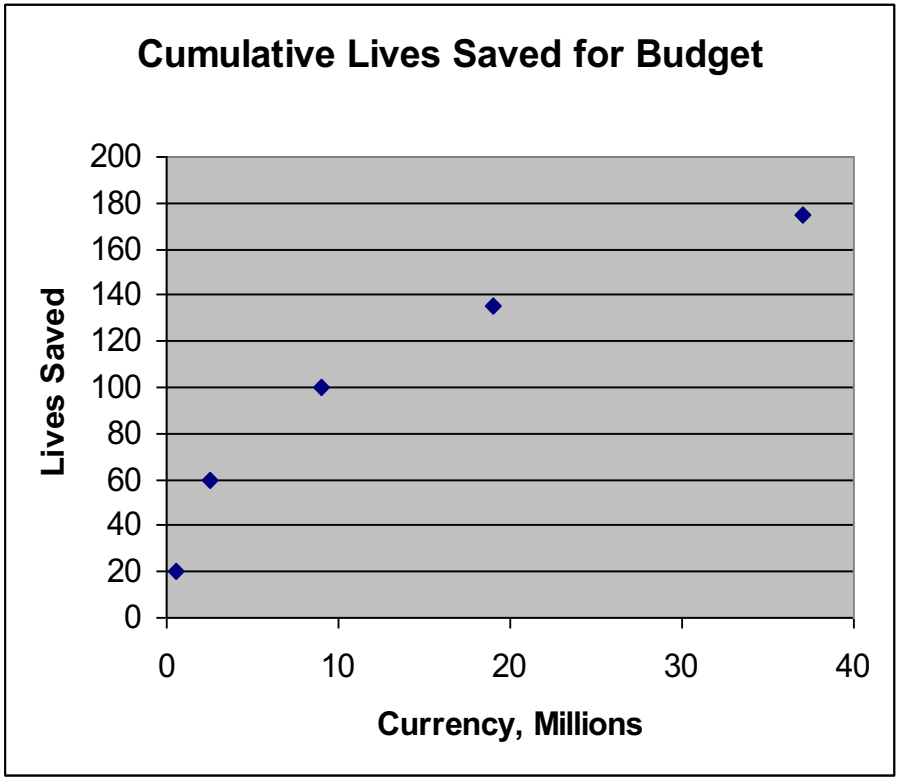
Data for of Cost-Effectiveness Analysis

	Possible Projects			Cost-Effective Combinations			
	Lives Saved	Cost	Cost-Effect.	Combo.	∑ Lives	∑ Cost	Marginal CE
Visual Exam	20	0.5	40.0	VE	20	0.5	40.0
X-Rays	40	2	20.0	VE + X-Ray	60	2.5	20.0
Lab Tests	60	7	8.6	X-Ray + Lab	100	9	6.2
MRIs	75	12	6.3	MRI + Lab	135	19	3.5
Biopsy	100	25	4.0	MRI + Bio.	175	37	2.2

NOTE: Each project has its own cost-effectiveness. Overall cost-effectiveness might sometimes just add projects. In general, however, an advanced technology often substitutes for a lesser one. In this example, MRI (Magnetic Resonance Imagining) thus substitutes for X-Rays, and so on.

Cost-Effectiveness Analysis





If budget is fixed, we deploy combination that maximizes results. If not, then we have to ask if extra results are worth the extra expense, that is, "Is the marginal cost-effectiveness worthwhile?"

Recommended Procedure (if you have discretion to choose)

- Examine Nature of projects
  - Easy to put into $ terms? Steady cash flows? Closure costs? Or various project lifetimes?
  - An operating or a straight capital investment?
- Choose Method Accordingly
- No method is perfect -- ultimately a judgment
- Current "best practice" uses several criteria; uses judgment to decide on project

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