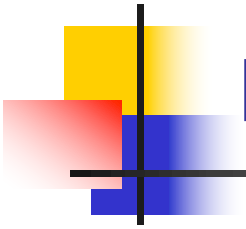
# Bayesian Analysis: An Illustrative Application

**Andreas Schwab**
Iowa State University

Academy of Management Conference
2023



# Bayesian Analyses

- Bayesian statistics offer an established methodology for drawing inferences and assessing plausibility of theories.
- Bayesian analysis advantages
  - Predictive probability statements for hypothesized effects based on the specific observed data
  - Enables incorporating of prior knowledge into the estimation of hypothesized effects
  - Encourages the comparison of alternative models

# Bayesian analysis

- Distinctly different from Statistical Significance Tests
- 3 Steps of Bayesian Analysis

  (1) Specify Prior Distributions

  (2) Estimate Posterior Distribution using collected data to update Prior Distributions

  (3) Use Posterior Distribution to evaluate hypotheses

# Bayesian Analysis
# Step 1: Specify Prior Distributions

- Specify upfront a "prior" probability distribution for hypothesized effects based on what we already know about this effect.

- Alternative approaches
  - Uninformed priors
  - Previously published research
  - Theory-based priors
  - Experts and knowledgeable individuals
  - Sequential priors based on earlier gathered data

# Bayesian Analysis
# Step 2: Estimate Posterior Distribution

$$p(\theta|\text{data}) \propto p(\text{data}|\theta)p(\theta)$$

$$\text{“posterior”} \propto \text{“likelihood”} \times \text{“prior”}$$

- Bayesian analyses calculate posterior distributions of the proposed effects by updating the expected distribution (prior) using the observed data (likelihood).
- Markov Chain Monte Carlo (MCMC) sampling to perform this update (“Bayesian Magic”).

# Bayesian Analysis
# Step 3: Evaluate Posterior Distribution

- Posterior distributions enable evaluation of both the strength and uncertainty of hypothesized effects.
- Posterior distributions also enable the comparison of alternative models – including models employing different prior distributions.

# Bayesian Studies: An Illustrative Example

**Hansen, Perry, & Reese (2004). A Bayesian Operationalization of the Resource-Based View. *Strategic Management Journal*.**

## Hansen, Perry, & Reese (2004). A Bayesian Operationalization of the Resource-Based View. *Strategic Management Journal*.

- Research Objective:

  Effects of administrative decisions on firm performance.
- Hypothesis:

  Buying organizational units improves firm financial returns.
- Method:
  - Bayesian hierarchical linear analysis that also accounts for industry, firm, and year effects.
  - Markov-Chain Monte Carlo sampling
  - Flat "uninformed" priors (with robustness checks for alternative priors)

# Hansen, Perry, & Reese (2004). A Bayesian Operationalization of the Resource-Based View. *Strategic Management Journal*.

