# 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

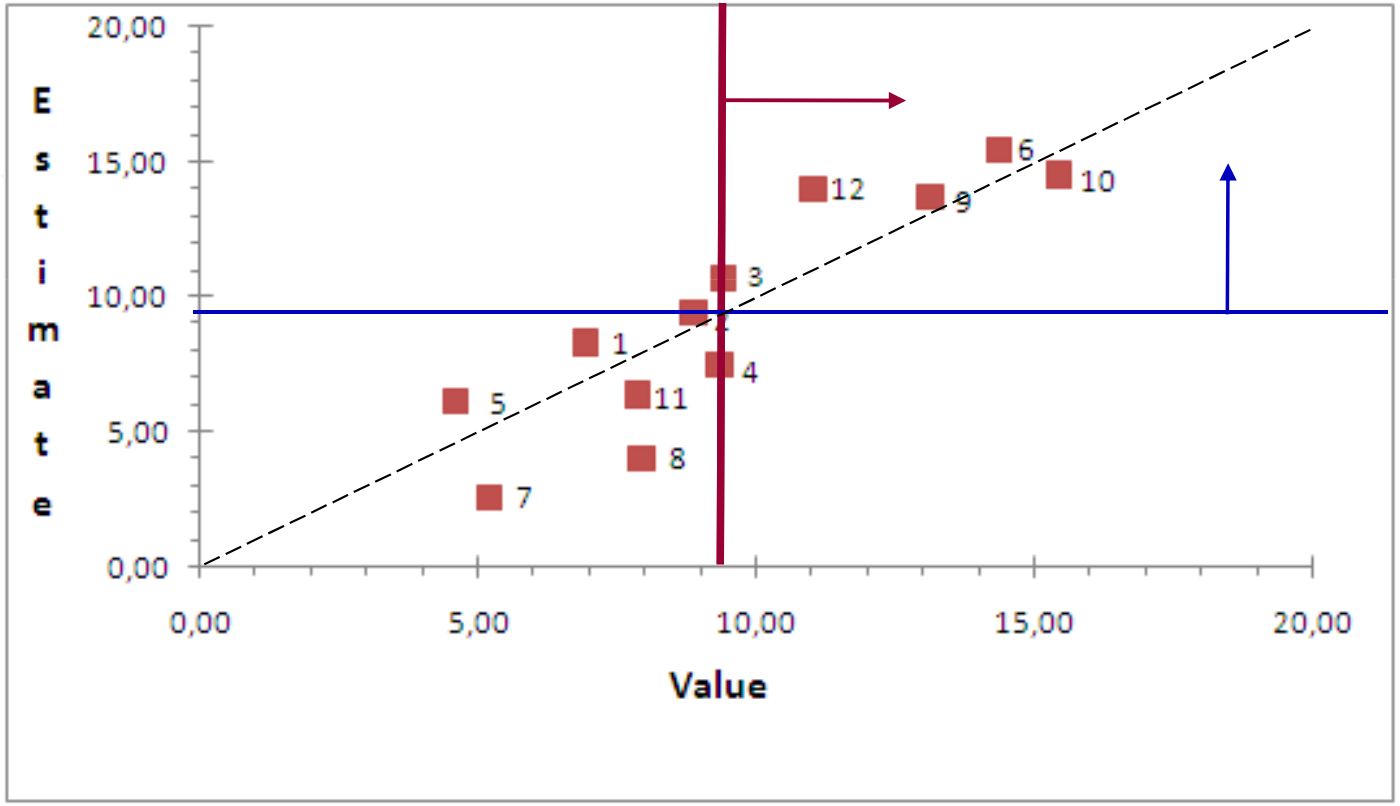
# Logic behind the optimizer's curse

- Projects offer different amounts of value (eg 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 | | |
| Std_v | 4 | Std_e | 2 |

| | V | V+e | Optimum | Selected |
|---|---|---|---|---|
| 1 | 6,94 | 8,28 | 0 | 0 |
| 2 | 8,86 | 9,36 | 0 | 1 |
| 3 | 9,39 | 10,68 | 1 | 1 |
| 4 | 9,33 | 7,44 | 1 | 0 |
| 5 | 4,60 | 6,07 | 0 | 0 |
| 6 | 14,34 | 15,46 | 1 | 1 |
| 7 | 5,20 | 2,54 | 0 | 0 |
| 8 | 7,93 | 3,97 | 0 | 0 |
| 9 | 13,10 | 13,74 | 1 | 1 |
| 10 | 15,41 | 14,56 | 1 | 1 |
| 11 | 7,86 | 6,35 | 0 | 0 |
| 12 | 11,00 | 14,02 | 1 | 1 |
| | | | 6 | 6 |
| | | | 72,57 | 77,82 | 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?

