Evaluating and Choosing Preferred Projects

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Outline

THE THOUGHT

- Fundamental Question: To what extent is it meaningful to look for "the best"?
- What can we expect to do?
- Value Functions (simple form of Utility)

THE METHODS

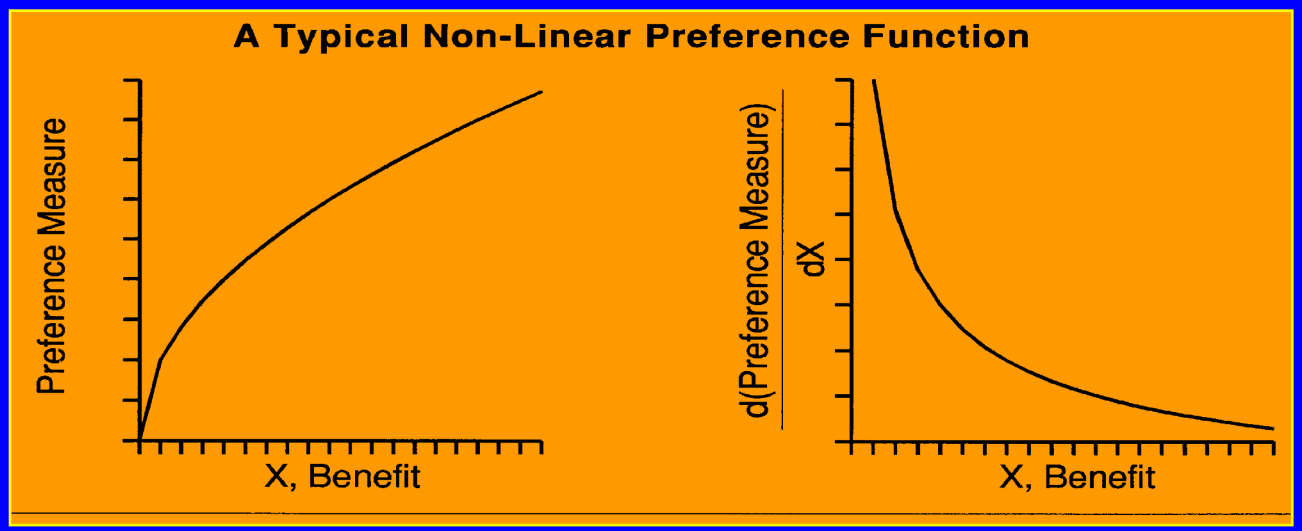
- Target Curves
- Dominant Designs
- Tables

The Thought

- To what extent is it meaningful to optimize, to look for "the best?"
- What defines "best"?
  - Extreme (high or low) of all other possibilities
- This supposes what?
  - Either (1): we have one metric of performance
  - Or (2): metrics can be put on single scale
- Is (1) realistic? Is (2)?
- Under What Conditions?

Implied Need: "Value Function"

- **Definition: V(X) is a means of**
  - **ranking the relative preference of**
  - **an individual for a**
  - **bundle on consequences, X**
- **A non-quantitative form of Utility Function**



Diminishing Marginal Utility

more of anything becomes less valuable

Let's think of lunch

- How would you value helping of…

- 1 serving ?
- 2 ?
- 3 ?
- 4, I made this especially for you?

Diminishing Marginal Utility
Does it always apply?

Can you think of exceptions?

Actually "exceptions" with "Decreasing Marginal Utility" are common:

- Critical Mass – only valuable if have enough
- Network – more connections, more valuable
- Threshold or Competition – only valuable if it
  - reaches required level ('must have 70 to get driver's license') or
  - matches or beats competition

Conditions for a "Value Function"

Basic Axioms

1. Completeness or Complete Preorder

People have preferences over all $\underline{X_i}$

2. Transitivity

If X_1 is preferred to X_2; and X_2 is preferred to X_3 ;
Then X_1 is preferred to X_3

Caution: Assumed True for Individuals;
<u>NOT</u> Groups (discussion below)

Basic Axioms (continued)