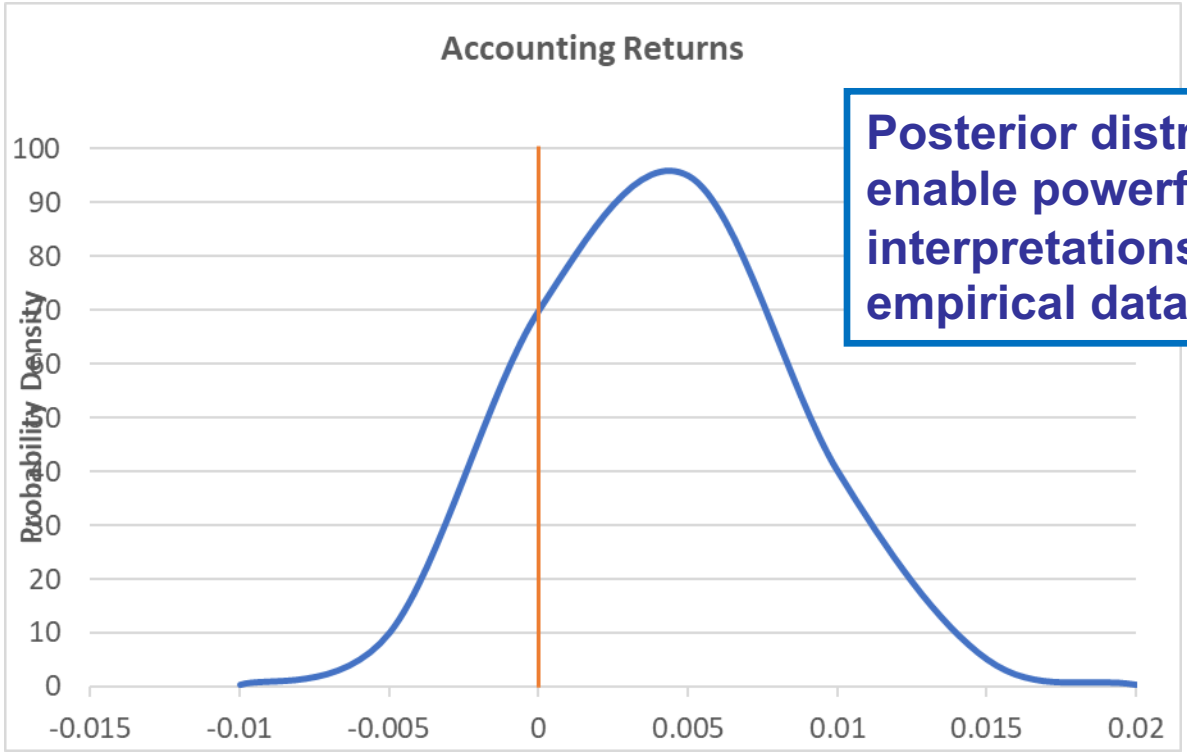
- Results: Probabilities for Effects of Administrative Actions on Firm Performance

| Actions | Accounting Returns |
|---|---|
| Buying units | 0.8111 |
| Selling units | 0.5584 |
| Org. restructuring | 0.9274 |
| Alliances | 0.4571 |
| Hiring | 0.5867 |
| New Markets | 0.4646 |
| Finanical restructuring | 0.0516 |
| Personnel changes | 0.1169 |
| Lay-offs | 0.3082 |
| New products | 0.7434 |

**Buying units has a 81% probability of improving firm performance.**

# Hansen, Perry, & Reese (2004). A Bayesian Operationalization of the Resource-Based View. *Strategic Management Journal*.

