Impact Analysis/Evaluation and Cost-Benefit Analysis

- Formative vs. summative evaluations
  - Process-based vs. outcome-based
- Quantitative, qualitative, mixed methods
- Purpose
  - Ex-ante analysis of plan, program, or policy
  - Ex-post assessment or evaluation

Why Evaluate Plans, Programs or Policies?

- Understand the impact of a program
  - Fiscal impacts
  - Societal impacts
- Help improve plan or policy to increase or create impact
- Improve implementation to increase or create impact
- Assist in reconceptualizing purpose and objectives
- Assist in building consensus on goals and objectives
- Help inform decisions about investment or subsidy levels
- Verify or quantify impacts – possibly for political and public relations purposes

Early Questions…

- Why is the analysis being done?
- Who is the audience?
- What sorts of resources and time are available for the analysis?
- Who will do it?
- What are the end-outcomes? What are the intermediate outcomes or outputs?
- Which indicators and data will be used?
- Where will these come from?

Criteria Types → Analytical Approaches

Key Criteria Types:

- Technical feasibility
  - Effectiveness
  - Adequacy
- Economic and financial possibility
  - Fiscal benefits and costs to government
  - Total societal benefits and costs
- Equity
- Risk and Uncertainty
- Reversibility
- Political viability
- Administrative operability
- Other types of criteria: security, liberty, rights

Distributional and Equity Issues

- C’s and B’s for *whom*?
- Vertical vs. horizontal equity
- “Standing” in the analysis
- Transitional equity
- Intergenerational equity
- Interactions with risk, uncertainty, and reversibility

CBA Issues…

- Costs and benefit valuation types:
  - monetary
  - monetarizable
  - tangible but nonmonetarizable
  - intangible
- Including opportunity costs
- Direct vs. indirect –
  - first- vs. second- or third-level effects
- Long-term vs. short-term
- Intended vs. unintended effects

Fixed Costs, Variable Costs, Marginal Costs

- Sunk cost – cost already expended and not recoverable
- Fixed cost – the costs incurred regardless of the amount of services provided or goods produced – i.e., does not vary with scale of the program
  - Basic infrastructure and administrative costs
  - Assumed to be incurred before the first unit of services or goods are provided/produced
- Variable costs = the portion of total costs that varies with scale
- Average costs = total costs / number of units of output
- Marginal cost = cost of producing one more unit of output

Relationships between FC, VC, TC and MC

$TC = FC + VC$

$$AC = \frac{TC}{Q}$$

$$MC = \frac{VC_{n+1} - VC_n}{Q_{n+1} - Q_n}$$

Where n is the number of units of service provided

Since $VC = TC - FC$, and FC is constant,

$$MC = \frac{TC_{n+1} - TC_n}{Q_{n+1} - Q_n}$$

Cost-Benefit Analysis – what can it do?

- Do the benefits exceed the costs? Is B > C?

  Or… What is the ratio of benefits to costs? Is B/C >1?

- What is the ***net*** benefit of the project (B – C)
  - Is it higher than other alternatives?

- Cost-effectiveness
  - Of the programs meeting minimum effectiveness criteria, which costs least?
  - Hold benefits constant, then identify differences in costs

Present Value

- What is $100 next year worth to you in today's dollars?
- How much can you earn on a liquid, risk-free investment?
- Assume 3%   >>   103% * $Today = $100 next year

  >> $100/1.03 = $Today = $92.59

General formula for present value : $PV\left[S_{n*m}\right] = \frac{S_{n*m}}{(1+r/m)^{n*m}}$

where r is annual discount rate, n is number of years, m is compounding periods per year (e.g., quarterly, m=4).

If $m = 1$ → $PV\left[S_n\right] = \frac{S_n}{(1+r)^n}$

Decomposing Discount Rates

$$r = r_{real} + r_{inf} + r_{risk}$$

$$r_{risk} = r_{project} + r_{liquidity} + r_{other\ risks}$$

Calculating the Net Present Value of a Project

$PV(B) = B_0 + PV(B_1) + PV(B_2) + \ldots$

$PV(C) = C_0 + PV(C_1) + PV(C_2) + \ldots$

$NPV = PV(B) – PV(C)$

Alternatively, the same result can be calculated as:

$NPV = B_0 - C_0 + PV(B_1 - C_1) + PV(B_2 - C_2) + \ldots$

Table 7-1 Basic Data for the Discounting Example

	YEAR					
	0	1	2	3	4	5
Benefits	0	$4,000	$4,000	$4,000	$4,000	$4,000
Costs	$15,000	0	0	$1,223	0	0
Discount rate (r)	4%	4%	4%	4%	4%	4%
Discount factor $1/(1 + r)^n$	1.0	.9615	.9246	.8890	.8548	.8219

From: C. Patton and D. Sawicki, *Basic Methods of Policy Analysis and Planning*, Prentice Hall, Second Addition, 1993.