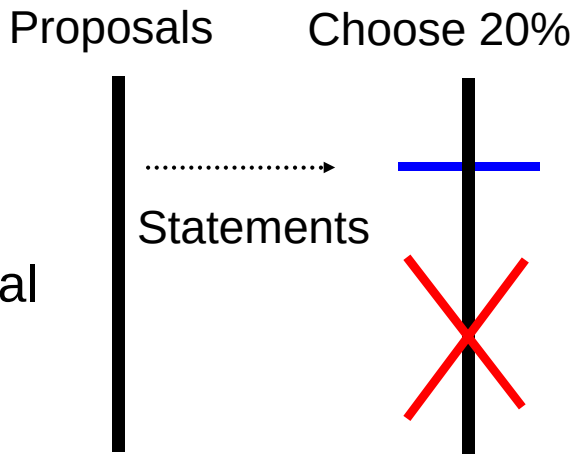
# Approach and research questions

- 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

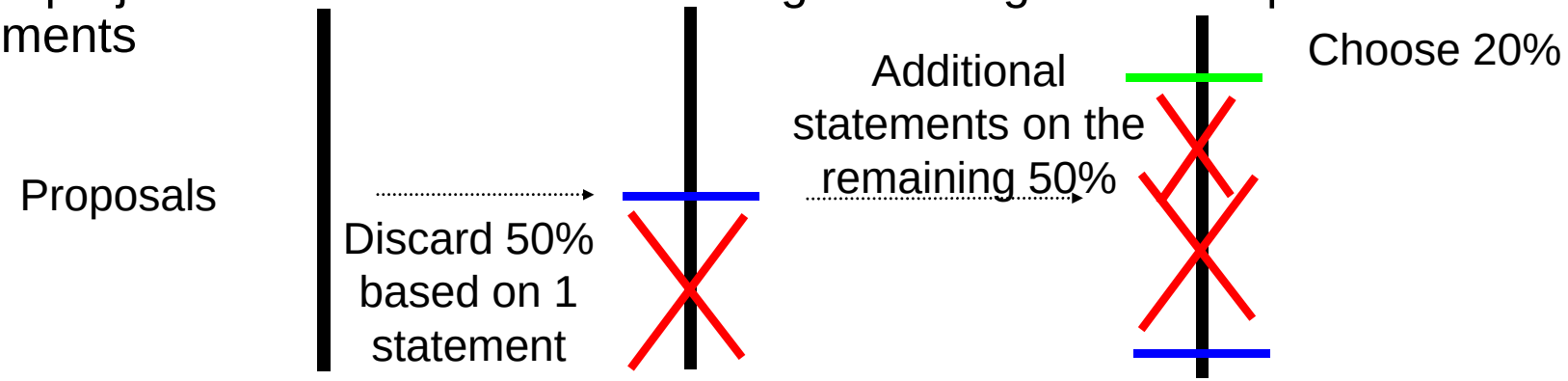
- 100 project proposals
  - 20 out of these will be selected (➔ approval rate 20 %)
- At least one statement on each proposal
  - All statements have the same cost (e.g., about 0.5% of project costs)
- The “true” underlying value distributed on the range 1-5
- Evaluation statements convey information 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



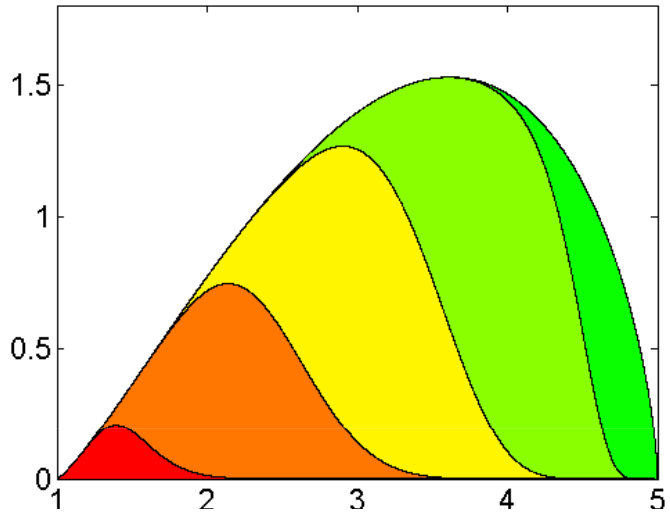
# Distributions of underlying value and statements

