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Building resilient and proactive strategies through scenario planning

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Background

- Companies that leverage <u>platform business models</u> have grown dramatically over the past decade
  - Network effects: users attract more users (Facebook, PlayStation…)
  - Efficient matching and asset utilization (eBay, Uber, Airbnb…)
  - Sources of innovation (iOS, Windows…)

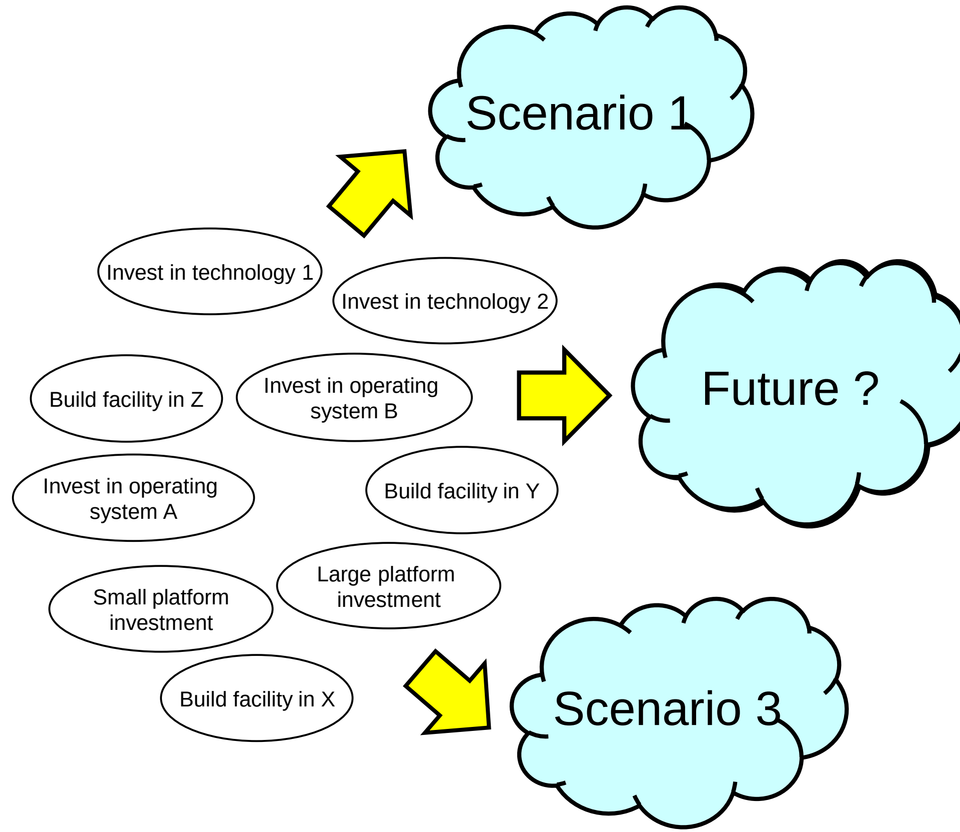
- Case study with Finnish companies operating in the steel industry
  - What kinds of business strategies are needed to build a platform ecosystem?
  - How to select a business strategy that is resilient across different scenarios of the future operational environment?

Scneario planning

- The future operational environment of organizations is typically uncertain
  - Different environments call for different strategic actions

