Optimizer's Curse in Project Portfolio Selection

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Characteristics project portfolio selection

- Large number of proposals
  - Typically dozens or even hundreds of proposal

- Only a fraction can be selected with available resources
  - Even other resources than money may matter (critical competences)

- “Value” may be measured with regard to several criteria
  - International collaboration, innovativeness, feasibility of plans

- Reliable information about value is hard to obtain
  - Different experts may give different ratings
Logic behind the optimizer’s curse

- Projects offer different amounts of value (e.g., NPV)
- Estimates about projects’ values are uncertain
- Decisions are based on these uncertain value estimates
- Projects whose values have been overestimated have a higher chance of getting selected
- Thus the DM should expect to be disappointed with the performance of the selected portfolio
Example on choosing 6 out of 12 projects

| $\mu_v$ | 10 |
| $\text{Std}_v$ | 4 |
| $\text{Std}_e$ | 2 |

<table>
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<tr>
<th>V</th>
<th>V+e</th>
<th>Optimum</th>
<th>Selected</th>
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| 6  | 6  |

$72.57 \quad 77.82 \quad 5.25$
Value of information and optimality in DA

- The optimizer’s curse: skepticism and postdecision surprise in decision analysis (Smith and Winkler, 2006)
  - Positively correlated errors aggravate the curse

- Value of information in project portfolio selection (Keisler, 2004)
  - Different selection rules have an impact on the quality of the selected portfolio

- How bad is the optimizer’s curse in project portfolio selection?
- What selection rules are better than others?
Approach and research questions

Key questions
- How does (i) the number and (ii) quality of evaluation statements impact the optimal project portfolio?
- What kinds of evaluation and selection procedures outperform others?

Concepts
- **True value**: Value (e.g., quality, research output) which would be produced, if the project were to be funded
- **Estimated value**: Value that the expert reports in his/her evaluation statement
- **Optimal portfolio**: The portfolio that maximizes the aggregate sum of true values (typically not known, can be determined only if true values are known)
- **Selected portfolio**: The portfolio that maximizes the sum of estimated values

Results based on simulation and optimization models
Illustration of project evaluation and selection

- 100 project proposals
  - 20 out of these will be selected (approval rate 20%)

- At least one statement on each proposal
  - All statements have the same cost (e.g., about 0.5% of project costs)

- The “true” underlying value distributed on the range 1-5

- Evaluation statements convey information about the true value
  - Statements also in the same range involve uncertainties

- Statements inform decision making
Examples of selection mechanisms

- **One-phase ("batch-mode"):**
  - Equally many evaluations (1 or several) on each proposal
  - Projects selected on the basis of the average of reported ratings on the evaluation statements

- **Two-phase:**
  1. Discard 50% of proposals based on a single evaluation statement
  2. Acquire additional statements on the remaining 50%
  3. Select projects on the basis of the average of ratings on the reported statements
Distributions of underlying value and statements

- Distribution of “true” value is modelled through a probability distribution

- Evaluation statements depend on the true value
  - “Good” proposals are likely to have a higher rating on the 1-5 scale

\[
x \sim N(\alpha_i, \sigma_x)
\]

\[
\varepsilon \sim N(0, \sigma_\varepsilon)
\]

\[
\frac{e^x}{1 + e^x}
\]

\[
\frac{e^{x+\varepsilon}}{1 + e^{x+\varepsilon}}
\]
Optimizer’s curse in the average quality of projects

(based on the distributions on the preceding slide)
Evaluations help approach the societal optimum

![Graph showing the relationship between evaluation cost and portfolio value for small and large uncertainties. The graph compares 2-phase and 1-phase evaluation methods.](image-url)
But justice to the individual is difficult to guarantee

![Graph showing the share of selected projects (%) that are also in the optimal portfolio versus evaluation cost (% of project cost). The graph includes lines for different uncertainties and cost phases.]
Impact of competitive tendering on productivity 1(3)

- Include the effort of proposal preparation
  - Approval rate 20% (select 20 projects out of 100 proposals)

- When do the benefits of further statements exceed the cost of obtaining them?
  - Evaluation costs estimated here at 0.5% of project costs
  - A statement on a 100 000€ project costs 500 €

- Account for the efforts required by proposal preparation, too
  - Preparation efforts estimated at 5% of project costs (100 000€ * 0.05 = 5000€)
  - If one statement is obtained on all projects, the total cost will be
    20*100 000€ + 100*5500€ = 2,55 M€
Impact of competitive tendering on productivity 2(3)

The diagram illustrates the impact of different preparation costs on productivity. The x-axis represents the aggregate preparation and evaluation cost (% of project cost), while the y-axis shows the average value (research production) per unit of total expenditure.

- **0% preparation cost**: The graph shows a clear trend where lower preparation costs lead to higher productivity.
- **5% preparation cost**: There is a noticeable drop in productivity compared to low preparation costs, with the line indicating a sustained decrease as the cost increases.
- **10% preparation cost**: The productivity further decreases, indicating the significant impact of higher preparation costs.

The legend includes options for 2-phase selection, 1-phase selection, and random selection with no tendering. The data is based on larger uncertainties, suggesting variability in the results.

Overall, the diagram highlights the importance of managing preparation costs to maintain productivity in competitive tendering scenarios.
Impact of competitive tendering on productivity 3(3)

- Competitive tendering enhances productivity when
  - There is high variability in the quality of proposals
  - Approval rate is high enough
  - Proposal preparation does not require excessive efforts
  - Evaluation statements are reasonably good (i.e., correlated with actual quality)

- Current situation
  - Productivity of Finnish research has declined?

- Observations
  - Preceding results merely exemplify what kinds of questions can be answered
  - Parameters can be estimated from data (databases, expert judgements)
  - Lends support for improving evaluation and selection processes