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

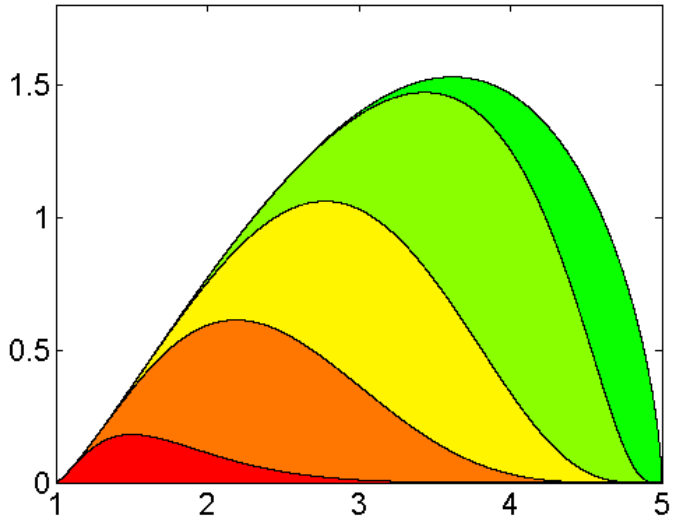
$$\frac{e^x}{1+e^x}$$

$$x \sim N(\alpha_i, \sigma_x)$$

$v =$



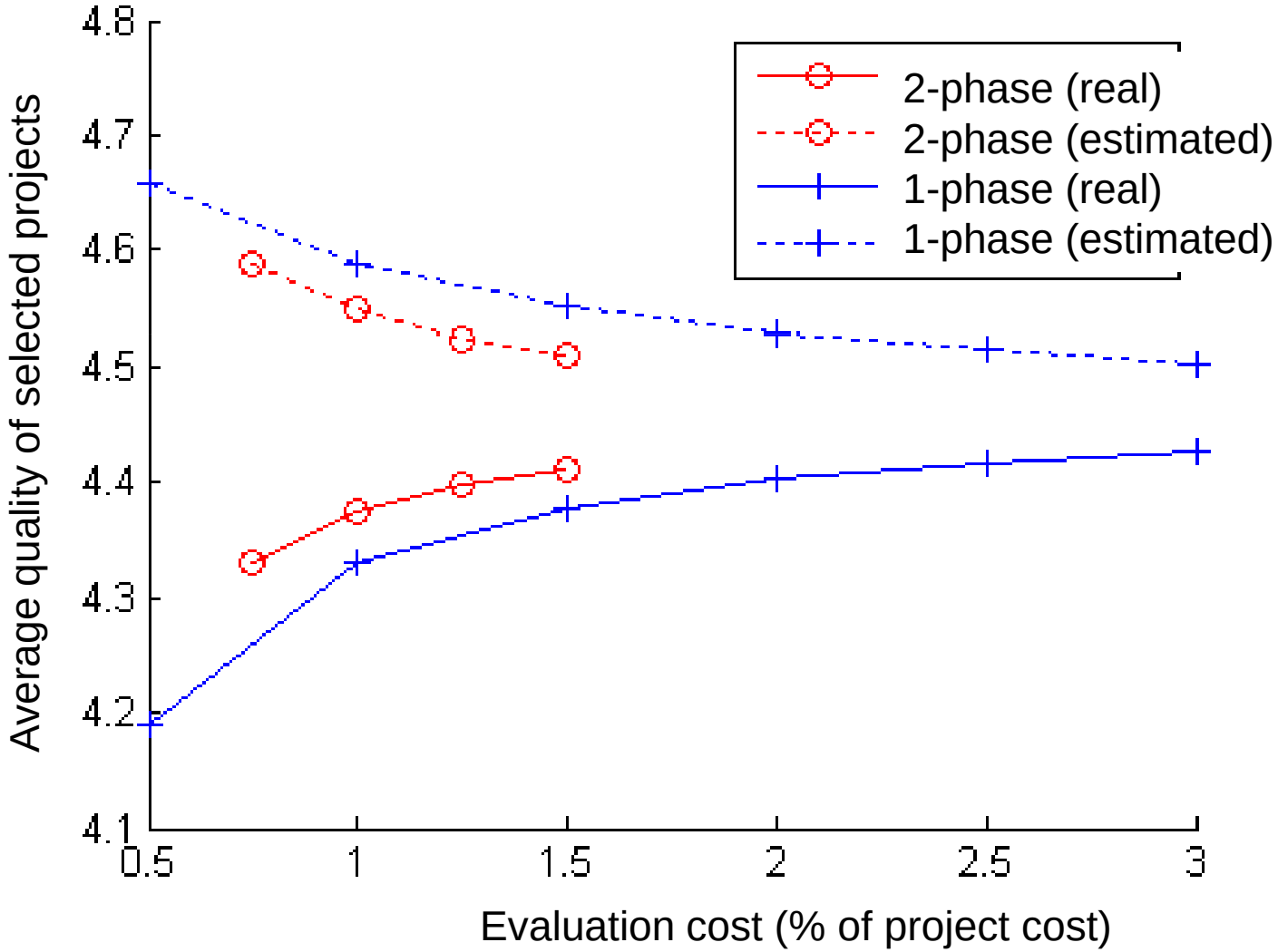

- Evaluation statements depend on the true value