PV (B) (or DB) = 0 + $4,000/(1+ 0.04) + $4,000/(1+0.04)^2 + $4,000/(1+0.04)^3 + $4,000/(1+0.04)^4 + $5,000/(1+0.04)^5

PV(C) (or DC) = $15,000 + $1,223 / (1+0.04)^3

NPV = PV(B) – PV(C)= $17,807.20 - $16,087.25 = $1,719.95

A Cost-Benefit Example

- Tunnel vs. ferry
- Discount rate = 8%
- Tunnel costs:
  - $64 million in year 0 for construction
  - $20,000 each year
  - $500,000 every 10 years in deferred maintenance
  - Life of tunnel 50 years
- Benefits
  - $500,000 in ferry expenses annually
  - Commute time: 5,000 commuters * ½ hr *$8/hr*250 days
  - $1.50 per day-car * 3,000 cars * 250 days in other auto-related savings

From: C. Patton and D. Sawicki, *Basic Methods of Policy Analysis and Planning*, Prentice Hall, Second Addition, 1993.

The Cost-Benefit Calculation

annuity factor, 50 yrs

Costs = $64MM + $20,000 * [(1-1/(1+r)^{50})/r] + $500,000 * [1/(1+r)^{10} + 1/(1+r)^{20} + 1/(1+r)^{30} + 1/(1+r)^{40}]

Benefits = [$500,000 + (5,000 * 250 days * ½ * $8) + (3,000 * 250 days * $1.50)] * [(1-1/(1+r)^{50})/r]

(yearly benefit for 50 years)

With r = 0.08, Benefits – Costs = $16.4MM

Sensitivity Analysis – Changing r, and Changing the Value of Commuting Time

Table 7-3 Using Sensitivity Analysis to Test the Effect of the Discount Rate

Discount Rate	Discounted Benefits	Discounted Costs	NPV
0%	$306.25 M	$67.50 M	+$238.75 M
6%	$104.42 M	$64.91 M	+$ 39.51 M
8%	$ 81.06 M	$64.67 M	+$ 16.39 M
10%	$ 65.65 M	$64.51 M	+$ 1.14 M
11%	$ 59.90 M	$64.45 M	−$ 4.55 M
12%	$ 55.02 M	$64.42 M	−$ 9.40 M

Table 7-4 Testing the Sensitivity of Commuters' Time

Value of Commuters' Time per Hour	NPV
$ 0 per hour	−$44.28 M
$ 1 per hour	−$36.63 M
$ 2 per hour	−$28.98 M
$ 3 per hour	−$21.34 M
$ 4 per hour	−$13.68 M
$ 5 per hour	−$ 6.04 M
$ 6 per hour	+$ 1.60 M
$ 7 per hour	+$ 9.25 M
$ 8 per hour	+$16.39 M
$16 per hour	+$78.08 M

From: C. Patton and D. Sawicki, *Basic Methods of Policy Analysis and Planning*, Prentice Hall, Second Addition, 1993.

Discounted Cash Flows and the Long-Term

DCF/IRR/CBA methodology generally favors near-term returns over longer-term returns

Planning outputs and outcomes can last for decades, but DCF often largely neglects benefits in "outlying" years (e.g., 10+)

→ Does DCF undervalue durability?

- → Physical durability
- → Market durability
- → Social durability
- → Environmental durability and sustainability