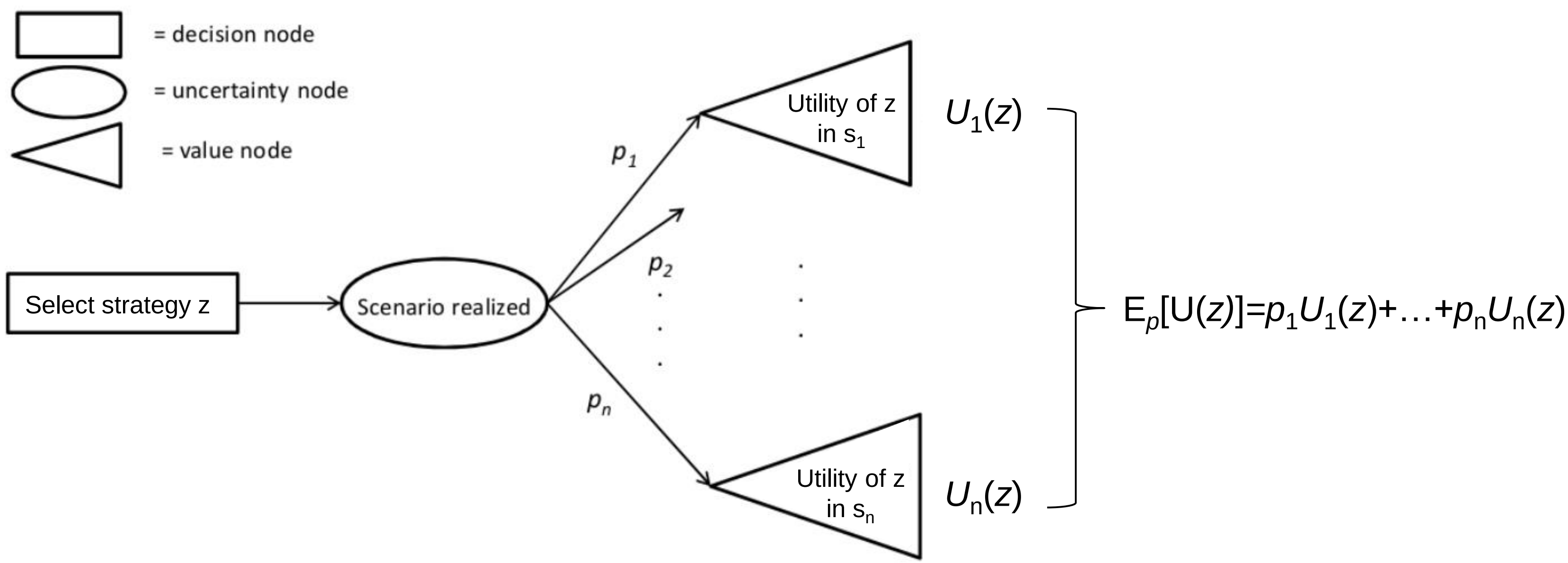
- Traditional strategic planning: focus on the most likely future

- Scenario planning: consider a set of plausible futures



Scenario-based strategy development

- Build scenarios $s_1,\dots,s_n$ to characterize future environments
- Assign probabilities $p_1,\dots,p_n$ to these scenarios
- Evaluate how available actions perform in these scenarios
- Select the combination of actions z (=strategy) which has the highest expected utility



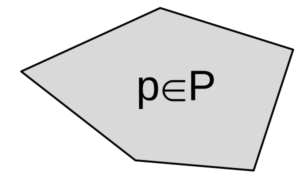
Scenario-based strategy development

- Precise estimates for scenario probabilities may not be obtained
  - Psychological biases, time constraints etc.
  - Experts' views may differ
  - The 'best' strategy may be sensitive to small changes in scenario probabilities

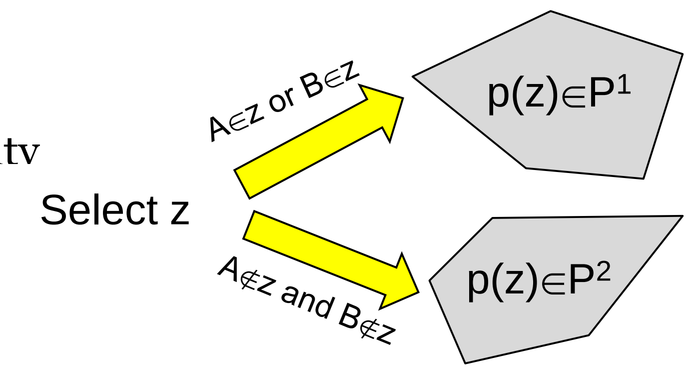
- Actions may impact scenario probabilities
  - E.g., investments in lobbying for stronger regulation may increase the probability of 'high regulation' scenario
  - Neglecting these impacts may lead to suboptimal decisions

Incomplete and action-dependent scenario probabilities

- Incomplete probability information
  - ‘Scenario 1 is more probable than scenario 2’
  - ‘The probability of scenario 3 is between 40% and 60%’
  - Such statements can be moleded by linear constraints that define *a set of feasible probabilities*