3. Monotonicity or Archimedean Principle

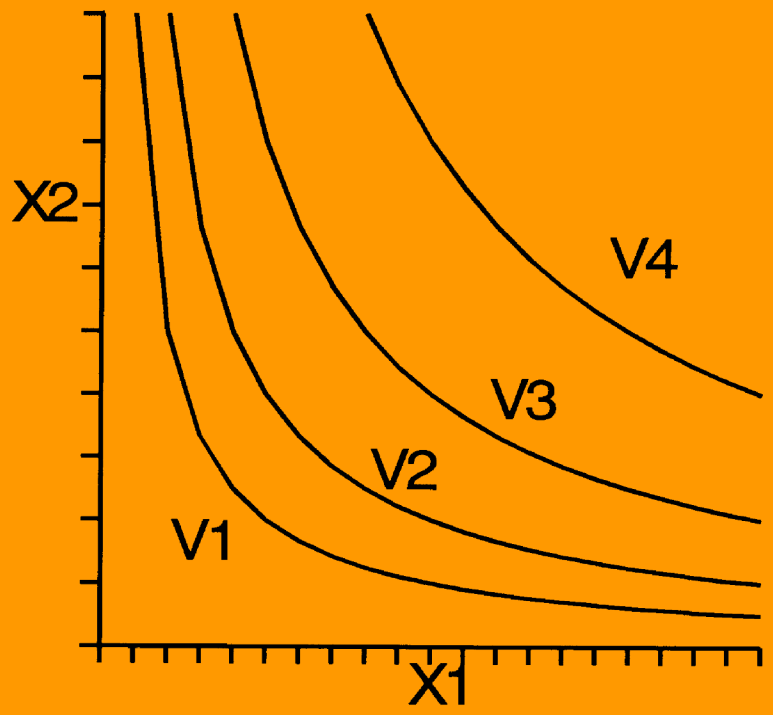
- For any $\underline{X}_i$ ($\underline{X}^* \geq \underline{X}_i \geq \underline{X}_*$)
  there is a weighting, w ($0 < w < 1$) such that
  $V(\underline{X}_i) = w\, V(\underline{X}^*) + (1 - w)\, V(\underline{X}_*)$
- In short, value in middle is between value at ends
- That is, More is Better (or Worse)
- Reasonable?
- No, not always true! Let's look at a case…
- for example, salt on food…
- More may be better – until more is worse!

Consequence of V(X) Axioms

- Existence of V(X)
- Ranking Only
- "Strategic Equivalence" of Many V(X)
  Any Monotonic Transform of a V(X)
  …. is still an Equivalent V(X)

  For example, ranking the same for both:
  $V(X_1, X_2) = X_1^2 X_2 \iff 2 \log(X_1) + \log(X_2)$

Value Functions



Isovalue Contours

Demand Function
(Maximize Value Given
a Budget Constraint)

Does this apply to groups?

- Do all members in a group have same preferences?
- Possibly….
- In general, however:
  - Groups composed of stakeholders with different interests (builders, owners, users…)
  - Their interests almost certainly diverge
- Can we expect them to agree?
- NO!

Example Intransitivity for Groups

Voter	Choice Order for Candidate		
	Left	Center	Right
Tom	1	2	3
Diana	3	1	2
Harriet	2	3	1

- WHO WINS ELECTION?
- Left against Center: Left wins 2:1
- Center against Right: Center wins 2:1
- So: Left is preferred to Right? Wrong!!!
- Left against Right: Right wins 2:1 !!!

Where does this leave us?

- Under certain assumptions (conditions), Individuals can rank alternatives (from least to most preferred)
- This does not apply to groups
  - If they agree on a process (set of voting rules)
  - Then, they might be able to agree on a result
  - Arrow's Impossibility Theorem (or Paradox) [No "fair" voting system, without a dictator, satisfies everyone's preferences…]

Concept of "best" not meaningful for design of complex systems => "preferred"

Take-Aways: Thoughts

- Evaluation is complex
  - Many metrics of performance
  - Plus Uncertainties
- Concept of "Best" is problematic
  - Individuals may have a value function
  - But groups are unlikely to do so
  - Especially stakeholders with different interests
- Preferred is more realistic concept
- Need to show dominating alternatives; Help Decision-Makers see trade-offs

