Finding efficient harvest control rules for data limited management

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Introduction

Objective: to find control rules that perform well in data poor situations.

- How do we measure performance?
- What do we mean by data poor?

Overview of study:

- Introduce a measure of control rule performance
- Define control rules
- Compare performance under different data scenarios
- Quantify data uncertainty
- Compare performance relative to data uncertainty

Efficiency

How do we measure performance?

Statistical efficiency measures the deviation of an estimated value $\hat{\theta}$ from the true value θ:

$$e(f) = \frac{1/I(\theta)}{E[(\theta - \hat{\theta})^2]}$$

From this definition we obtain our measure of performance.

Performance statistic:

$$e(HCR) \propto \frac{1}{E[(C - \hat{C})^2]}$$

Harvest control rules

How do we calculate C and $\hat{C}$?

Harvest control rule:

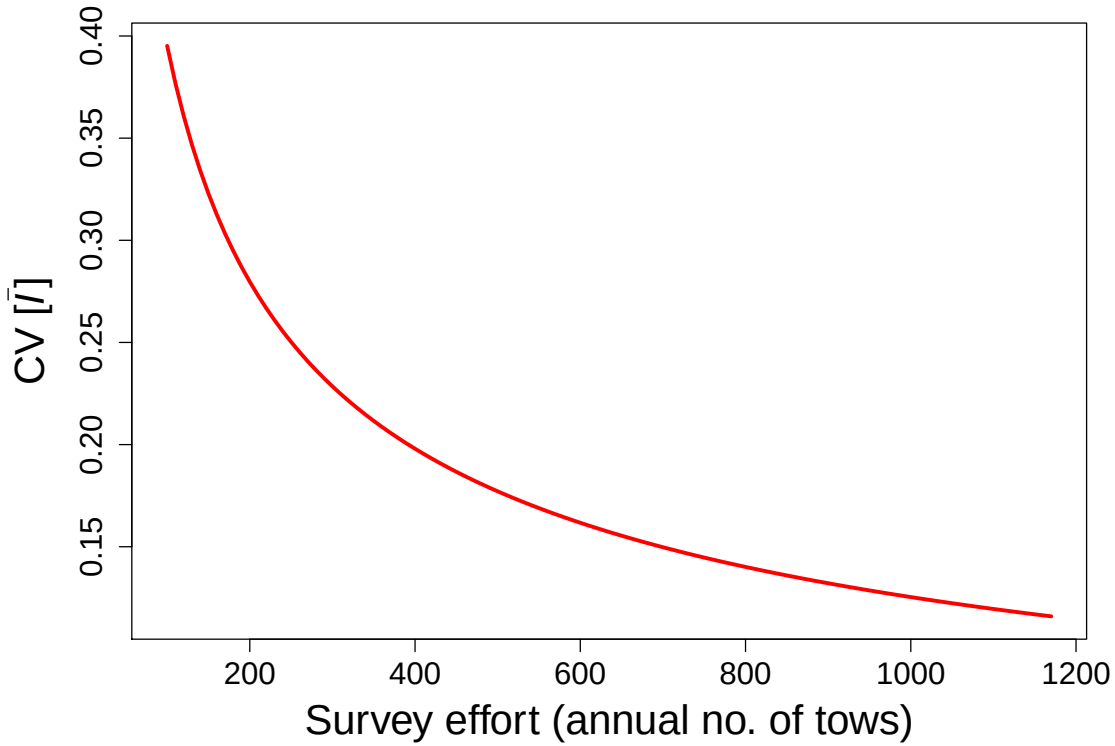
$$C_{y+1} = \frac{I_{y+1} C^{TAR}}{I^{TAR}}$$

Tested four methods of predicting $\hat{I}_{y+1} \longrightarrow \hat{C}_{y+1}$:

- Moving average
- Linear regression
- Smoothed index
- Model-based (Stock reduction analysis)