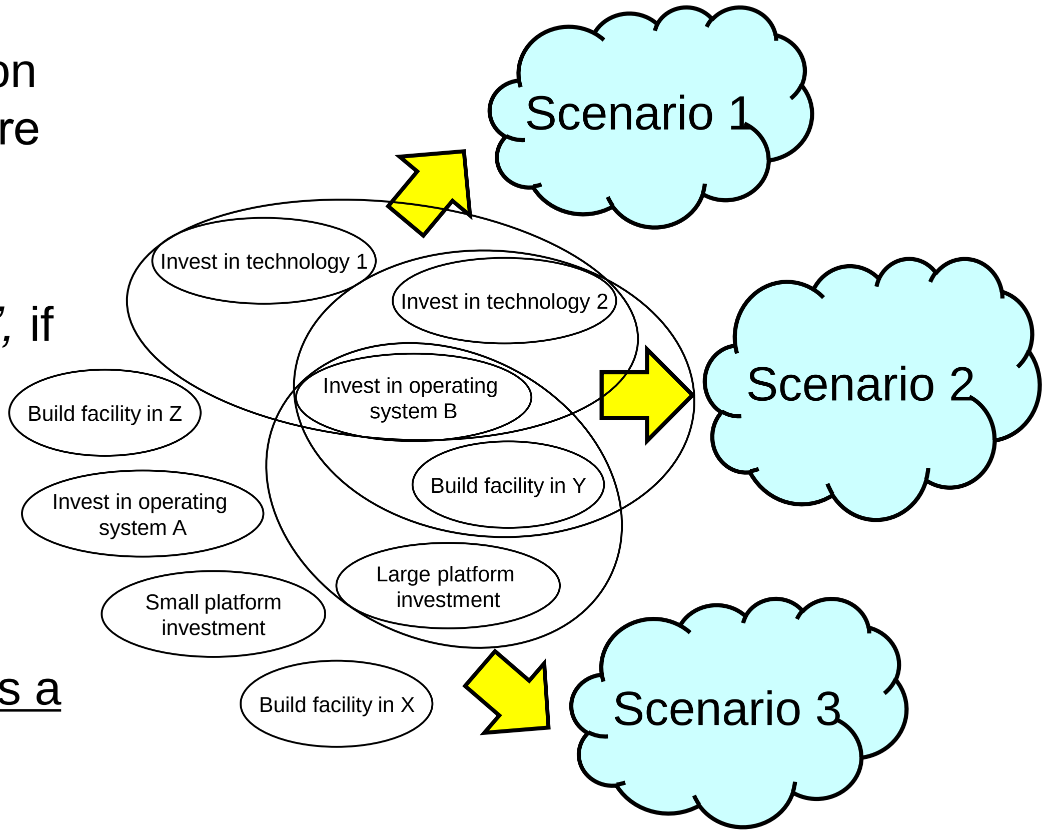
- Action-dependent probability information
  - ‘If either action *A* or *B* is selected, then the probability of scenario 1 is higher than 50%’
  - Statements define *different probability sets* for different strategies



Non-dominated strategies

- Incomplete probability information → strategies' expected utilities are *intervals*

- Strategy *z* dominates strategy *z'*, if
  - $E_{p(z)}[U(z)] \geq E_{p(z')}[U(z')]$ for all feasible $p(z), p(z')$
  - $E_{p(z)}[U(z)] > E_{p(z')}[U(z')]$ for some feasible $p(z), p(z')$