Analysis of Outcomes

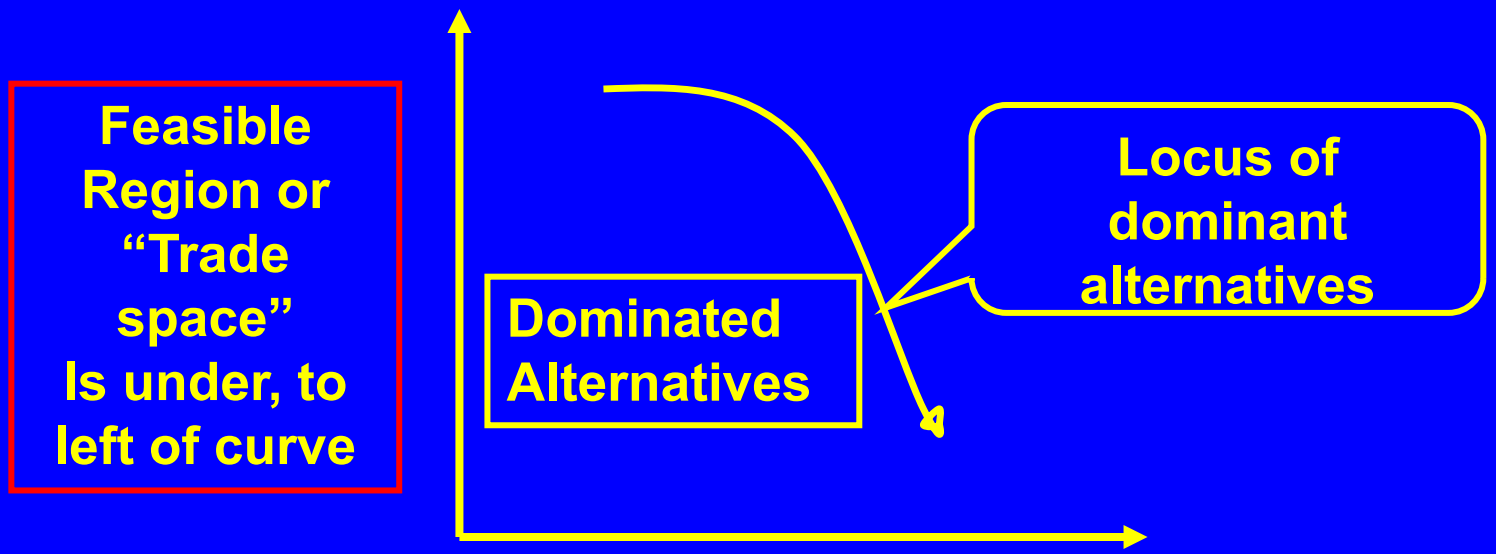
- What criteria?
- Target Curve, concept and construction
- Robustness?
- Tables of dimensions of preference

What can we expect to do?

- First, consider the nature of Problem for Evaluation and Choice
- Evaluation
  - Many dimensions, metrics of performance
  - Uncertainty about them, many states of metrics
  - Best is not defined
  - We can screen out dominated solutions
- Choice
  - Any single person, must see, make TRADEOFFS
  - Groups inevitably have to NEGOTIATE DEAL

Concept of "Dominance"

- **Idea: One alternative better than others on all dimensions**



If alternatives are dominated, they can be discarded

Is Expected Value best measure?

- "Expected Value" has been the index of choice for valuation…
- Is this appropriate? sufficient?

Conclusion about E(V)

- A useful single metric
- But Insufficient
- Cannot describe the range of effects

This is your A , B, C…

Other dimensions to explore

- The worst that could happen
  - People are "risk averse", sensitive to loss
  - With some notion of probability of loss
- The best that might occur
  - Upside also important
- Capex (capital expenditure = investment)
- Some measure of Benefit-cost

P_5 , P_{10} or VAR

- P_5 , P_{10} are values for 5%, 10% lowest end of a distribution. The percentage = probability losses do not exceed a particular level.
- VAR is a standard concept in finance = "Value at Risk"
  - P_{10} = 10% VAR
- Motivated by lenders, who are mainly concerned about getting repaid