Data scenarios

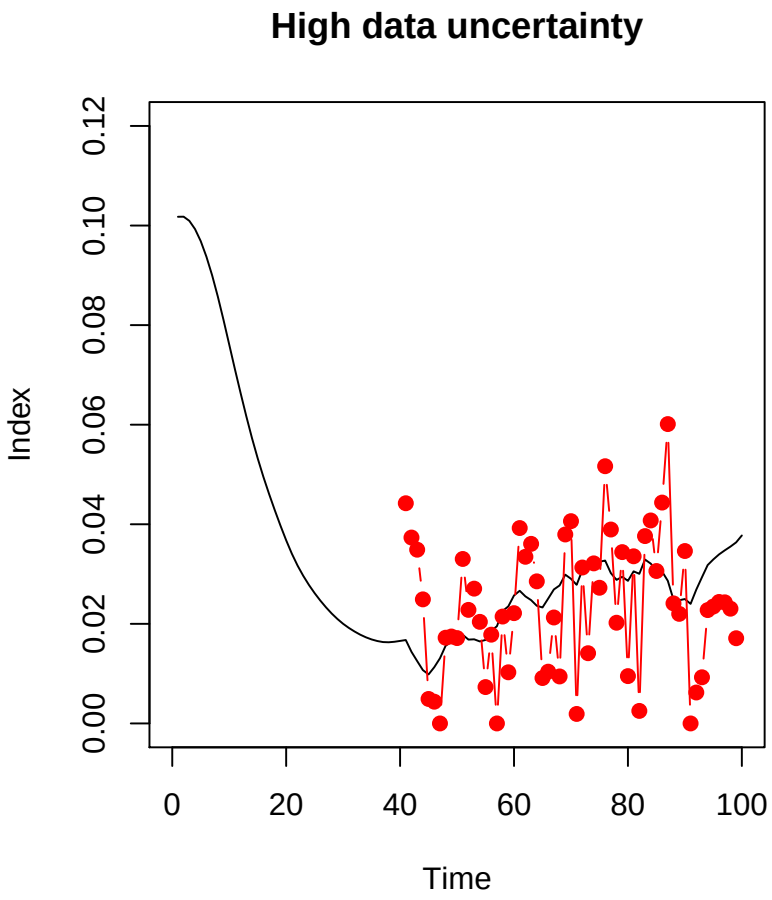
Information input for the control rule

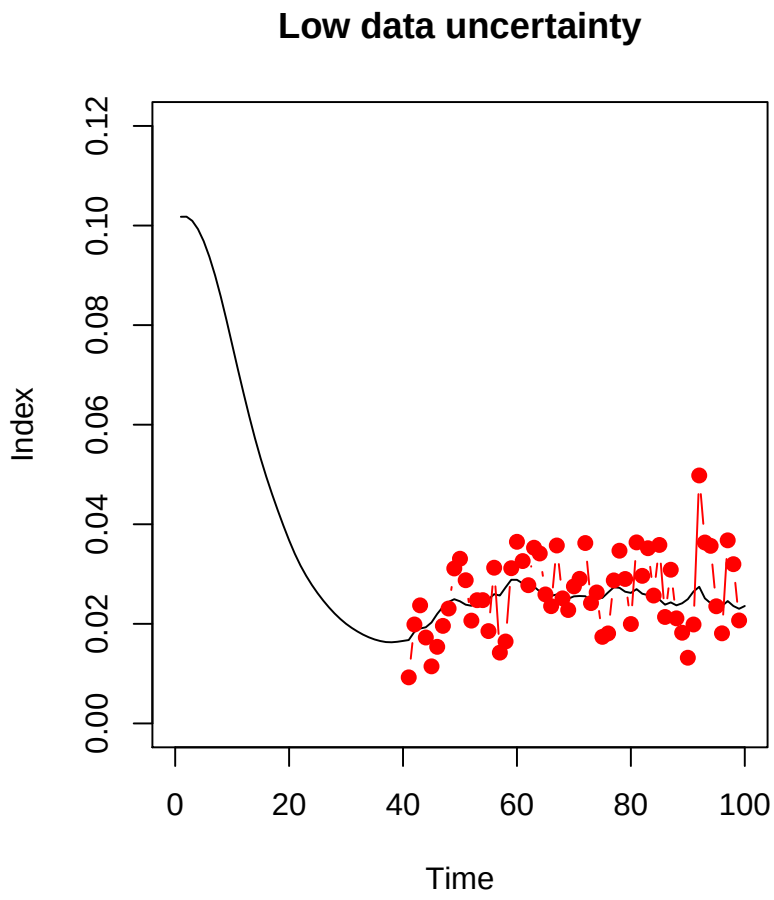


Experimental design: by changing the years of data available to the control rule (n) and the observation error (σ) we can modify the data uncertainty.