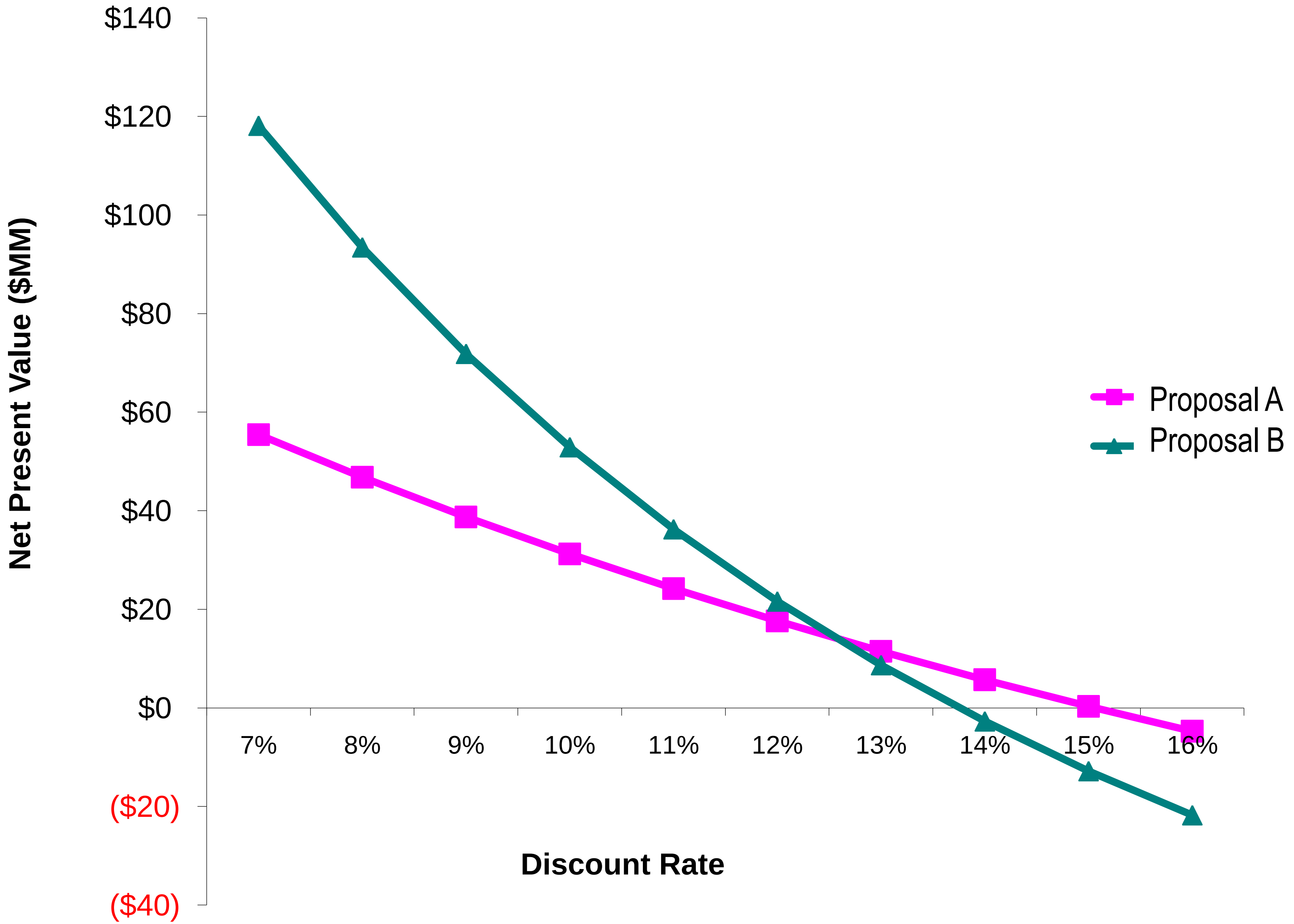
What's in a Discount Rate?

Annual Net Benefits (B-C), ($MM)

	Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Proposal A	(100)	0	8	11	13	14	15	176								
Proposal B	(100)	(5)	(5)	0	5	11	12	14	17	20	23	25	27	28	29	330