  - “Good” proposals are likely to have a higher rating on the 1-5 scale




$$\frac{e^{x+\varepsilon}}{1+e^{x+\varepsilon}}$$

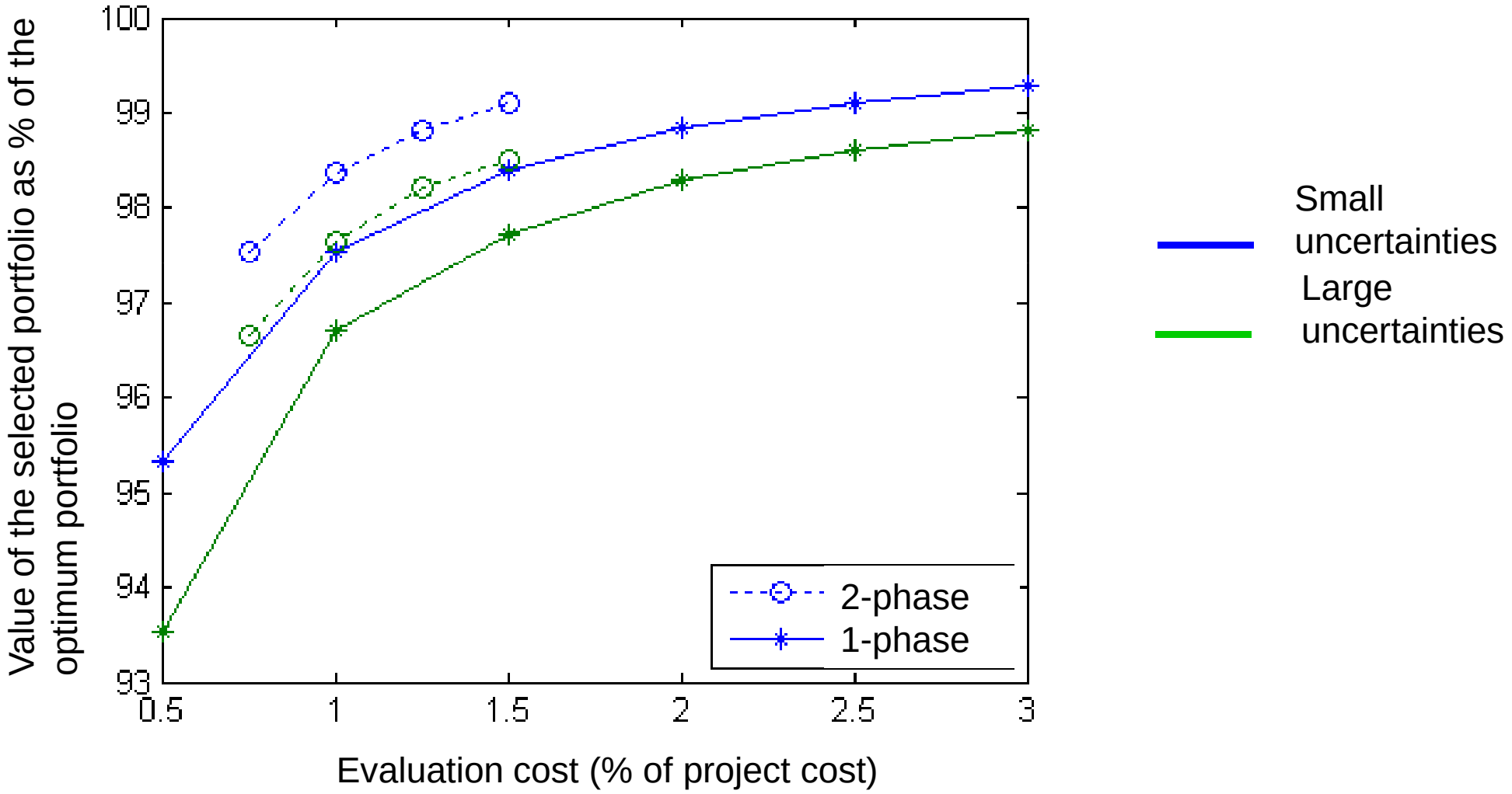
$$\varepsilon \sim N(0, \sigma_\varepsilon)$$