P_{90} , P_{95} or Value at Gain

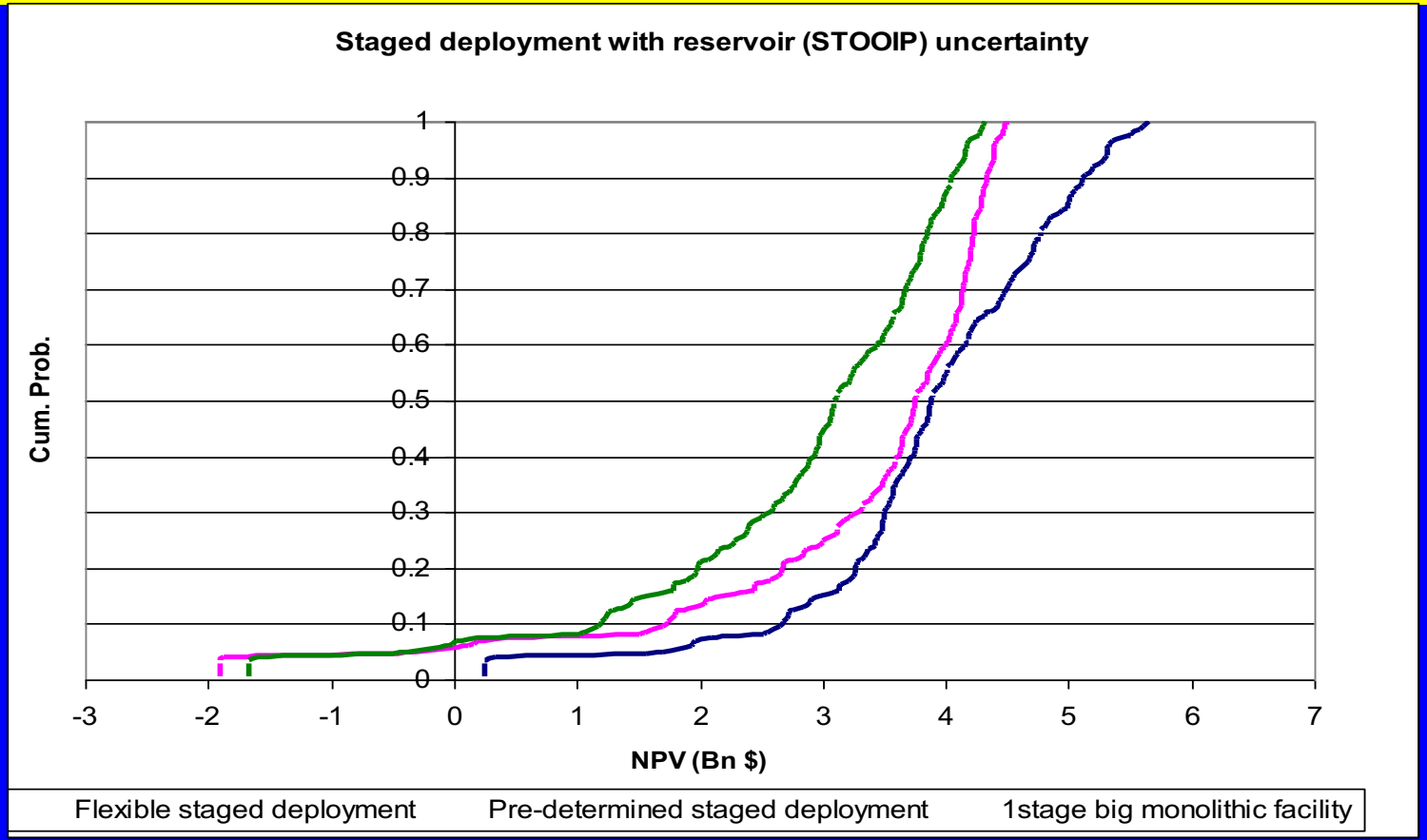
- We have developed this "VAG" concept as counterpart of "VAR"
- It represents the upside potential of a project
- Motivated by investors, interested in amount they may gain (not especially interesting to bankers…)

Target curve

- Target curve is the cumulative distribution of outcomes
- Going from worst case at x% probability
- To best case with y% probability
- combines VAR and “Value at Gain”