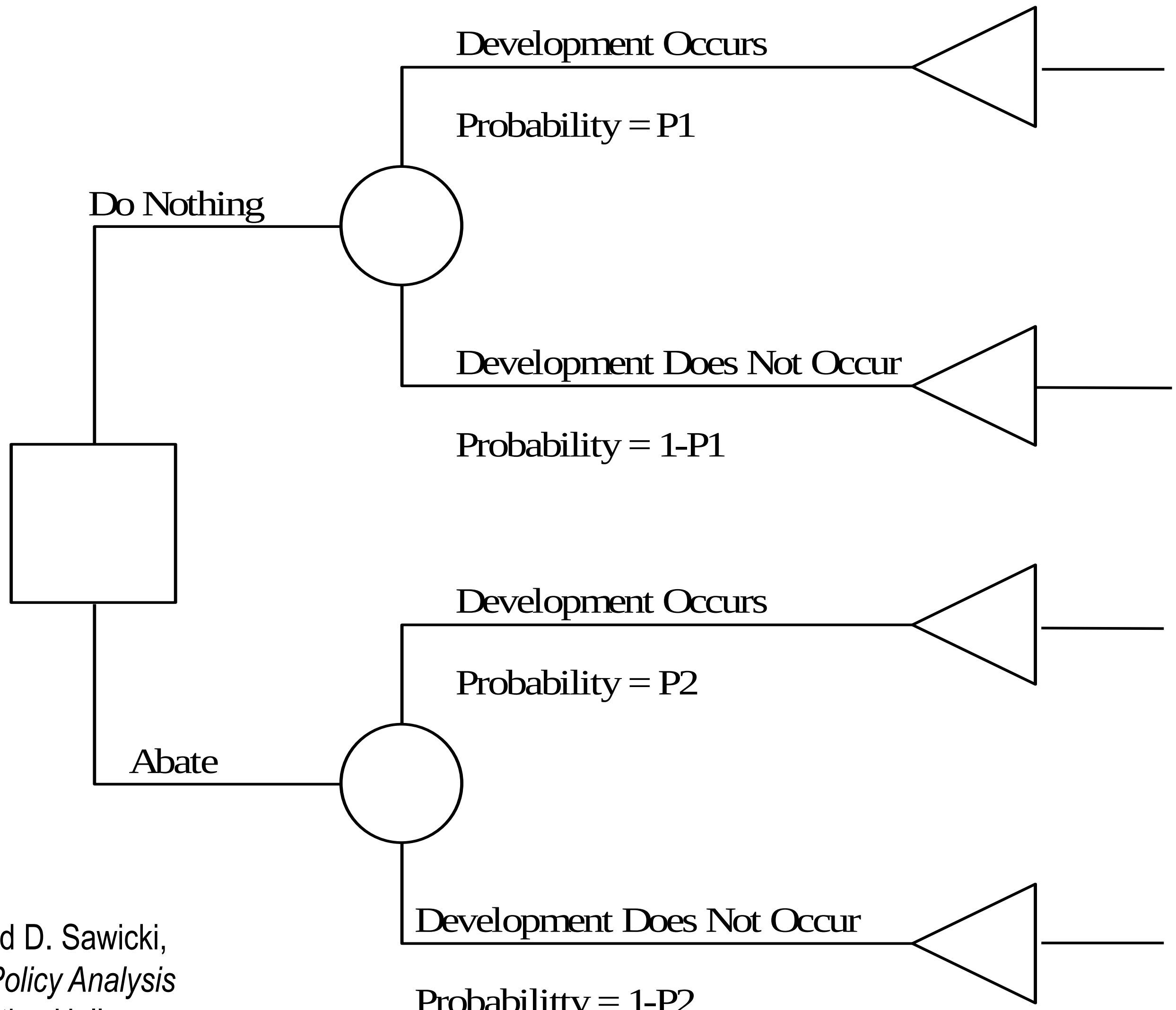
NPV@ Discount Rates

	8%	12%	16%
Proposal A	$43.35	$15.74	($4.08)
Proposal B	$86.54	$19.31	($18.74)



$140
$120
$100
$80
$60
$40
$20
$0
($20)
($40)
Net Present Value ($MM)
7%
8%
9%
10%
11%
12%
13%
14%
15%
16%
Discount Rate
Proposal A
Proposal B