# Optimizer's curse in the average quality of projects

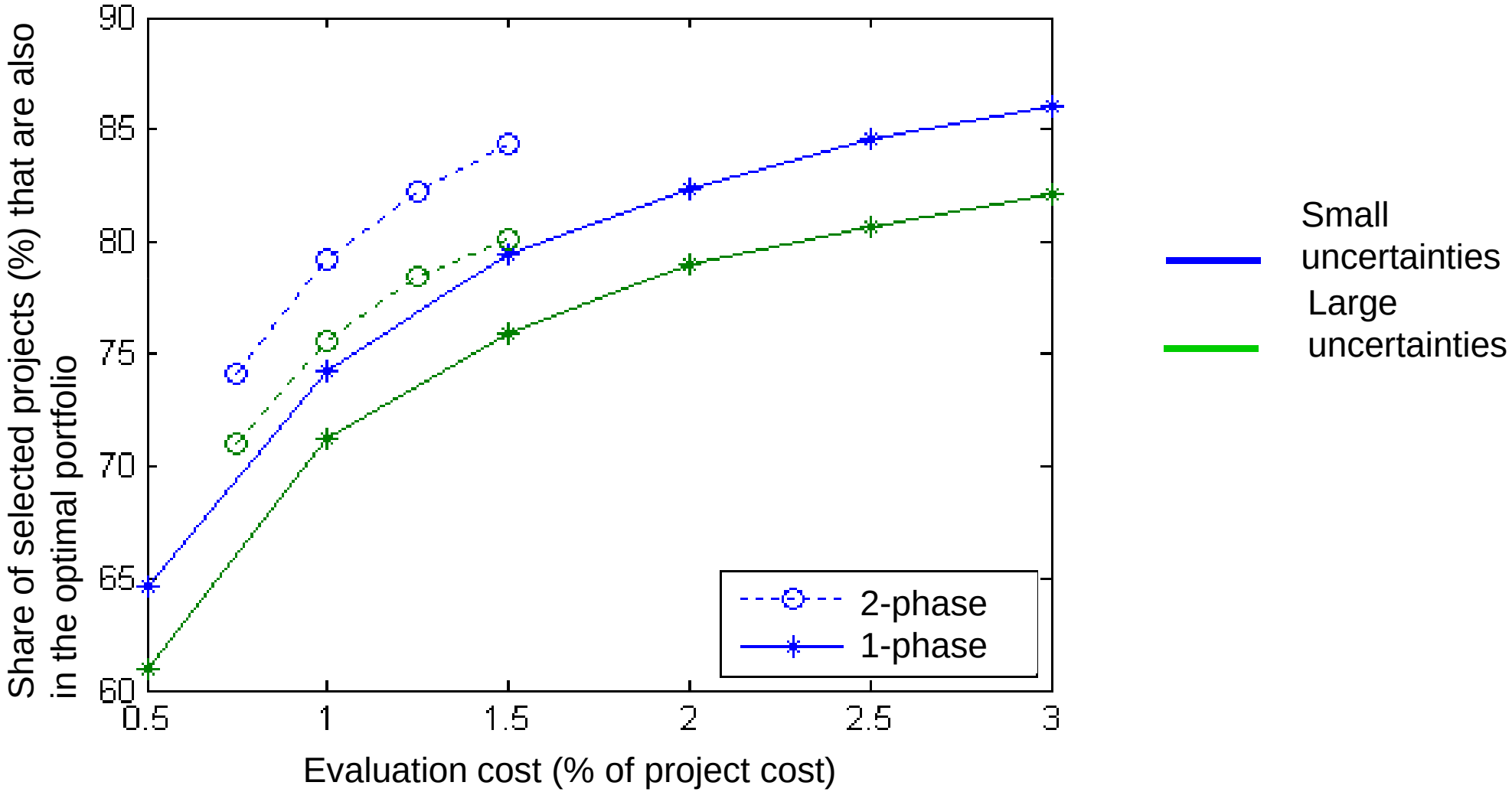



(based on the distributions on the preceding slide)