Simulation results

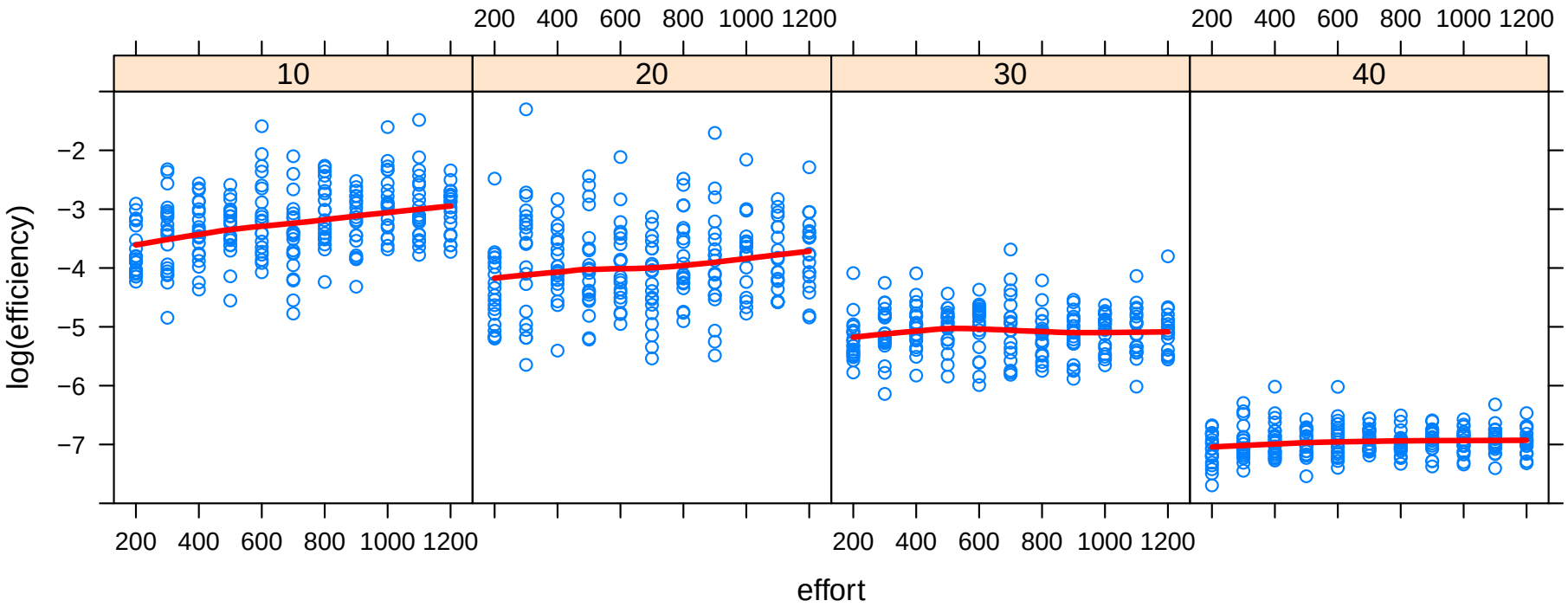
Illustrative results





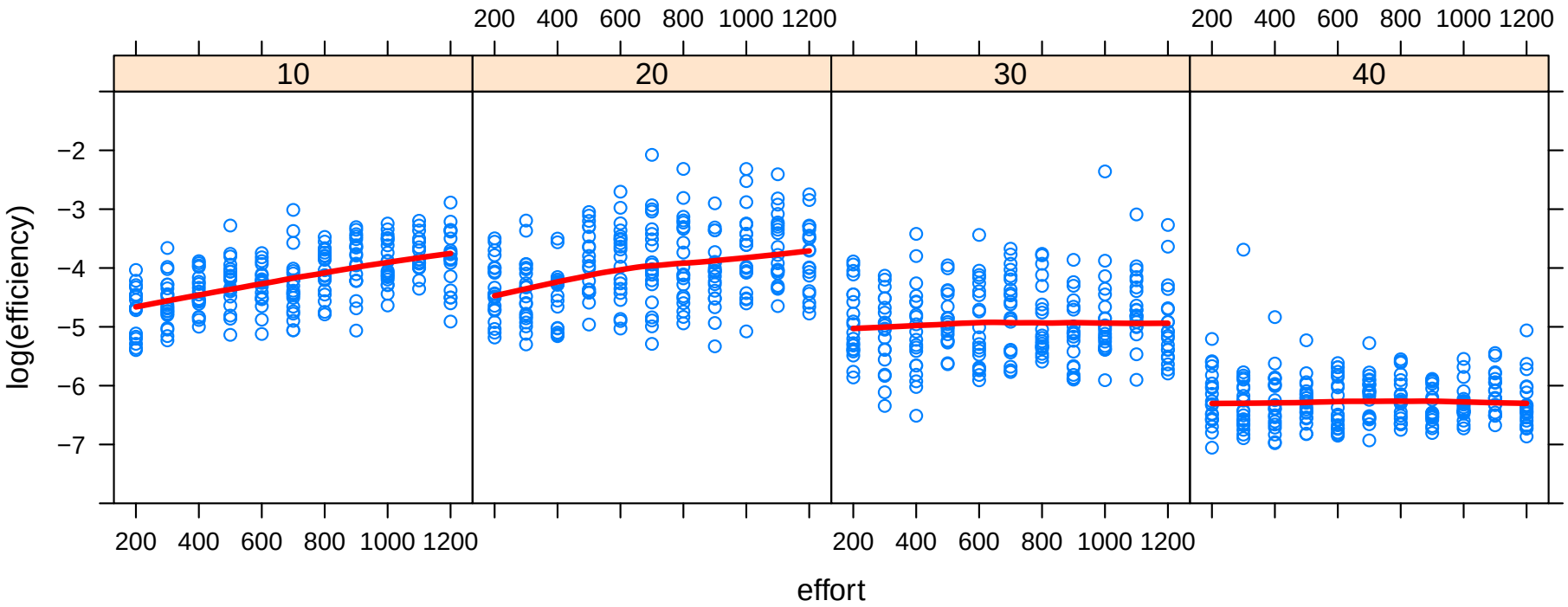
Simulation results

Moving average control rule