CBA Under Uncertainty

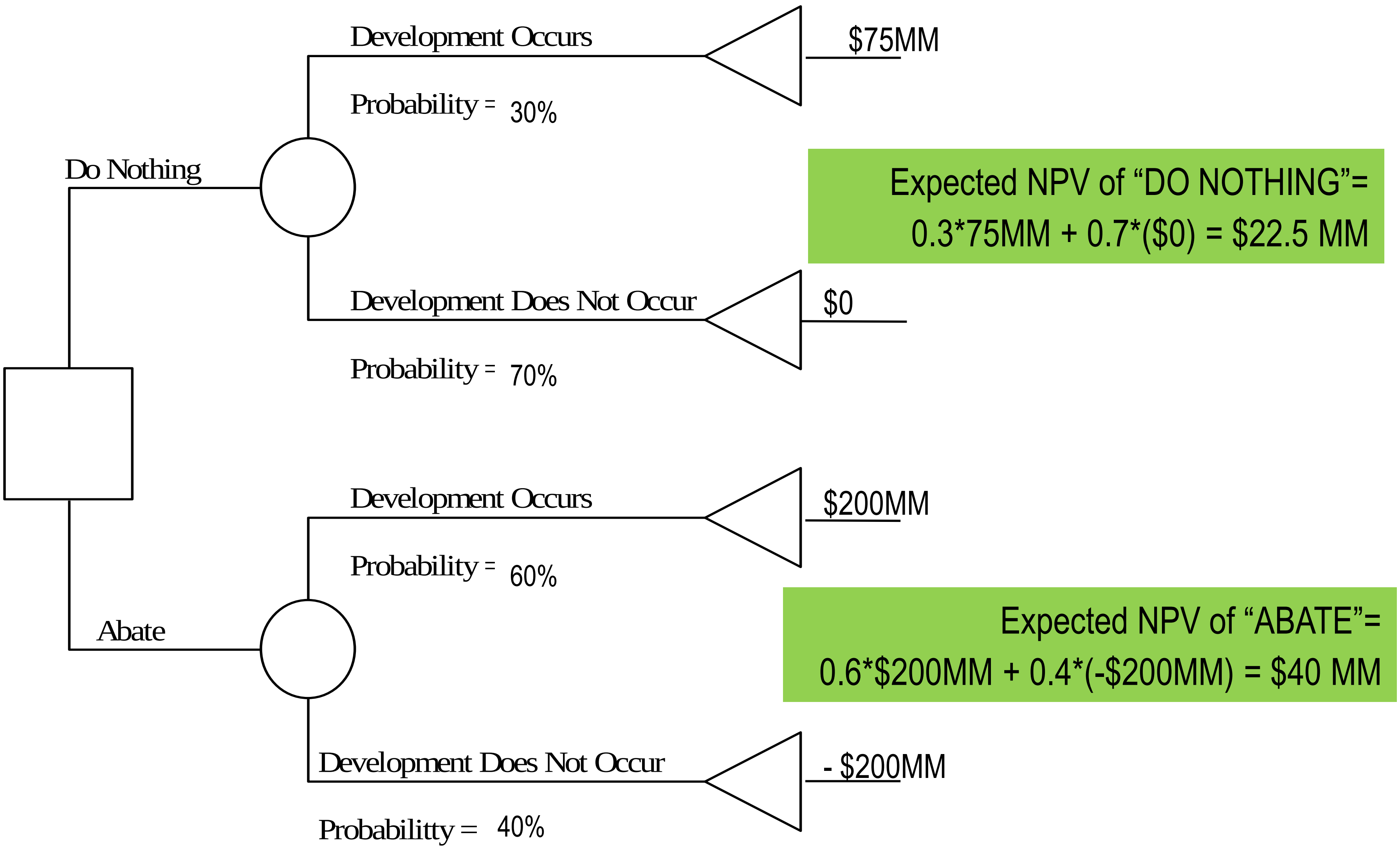


From: C. Patton and D. Sawicki, *Basic Methods of Policy Analysis and Planning*, Prentice Hall, Second Addition, 1993.

Table 7-6 The Costs and Benefits of Different Possible Outcomes of a Policy to Abate Taxes for Downtown Development (in millions of dollars)

Costs and Benefits of the Outcome	Outcome 1 Do Nothing/ Get Development	Outcome 2 Do Nothing/ Get No Development	Outcome 3 Abate Taxes/ Get Development	Outcome 4 Abate Taxes/ Get No Development
Increased property tax receipts	+$100	$0	+$900	$ 0
Decreased property tax receipts (taxes abated)	$ 0	$0	−$600	−$200
Increased public service costs	−$ 25	$0	−$100	$ 0
Net benefit (+) or loss (−) to city	+$ 75	$0	+$200	−$200

From: C. Patton and D. Sawicki, *Basic Methods of Policy Analysis and Planning*, Prentice Hall, Second Addition, 1993.


Development Occurs
Probability = 30%
$75MM
Do Nothing
Expected NPV of “DO NOTHING”=
0.3*75MM + 0.7*($0) = $22.5 MM
Development Does Not Occur
$0
Probability = 70%
Development Occurs
$200MM
Probability = 60%
Abate
Expected NPV of “ABATE”=
0.6*$200MM + 0.4*(-$200MM) = $40 MM
Development Does Not Occur
- $200MM
Probabilitty = 40%