# Evaluations help approach the societal optimum



# But justice to the individual is difficult to guarantee



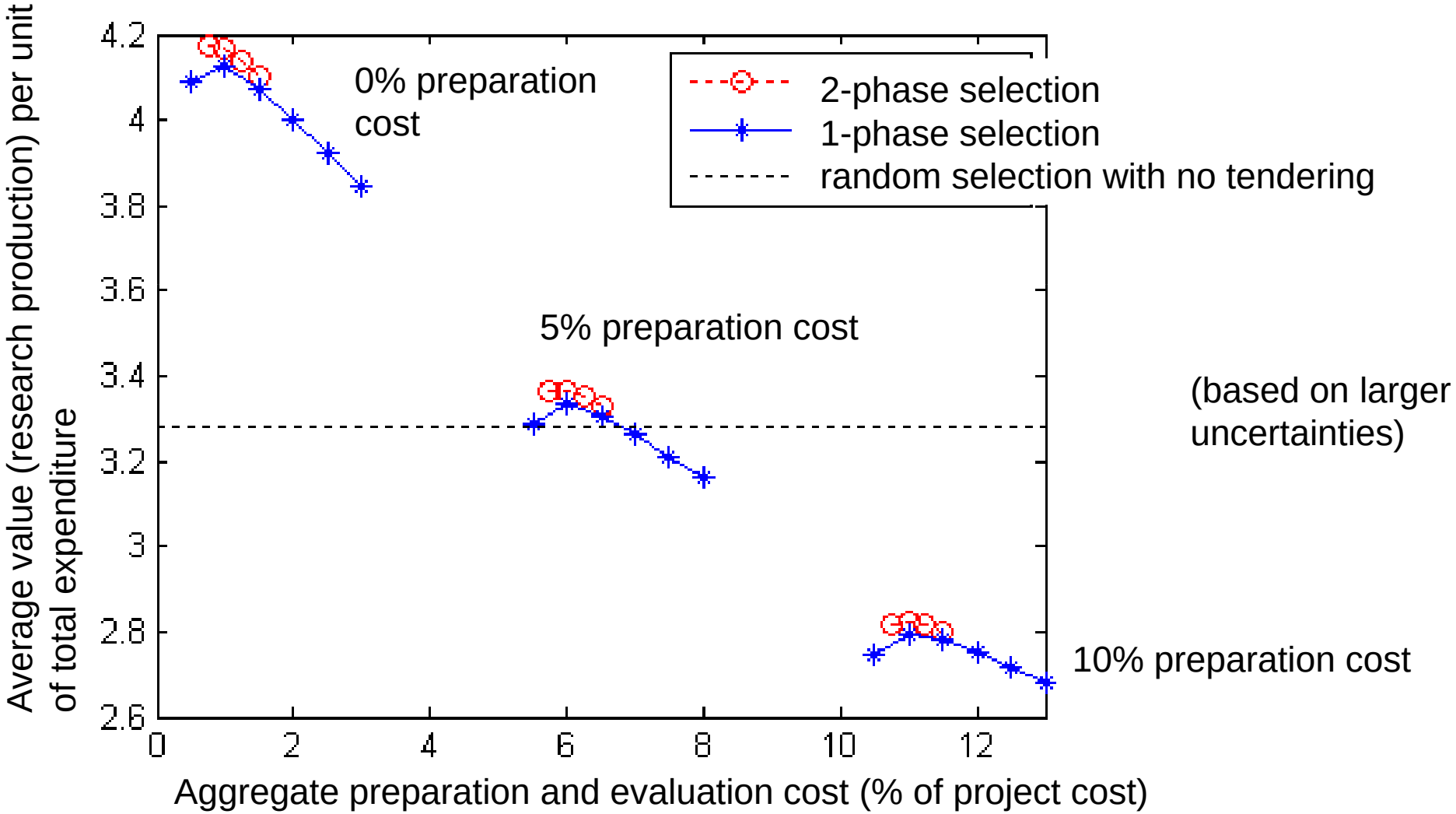
# Impact of competitive tendering on productivity 1(3)

- 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)



# 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