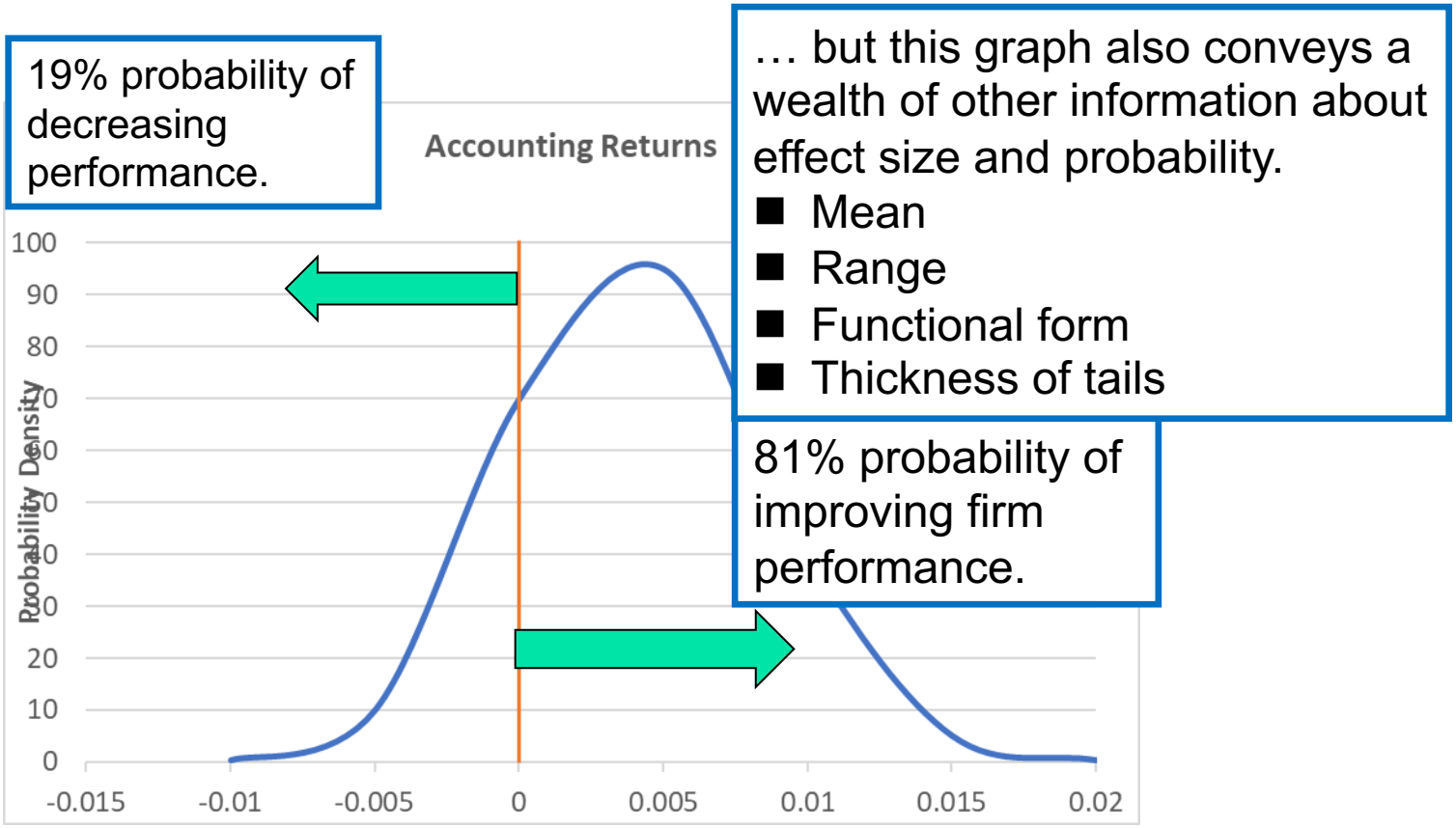
- Posterior Distribution of Effects on Firm Performance




**Posterior distributions enable powerful interpretations of the empirical data.**

# Hansen, Perry, & Reese (2004). A Bayesian Operationalization of the Resource-Based View. *Strategic Management Journal*.

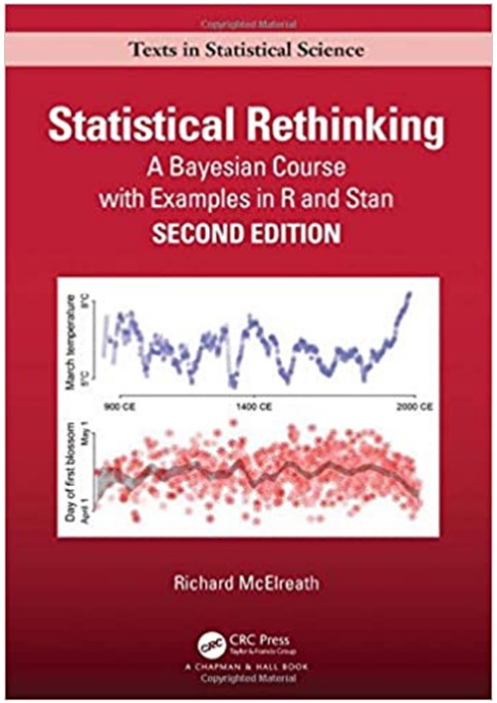
- Posterior Distribution of Effects on Firm Performance



# Conclusions

- Bayesian analyses can be applied to virtually any research question, statistical problem, and empirical context.
- Prior distributions create opportunities for integrating prior research for better accumulating knowledge across studies.
- In the past, the execution of Bayesian analysis difficult was difficult and sometimes tedious.

# Useful guides for Bayesian applications




Richard McElreath (2020).
Statistical Rethinking:
A Bayesian Course with
Examples in R and Stan