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Business Statistics

T1LM 2

Decision Support Tools

Content

Decision Making Environments

Decision Trees

Break- even Analysis

Ethics

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Decision Making Content

Decision Making Under Uncertainty

Decision Making Under Risk

Decision Making Under Certainty

Decision Making Under Uncertainty

The Decision Process

1. Clearly define the problem and the factors that influence it.
2. Develop specific and measurable objectives. To be achieved.
3. Develop a model and identify outcome alternatives.
4. Evaluate each alternative .
5. Select the best alternative based on predetermined criterion.
6. Implement the decision.

Decision Making Under Uncertainty

There are several criteria for making decisions under uncertainty

1. Maximax (optimistic)
2. Maximin (pessimistic)
3. Criterion of realism (Hurwicz)
4. Equally likely (Laplace)
5. Minimax regret

Example: Thompson Lumber Company

ALTERNATIVE	STATE OF NATURE	
	FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)
Construct a large plant	200,000	−180,000
Construct a small plant	100,000	−20,000
Do nothing	0	0

1. Maximax

Used to find the alternative that maximizes the maximum payoff

- Locate the maximum payoff for each alternative
- Select the alternative with the maximum number

ALTERNATIVE	STATE OF NATURE		MAXIMUM IN A ROW ($)
	FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)	
Construct a large plant	200,000	−180,000	200,000
Construct a small plant	100,000	−20,000	100,000
Do nothing	0	0	0

Maximax

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2. Maximin

Used to find the alternative that maximizes the minimum payoff

- Locate the minimum payoff for each alternative
- Select the alternative with the maximum number

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	MINIMUM IN A ROW ($)
Construct a large plant	200,000	−180,000	−180,000
Construct a small plant	100,000	−20,000	−20,000
Do nothing	0	0	0

Maximin

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3. Criterion of Realism (Hurwicz)

A *weighted average* compromise between optimistic and pessimistic

- Select a coefficient of realism α
- Coefficient is between 0 and 1
- A value of 1 is 100% optimistic
- Compute the weighted averages for each alternative
- Select the alternative with the highest value

$$\text{Weighted average} = \alpha * (\text{maximum in row}) + (1 - \alpha) * (\text{minimum in row})$$

Criterion of Realism (Hurwicz)

- For the large plant alternative using $\alpha = 0.8$

  $(0.8)(200{,}000) + (1 - 0.8)(-180{,}000) = 124{,}000$

- For the small plant alternative using $\alpha = 0.8$

  $(0.8)(100{,}000) + (1 - 0.8)(-20{,}000) = 76{,}000$

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	CRITERION OF REALISM ($\alpha = 0.8$)$
Construct a large plant	200,000	−180,000	124,000
Construct a small plant	100,000	−20,000	76,000
Do nothing	0	0	0

Realism

4. Equally Likely (Laplace)

Considers all the payoffs for each alternative

- Find the average payoff for each alternative
- Select the alternative with the highest average

ALTERNATIVE	STATE OF NATURE: FAVORABLE MARKET ($)	STATE OF NATURE: UNFAVORABLE MARKET ($)	ROW AVERAGE ($)
Construct a large plant	200,000	−180,000	10,000
Construct a small plant	100,000	−20,000	40,000
Do nothing	0	0	0

Equally likely

5. Minimax Regret

Based on *opportunity loss* or *regret*, the difference between the optimal profit and actual payoff for a decision

- Create an opportunity loss table by determining the opportunity loss for not choosing the best alternative
- The probabilities are not known
- Opportunity loss is calculated by subtracting each payoff in the column from the best payoff in the column
- Find the maximum opportunity loss for each alternative and pick the alternative with the minimum number

Minimax Regret

- Opportunity Loss Tables

STATE OF NATURE	
FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)
200,000 – 200,000	0 – (–180,000)
200,000 – 100,000	0 – (–20,000)
200,000 – 0	0 – 0

	STATE OF NATURE	
ALTERNATIVE	FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)
Construct a large plant	0	180,000
Construct a small plant	100,000	20,000
Do nothing	200,000	0

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Minimax Regret

ALTERNATIVE	STATE OF NATURE		MINIMUM IN A ROW ($)
	FAVORABLE MARKET ($)	UNFAVORABLE MARKET ($)	
Construct a large plant	0	180,000	180,000
Construct a small plant	100,000	20,000	100,000
Do nothing	200,000	0	200,000

Minimax

Decision Making Under Risk

(Expected Monetary Value)

Risk

- Each possible state of nature has an assumed probability
- States of nature are mutually exclusive
- Probabilities must sum to 1
- Determine the expected monetary value (EMV) for each alternative

Decision Making Under Risk

- Decision making when there are several possible states of nature and we know the probabilities associated with each possible state
- Most popular method is to choose the alternative with the highest ***expected monetary value (EMV)***