Slide adapted from Jijun Lin

Target Curve: Oceanic oil platform



About 30% Increase in Value from 2.7 to 3.5 Billion $

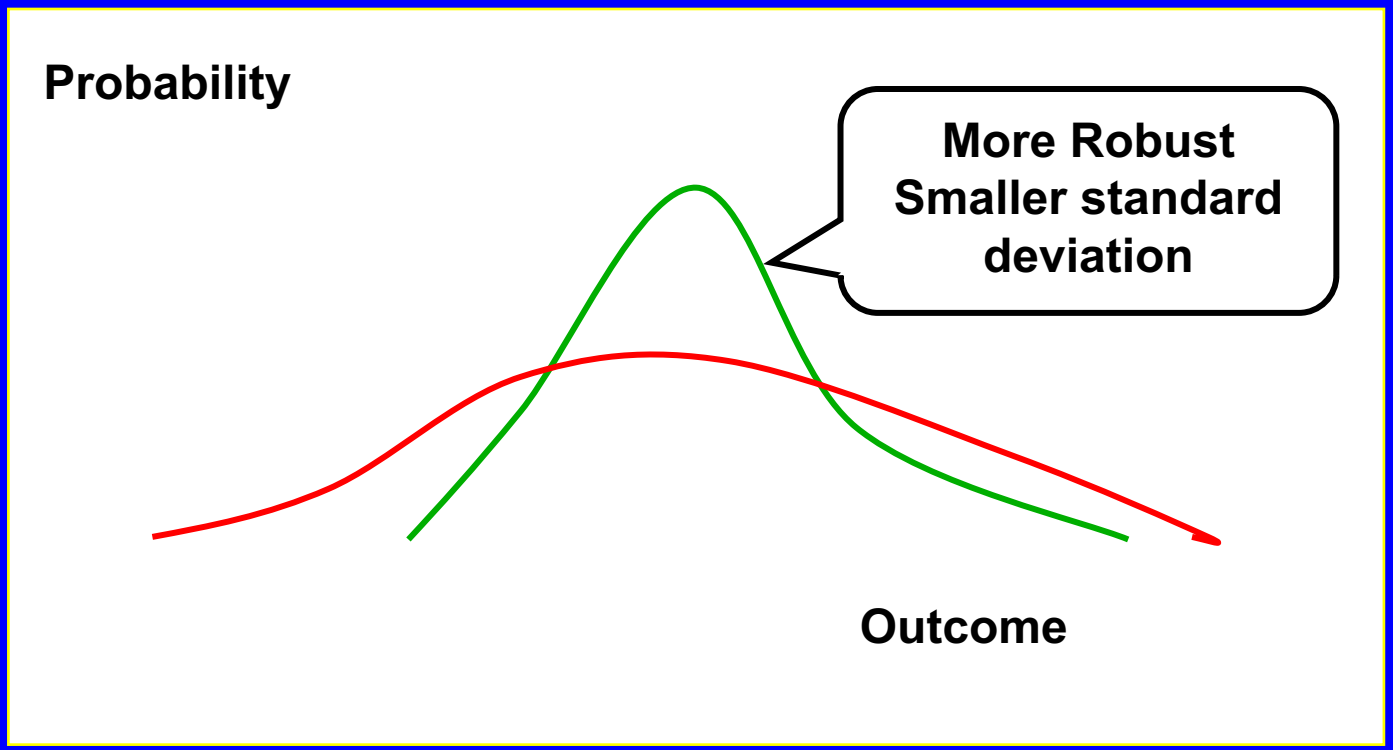
Dominance in Target Curves

- If Target Curve always to right of another…
- Does it dominate?
- Yes… but
- Does it mean that one alternative always performs better than the other?
- No! Frequency of occurrence does not translate that way!
  - Best case for one may be bad for another

Concept of "Robustness"

- Popular Basis for Design ("Taguchi method")
- What is it?
- Robust design = "a product whose performance is minimally sensitive to factors causing variability…"
- Robustness measured by standard deviation of distribution of outcomes

Illustration of Robustness



Do we want robustness?

- When might robustness be a good measure of performance?
- When we really want a particular result
  - Tuning into a signal
  - Fitting parts together, etc
- Is this what we want for maximizing value?
- No!! We want to limit downside but make upside as large as possible => higher σ