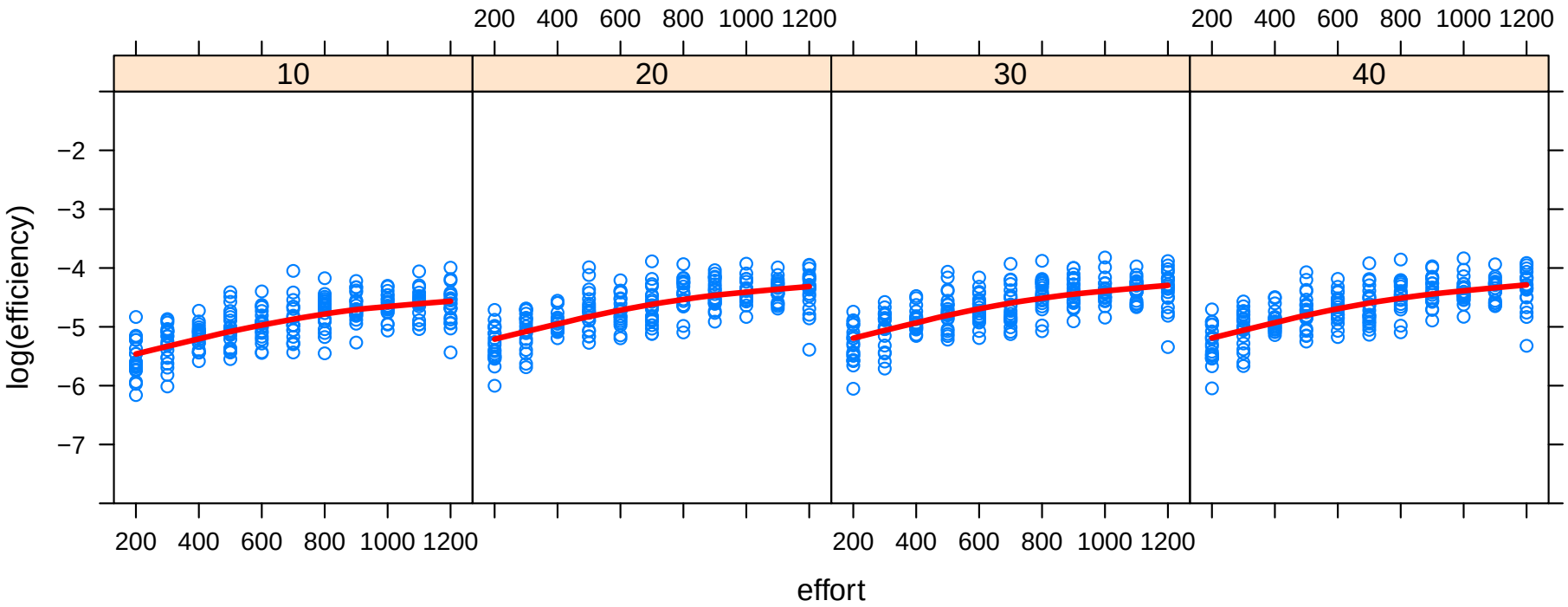
Simulation results

Regression-based control rule



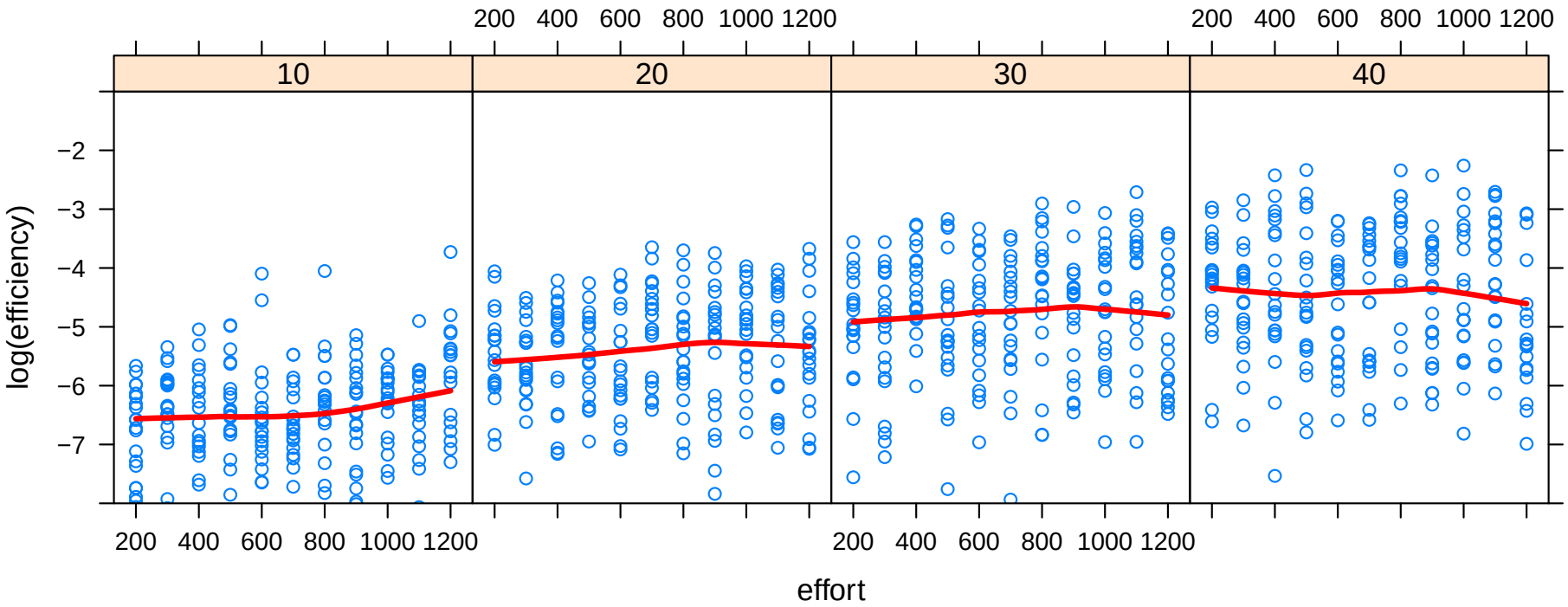
Simulation results

Smoothed index control rule



Simulation results