EMV Example

Alternatives	States of Nature: Favorable Market	States of Nature: Unfavorable Market
Construct large plant (A_1)	$200,000	-$180,000
Construct small plant (A_2)	$100,000	-$20,000
Do nothing (A_3)	$0	$0
Probabilities	.7	.3

1. $EMV(A_1) = (.7)(\$200{,}000) + (.3)(-\$180{,}000) = \$10{,}000$
2. $EMV(A_2) = (.7)(\$100{,}000) + (.3)(-\$20{,}000) = \$40{,}000$
3. $EMV(A_3) = (.7)(\$0) + (.3)(\$0) = \$0$

Decision Trees

Decision Trees

- Any problem that can be presented in a decision table can also be graphically represented in a ***decision tree***
- Decision trees are most beneficial when a sequence of decisions must be made
- All decision trees contain ***decision points*** or ***nodes*** and ***state-of-nature points*** or ***nodes***
  - A decision node from which one of several alternatives may be chosen
  - A state-of-nature node out of which one state of nature will occur

Decision Trees

1. Define the problem
2. Structure or draw the decision tree
3. Assign probabilities to the states of nature
4. Estimate payoffs for each possible combination of decision alternatives and states of nature
5. Solve the problem by working backward through the tree computing the EMV for each state-of-nature node

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Decision Table Example

Alternatives	State of Nature	
	Favorable Market	Unfavorable Market
Construct large plant	$200,000	–$180,000
Construct small plant	$100,000	–$ 20,000
Do nothing	$ 0	$ 0

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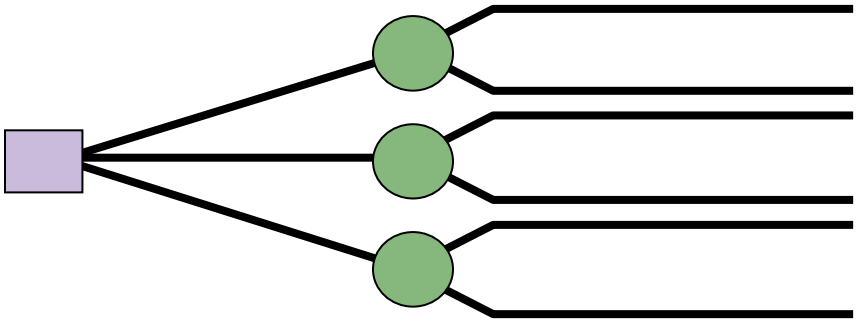
Symbols used in Decision Making

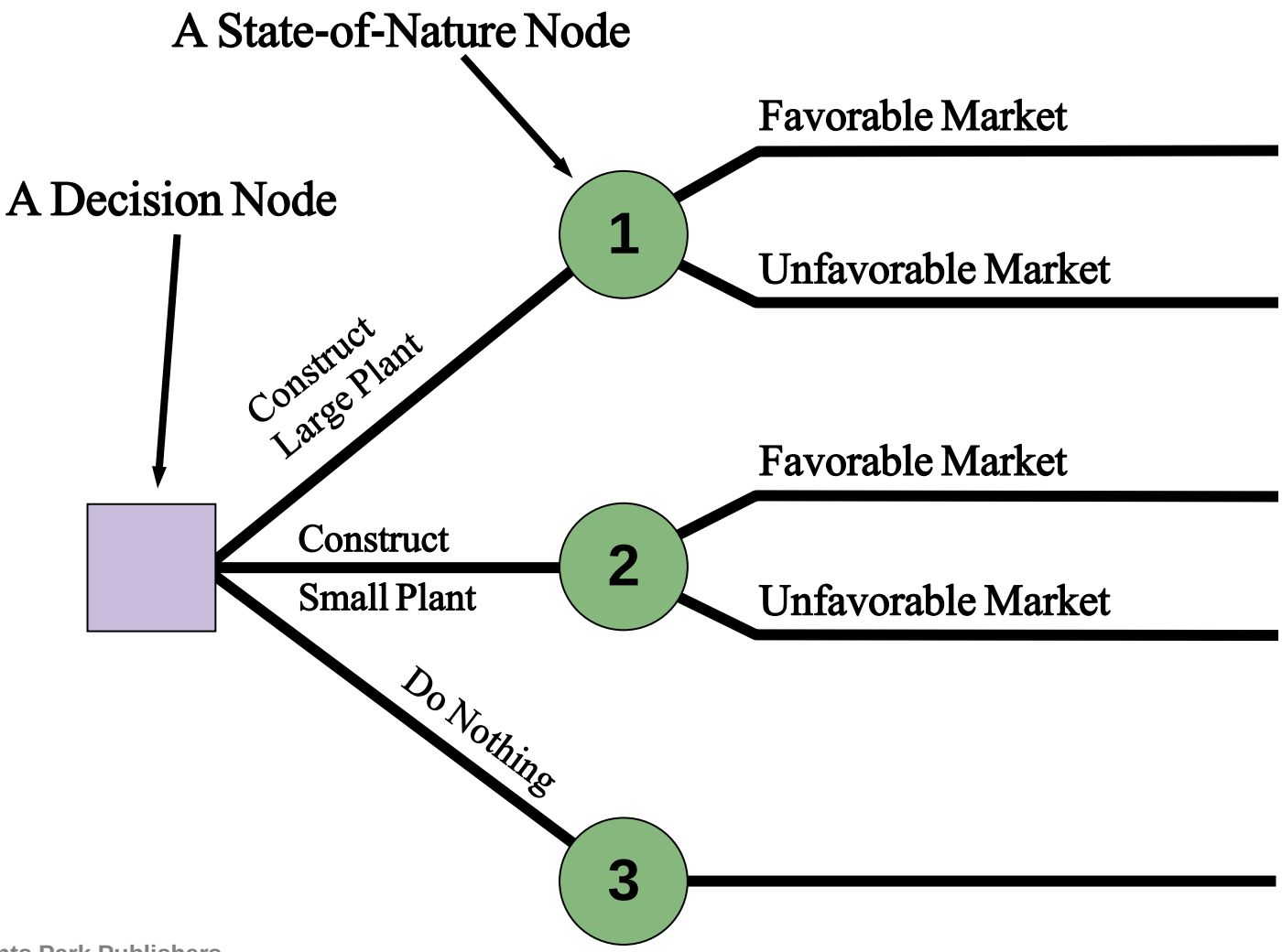
2. Symbols used in a decision tree:
   a. □ – decision node from which one of several alternatives may be selected
   b. ○ – a state-of-nature node out of which one state of nature will occur