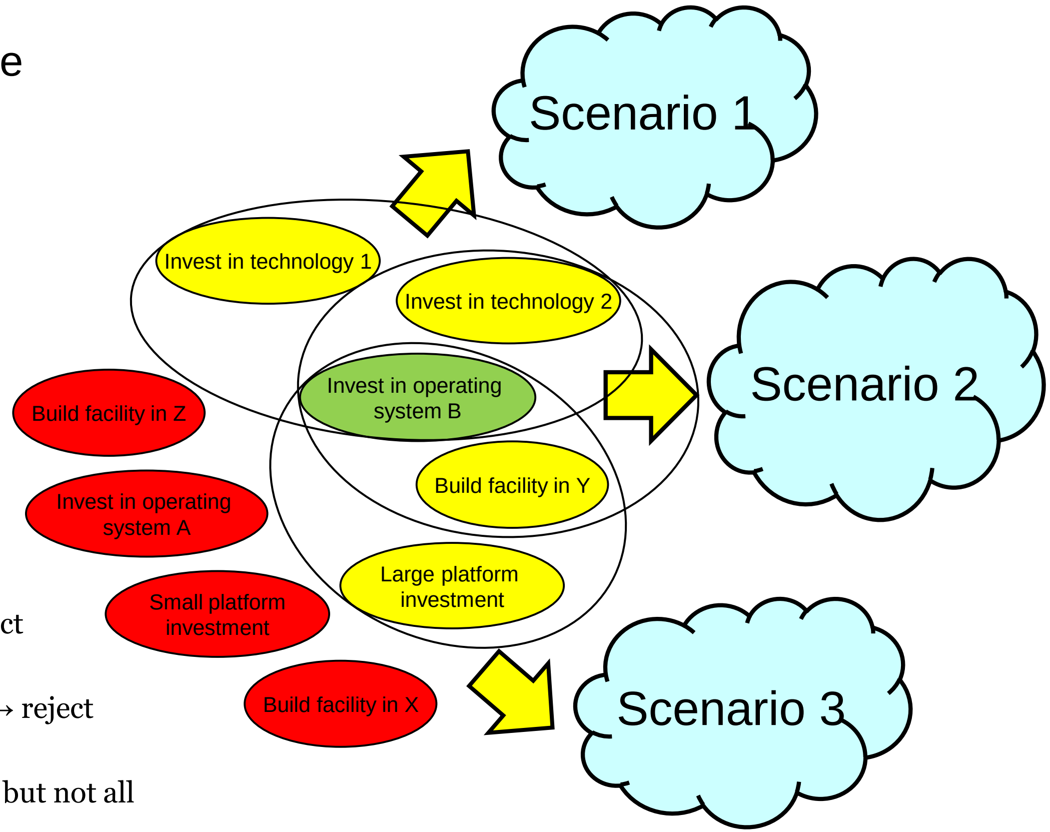


- <u>A rational decision-maker selects a *non-dominated (ND) strategy*</u>

Core index

- Action-specific recommendations are based on core index (CI)

$$\text{Core index of action } j = \frac{\#\text{ of ND strategies that include } j}{\#\text{ of ND strategies}}$$



- CI = 1: action included in all ND strategies → select
- CI = 0: action not included in any ND strategies → reject
- 0 < CI < 1: action included in some ND strategies but not all

Computation of ND strategies

- Action-dependent probability information divides the feasible strategies into K sets Z^k, $k=1,\ldots,K$ such that for all $z \in Z^k$, the set of feasible probabilities P^k is the same

- Within each Z^k, the set of ND strategies Z^k(ND) is equal to the set of Pareto optimal solutions to MOZOLP:

$$\mathrm{v-}\max_{z \in Z^k}[z^T X p^1, \ldots, z^T X p^r]$$

  where X is the matrix of the actions' scenario-specific utilities and $\{p^1,\ldots, p^r\}$ is the set of extreme points of P^k

- This MOZOLP can be efficiently solved by a dynamic programming algorithm*

Average computation time for Z^k(ND) (seconds)

		# of scenarios		
		3	5	7
# of actions	40	0.28	1.18	2.66
	50	3.06	9.89	20.72
	60	11.61	46.62	183.6

Average # of strategies in Z^k(ND)

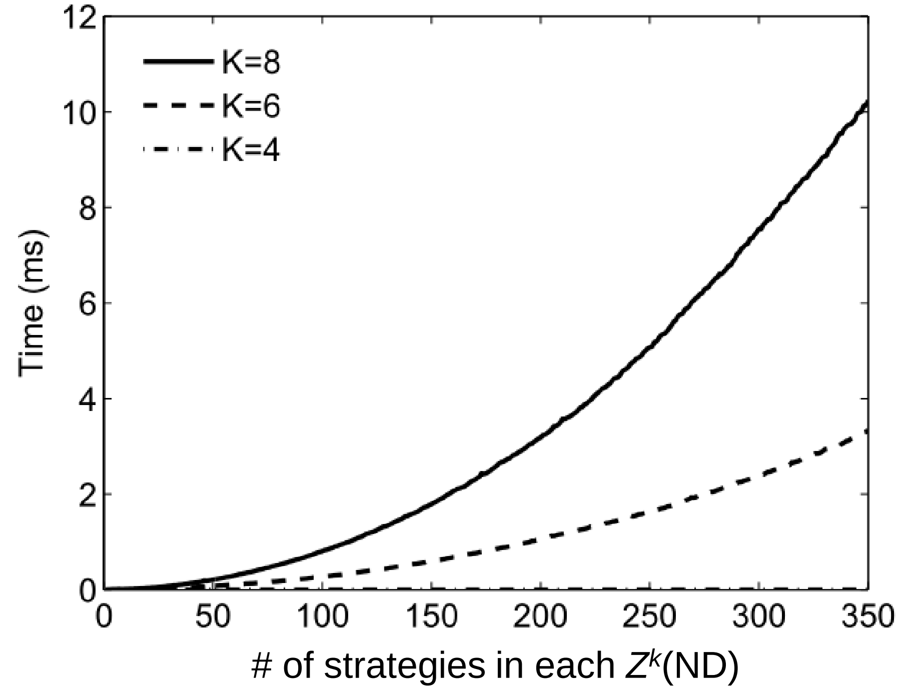
		# of scenarios		
		3	5	7
# of actions	40	27	54	74
	50	49	121	180
	60	85	220	312