Model-based control rule



Data uncertainty

Quantifying the information available to the control rule

If ε is the observation error residual, then the probability distribution of the mean residual is:

$$E[ln(\varepsilon)] \sim N\left(0, \sigma^2/n\right)$$

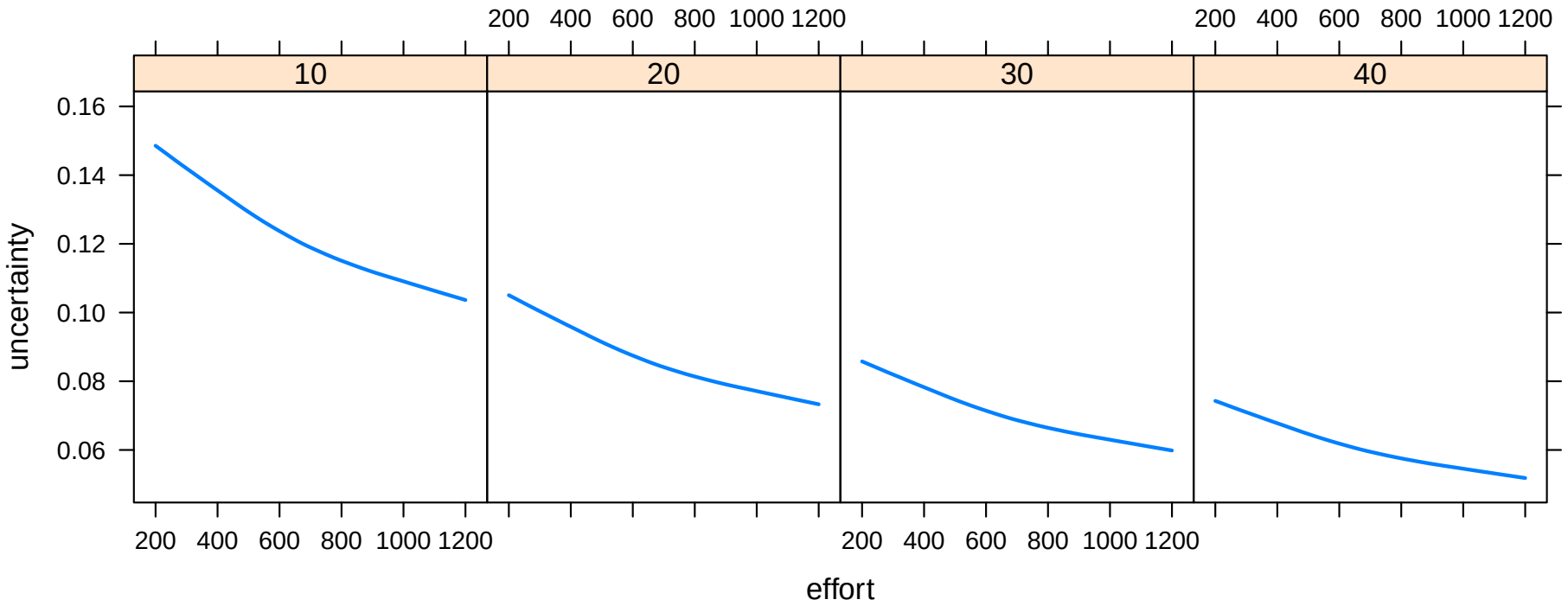
From this observation we obtain our measure of data uncertainty.