Structure of Decision Trees

- Trees start from left to right
- Represent decisions and outcomes in sequential order
- Squares represent decision nodes
- Circles represent states of nature nodes
- Lines or branches connect the decisions nodes and the states of nature



Thompson's Decision Tree



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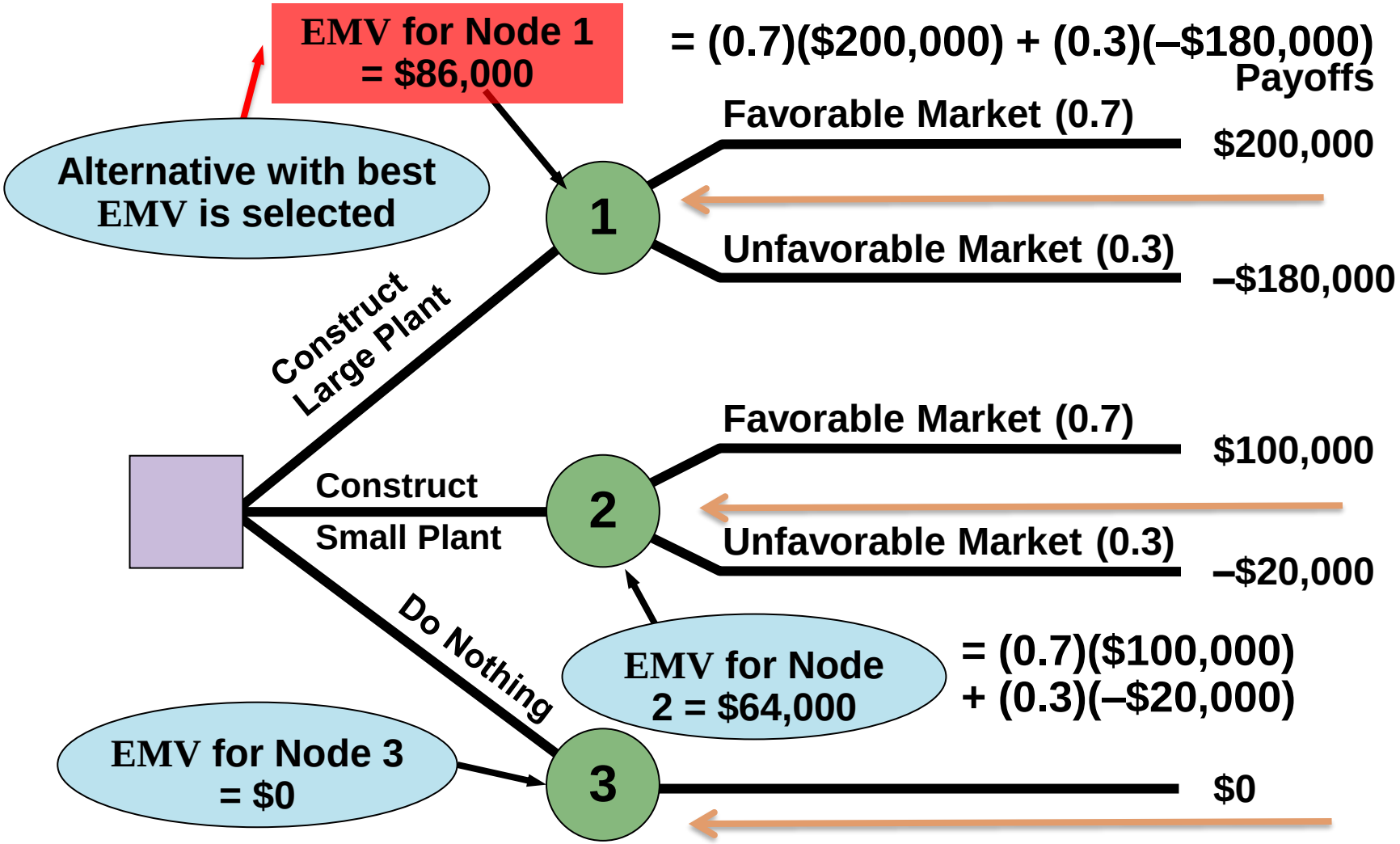
Decision Tree