Robustness does not maximize expected value

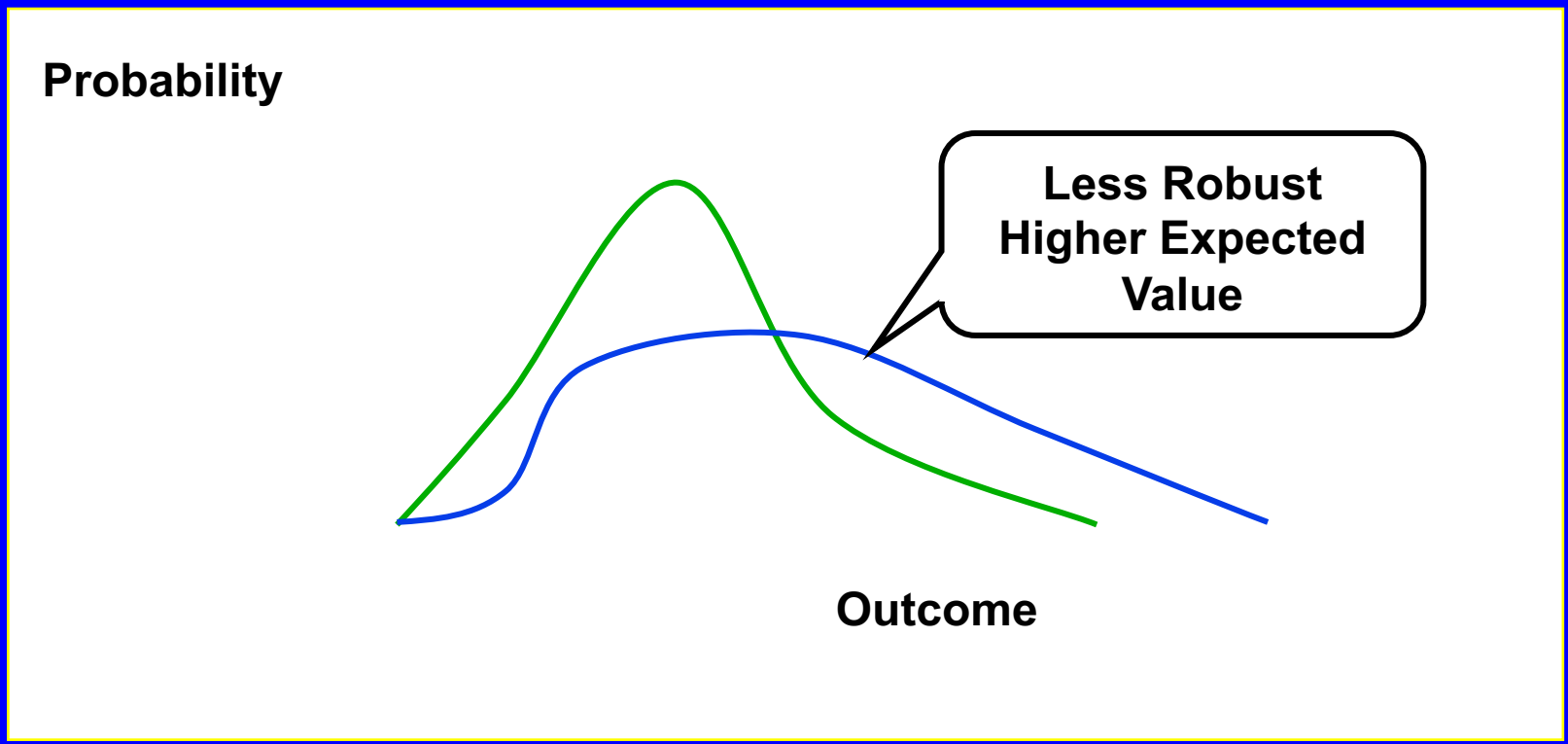


Table of Dimensions of Choice: Hassan Satellite Case

Architectural Value Parameter ($ million)	Rigid Fleet	Flexible Fleet I	Flexible Fleet II	Flexible Fleet III
E(NPV)	49.94	95.81	56.20	19.40
Std(NPV)	3.69	4.63	3.74	1.63
Flexibility Value	-	45.86	6.26	-30.55
Fixed cost, pay year 1	242	275	341	170
Fixed cost, pay year 6	242	-	-	170
PV(fixed cost) at year 1	392	275	341	276
Maximum possible gain	192	193	142	73
Maximum possible loss	162	68	131	86

Take-Aways: Method

- "Expected Value" not sufficient Measure
- Target Curve powerful visual image
  - Shows Maximum and Minimum
  - Compares alternatives
- Tables usefully show
  - Capex
  - Benefit-Cost of "Expected Value / Capex"
  - Value of Flexibility = Increase in Expected Project Value due to Flexibility

IDS.333 Risk and Decision Analysis

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