*Liesiö, J., P. Mild, and A. Salo. 2008. Robust Portfolio Modeling with incomplete cost information and project interdependencies, *European Journal of Operational Research, Vol. 190, pp. 679-695.*

Computation of ND strategies

- To exclude dominated strategies, pairwise dominance checks are carried out between strategies in different sets Z^k(ND), $k=1,\ldots,K$

Average computation times for pairwise comparisons between all strategies in Z^k(ND)



Example: Selection of R&D portfolio at a high-tech company

- Four scenarios:

Regulation	Low	High
Strong	<u>Scenario 1:</u> The company's technology shares the market with alternative low-cost technologies	<u>Scenario 2:</u> The company's new technology dominates the market
Weak	<u>Scenario 3:</u> Both the company's technology and alternative ones 'tank' in the market	<u>Scenario 4:</u> Alternative low-cost technologies dominate the market

Market demand

Source: Raynor, M.E., X. Leroux. 2004. Strategic flexibility in R&D. *Research Technology Management*, Vol. 47, pp. 27–32.

Example

- ❑ Eight available R&D projects (=actions)
  - Projects 1-4 maintain current businesses
  - Projects 5-8 develop new technologies
  - Portfolio must contain at least 25% of both types
  - Project 5 can only be selected if 8 is selected

- ❑ Investments in two campaigns (=actions)
  - *Lobbying campaign L* increases the probability of strong regulation
  - *Marketing campaign M* increases the probability of high market demand

- ❑ Budget $59M, risk neutral decision-maker

Example: projects' values and costs

s_1: Strong regulation, low market demand

s_2: Strong regulation, high market demand

s_3: Weak regulation, low market demand

s_4: Weak regulation, high market demand

Project	NPV ($M)				Cost ($M)	Average BCR
	s_1	s_2	s_3	s_4		
1	11	52	2	7	15	1.20
2	9	37	2	7	11	1.25
3	12	52	3	6	9	2.03
4	9	33	6	6	7	1.93
5	10	46	4	7	8	2.09
6	12	30	4	9	14	0.98
7	10	47	3	8	14	1.21
8	15	38	5	9	19	0.88
L	0	0	0	0	2	0
M	0	0	0	0	3	0
Optimal portfolio value	58	221	22	38		

Example: probability information

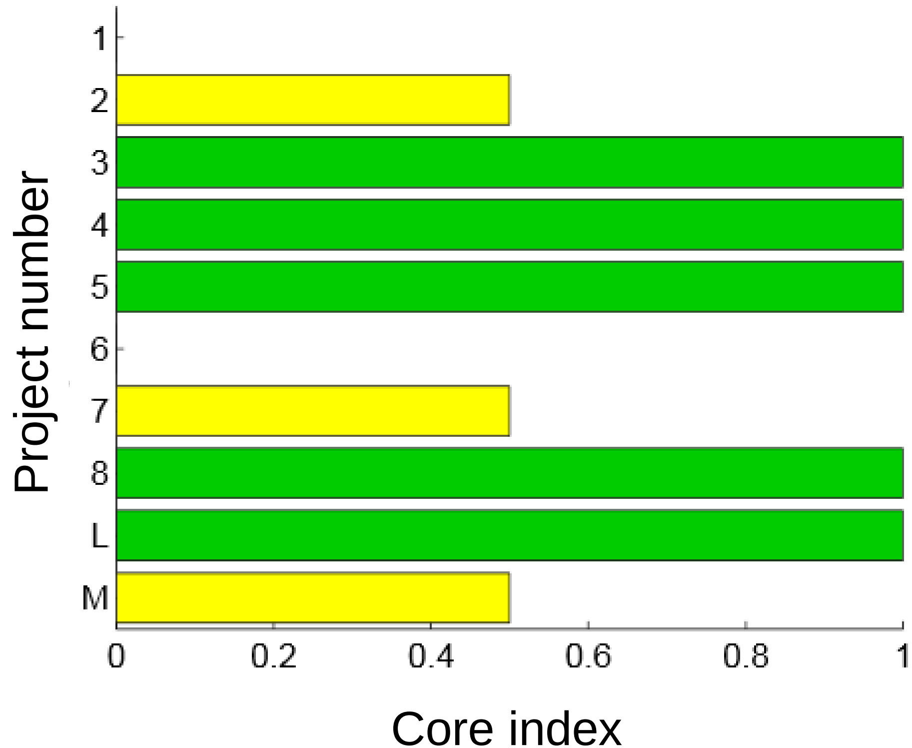
- Probability of strong regulation ($s_1 \cup s_2$) is
  - At least 70%, if the company invests in lobbying campaign *L*
  - At most 50% otherwise