Ethics, Sustainability, and Externalities

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Lies

More Lies

and

Statistics

Examples of Evidence

Scales used to mislead

A statistic is not a parameter

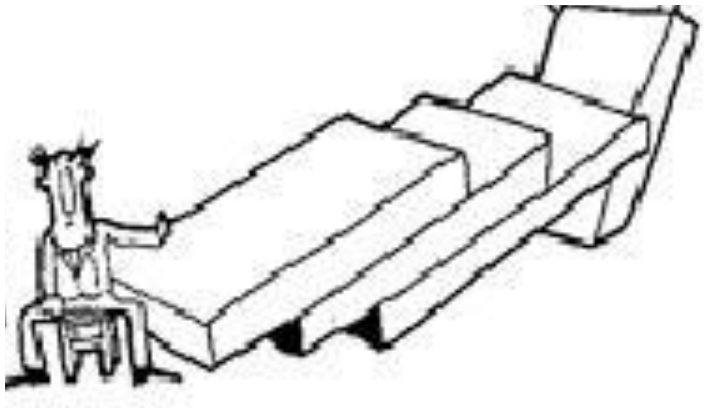
A parameter is not a statistic

Daily news and reporting (fact-check)

Ethics

- ☑ Management must deliver healthy, safe, honest quality products and services
- ☑ Dishonesty risks injuries, lawsuits, recalls, and increased oversight and regulations
- ☑ Organizations are judged based on the degree of externalities they create (positive and negative)
- ☑ Organizations are also judged by how they respond to problems (i.e.: Tylenol, Ford Pinto, Deep Water Horizon, VW, Toyota Prius, Lehman Bros.)

Perspective One



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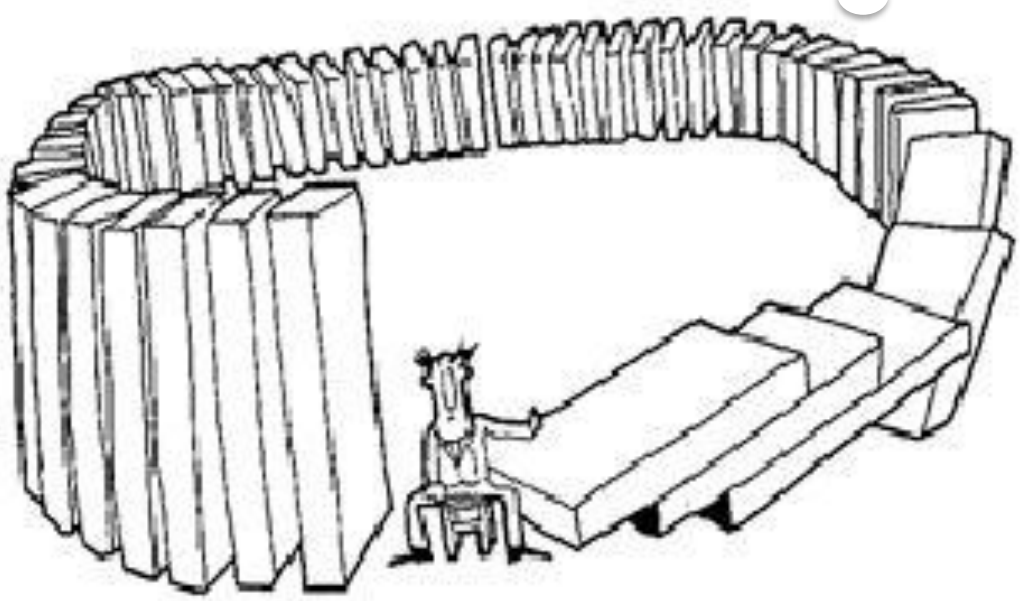
Perspective Two

In complex systems, cause and effect are often distance in time and space.