Data uncertainty:

$$u(D) := \frac{\sigma}{\sqrt{n}}$$

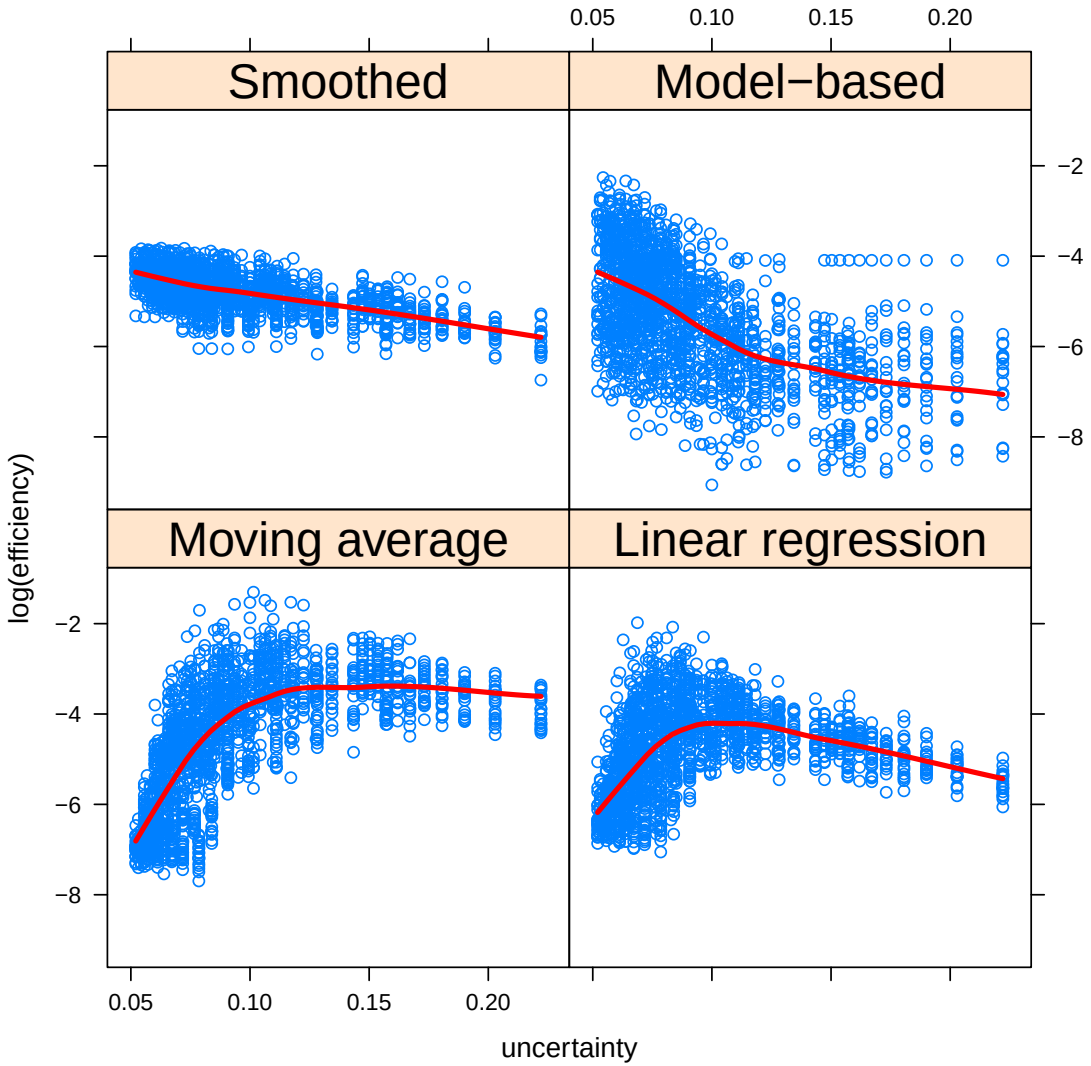
Data uncertainty

Quantifying the information available to the control rule



Simulation results

Efficiency against uncertainty



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