- Probability of high market demand ($s_2 \cup s_4$) is
  - At least 60%, if the company invests in marketing campaign *M*
  - At most 50% otherwise

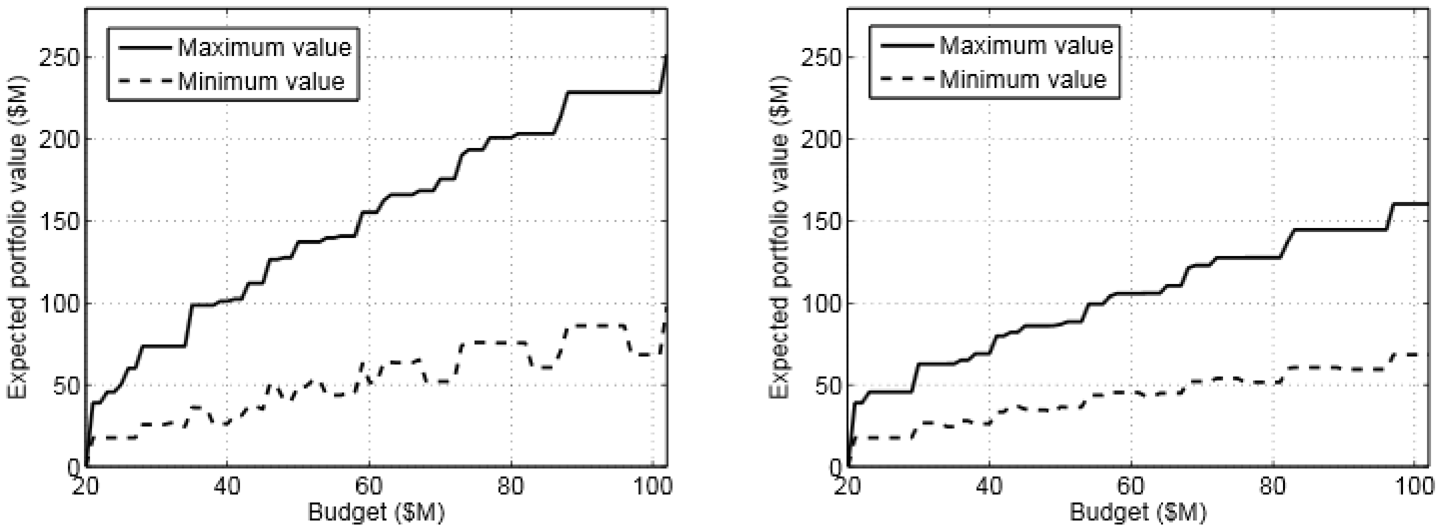
- Probability of each scenario ≥ 10% regardless of which actions are selected

Results

- 373 feasible portfolios
- Two non-dominated portfolios
  - $\{2,3,4,5,8,L,M\}$
  - $\{3,4,5,7,8,L\}$



Results



(a) Probabilities depend on selected projects. (b) Probabilities do not depend on selected projects.

- With $59M budget, the use of action-dependent probability information helps increase
  - the worst-case expected portfolio value by 39%,
  - the best-case expected portfolio value by 47%.

Conclusions

- Model to support the selection of a combination of actions (=strategy), when
  - Information about scenario probabilities is incomplete
  - Scenario probabilities may depend on selected actions

- The model helps select a strategy that is
  - *Resilient* in that it performs relatively well across scenarios
  - *Proactive* in that it promotes the realization of favorable scenarios

- Decision recommendations can be obtained
  - With fairly loose constraints on scenario probabilities
  - For actions that yield value only indirectly by affecting scenario probabilities

Case study

- Done: identification of plausible scenarios for future operational environment

- Next steps:
  - Listing of actions by decision-makers
  - Elicitation of parameters
    - *Actions' values in each scenario*
    - *Scenario probability information*
  - Computation of resilient and proactive strategies
  - Dissemination and discussion of the results