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Too often statistics are used to justify actions that result in negative externalities ! ! !

Externalities Definition

A consequence of an economic activity that is experienced by unrelated third parties. An externality can be either positive or negative.

Pollution emitted by a factory that spoils the surrounding environment and affects the health of nearby residents is an example of a negative externality.

An example of a positive externality is the effect of a well-educated labor force on the productivity of a company

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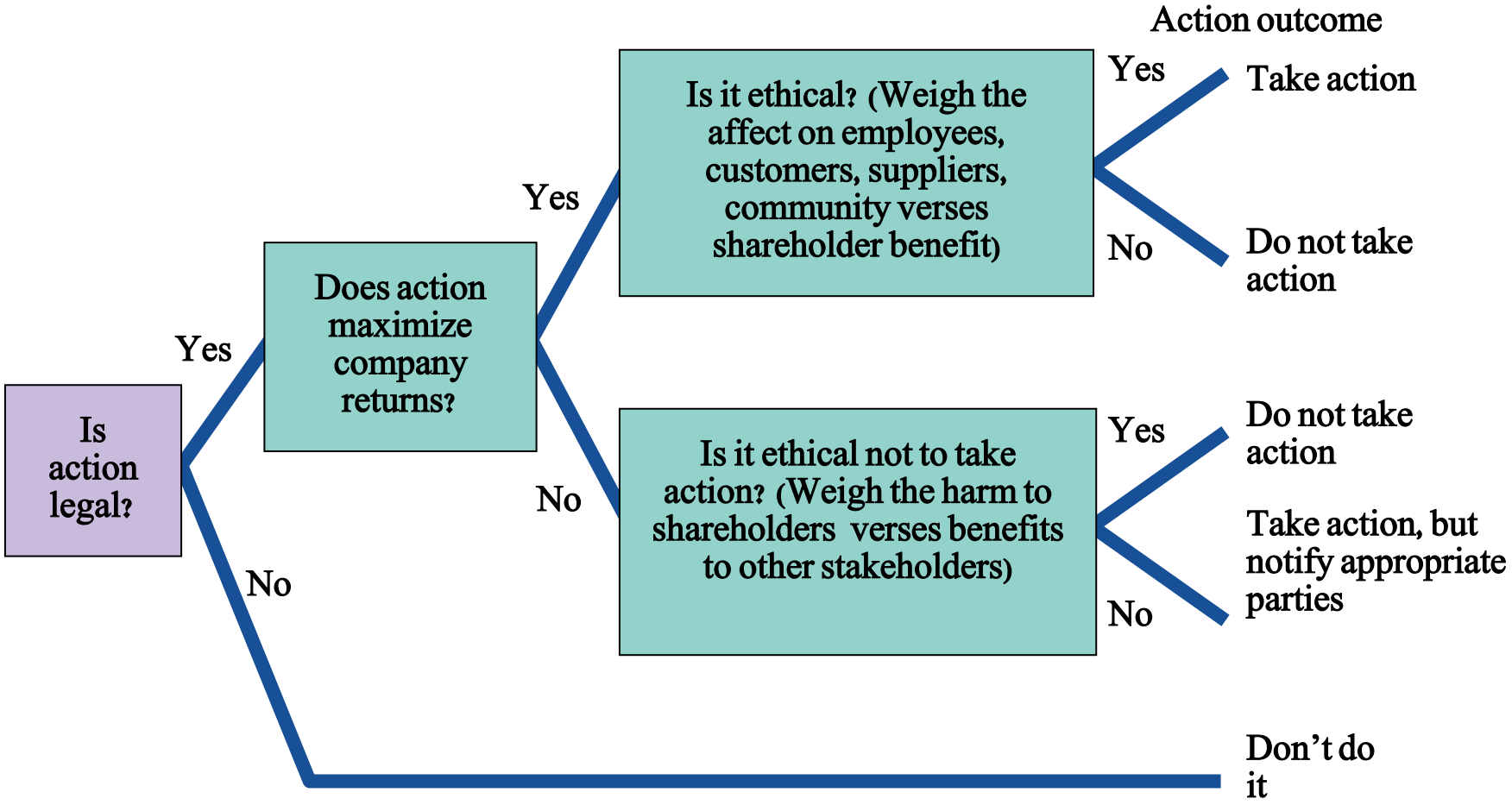
Decision Trees in Ethical Decision Making

- Maximize shareholder value and behave ethically
- Technique can be applied to any action a company contemplates

Decision Trees in Ethical Decision Making



Video

IBM and WWII

Taking the wrong side….

Video References

Milton Friedman

E-waste Hell

Pacific Trash Vortex

Unintended Consequences

Externalities

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Break-Even Analysis

Break-Even Analysis

- Technique for evaluating process and equipment alternatives
- Objective is to find the point in dollars and units at which cost equals revenue
- Requires estimation of fixed costs, variable costs, and revenue

Break-Even Analysis

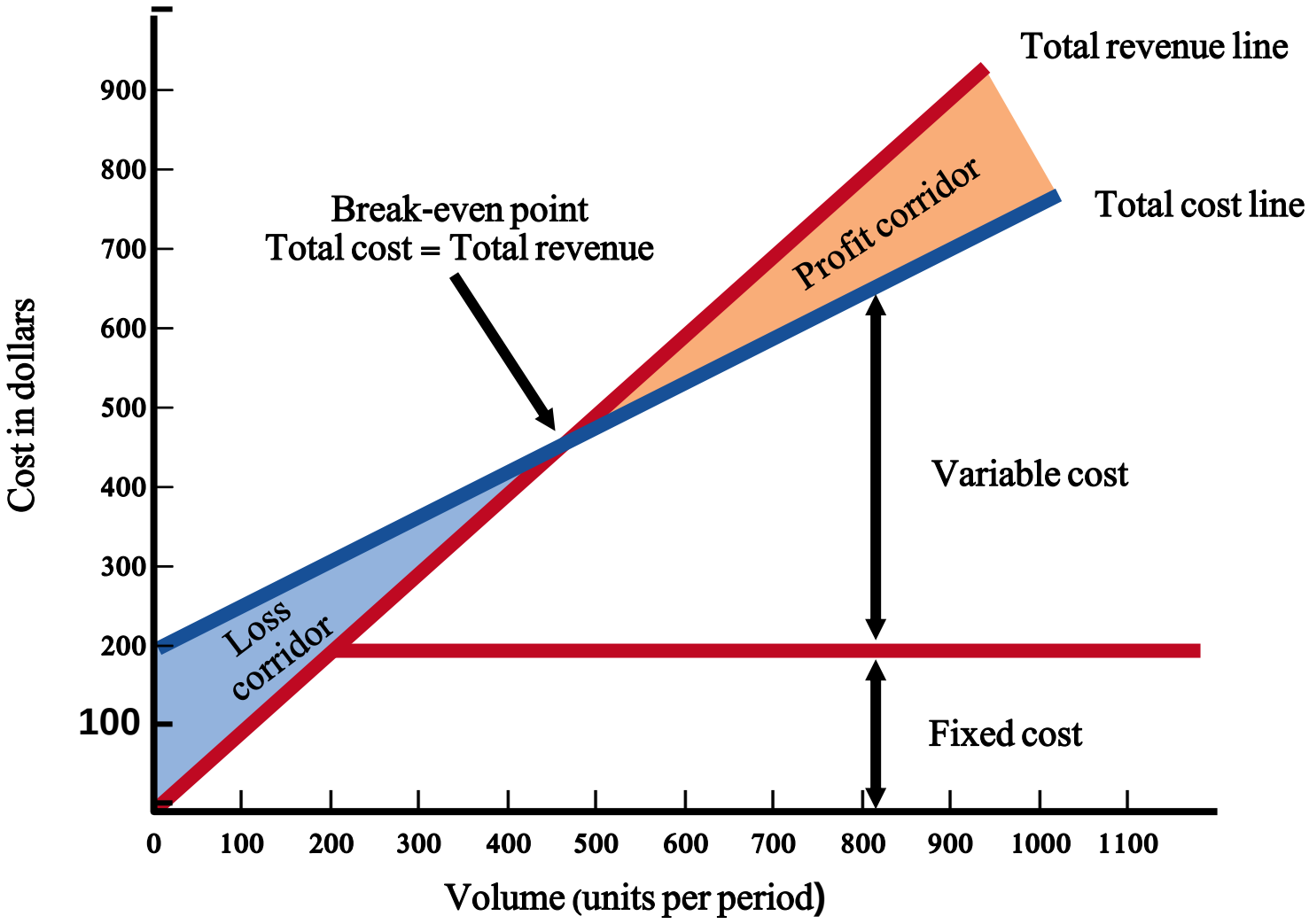
- Fixed costs are costs that continue even if no units are produced
  - Depreciation, taxes, debt, mortgage payments
- Variable costs are costs that vary with the volume of units produced
  - Labor, materials, portion of utilities
  - Contribution is the difference between selling price and variable cost

Break-Even Analysis

Assumptions

- Costs and revenue are linear functions
  - Generally not the case in the real world
- We actually know these costs
  - Very difficult to verify
- Time value of money is often ignored

Break-Even Analysis



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Break-Even Analysis

BEP_x = break-even point in units
$BEP_\$$ = break-even point in dollars
P = price per unit (after all discounts)

x = number of units produced

TR = total revenue = Px
F = fixed costs
V = variable cost per unit
TC = total costs = $F + Vx$

Break-even point occurs when

$$TR = TC$$

or

$$P*x = F + V*x$$

$$BEP_x = \frac{F}{P - V}$$

Break-Even Analysis

BEP_x = break-even point in units
$BEP_\$$ = break-even point in dollars
P = price per unit (after all discounts)

x = number of units produced

TR = total revenue = Px
F = fixed costs
V = variable cost per unit
TC = total costs = $F + Vx$

$$BEP_\$ = BEP_* P$$

$$= \frac{F}{P - V} * P$$

$$= \frac{F}{(P - V)/P}$$

$$= \frac{F}{1 - V/P}$$

$$\text{Profit} = TR - TC$$

$$= P*x - (F + V*x)$$

$$= P*x - F - V*x$$

$$= (P - V)*x - F$$

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Break-Even Example

Fixed costs = $10,000
Direct labor = $1.50/unit
Material = $.75/unit
Selling price = $4.00 per unit

$$BEP_{\$} = \frac{F}{1 - (V/P)} = \frac{\$10{,}000}{1 - [(1.50 + .75)/(4.00)]}$$

Break-Even Example

Fixed costs = $10,000
Direct labor = $1.50/unit
Material = $.75/unit
Selling price = $4.00 per unit

$$BEP_{\$} = \frac{F}{1 - (V/P)} = \frac{\$10,000}{1 - [(1.50 + .75)/(4.00)]}$$

$$= \frac{\$10,000}{.4375} = \$22,857.14$$

$$BEP_{x} = \frac{F}{P - V} = \frac{\$10,000}{4.00 - (1.50 + .75)} = 5,714$$

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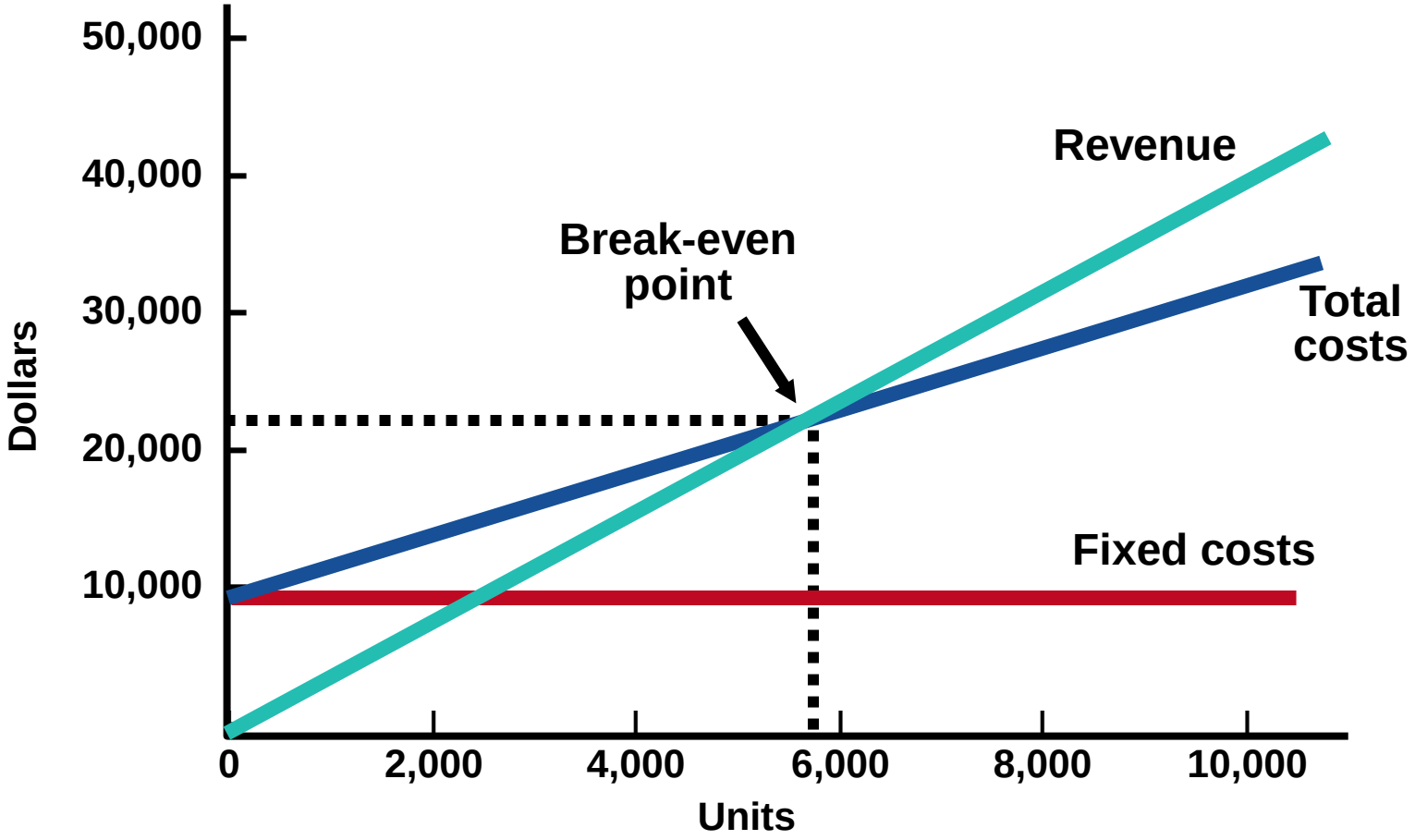
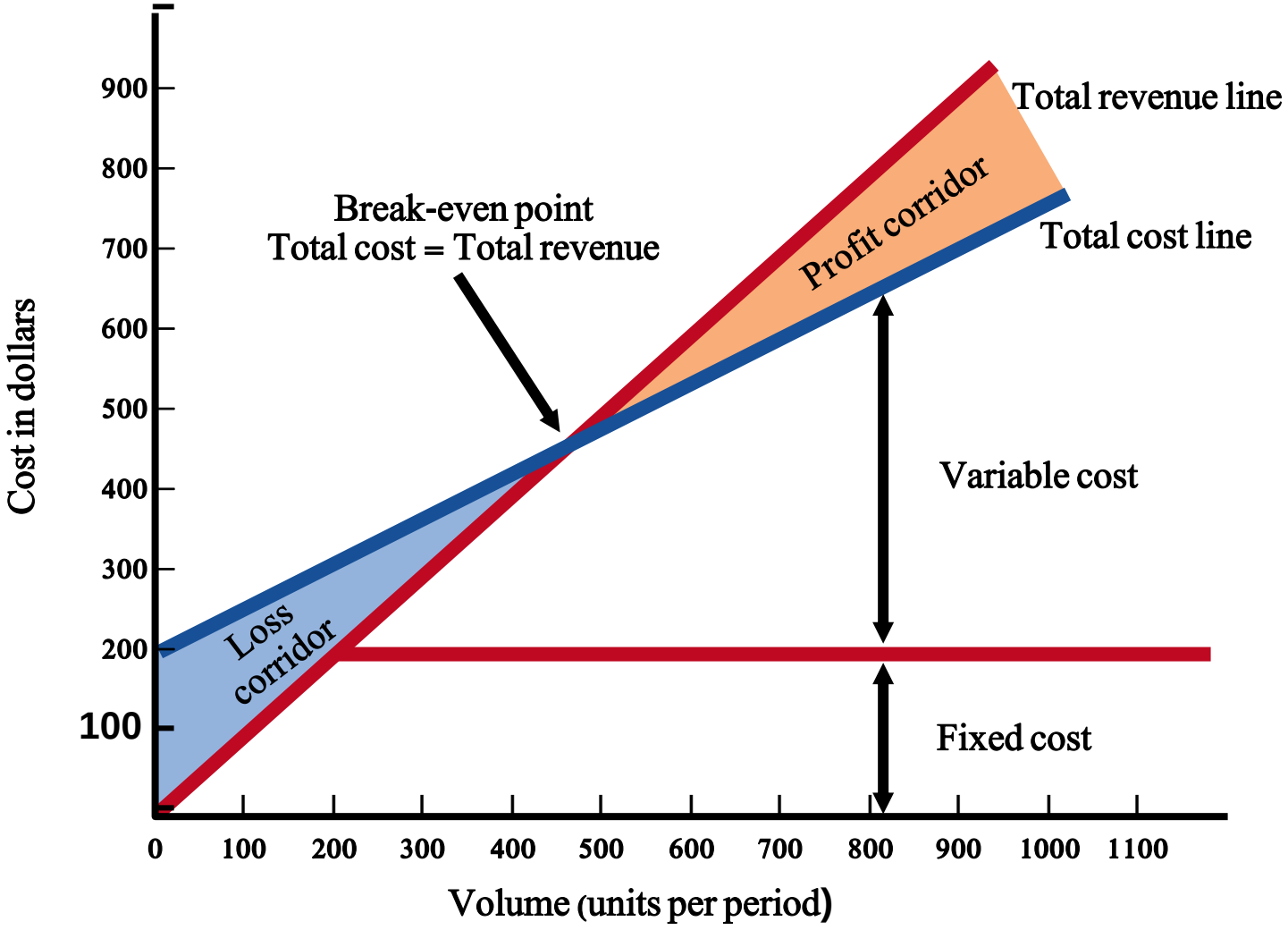
Break-Even Example



Excel Tool – Goal Seek

Data → What-if → Goal Seek



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T1LM2

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