

Bayesian Analysis for Small Subgroups

Intuitive Inferences with Heightened Precision

**Building Strong Evidence in Challenging Contexts:
Alternatives to Traditional Randomized Controlled Trials**

September 22, 2016 • OPRE

Mariel Finucane

Problem:

We often have samples that are too small to produce reliable estimates

Problem:

We often have samples that are too small to produce reliable estimates

Solution:

Hierarchical Bayes

Problem:

We often have samples that are too small to produce reliable estimates

Solution:

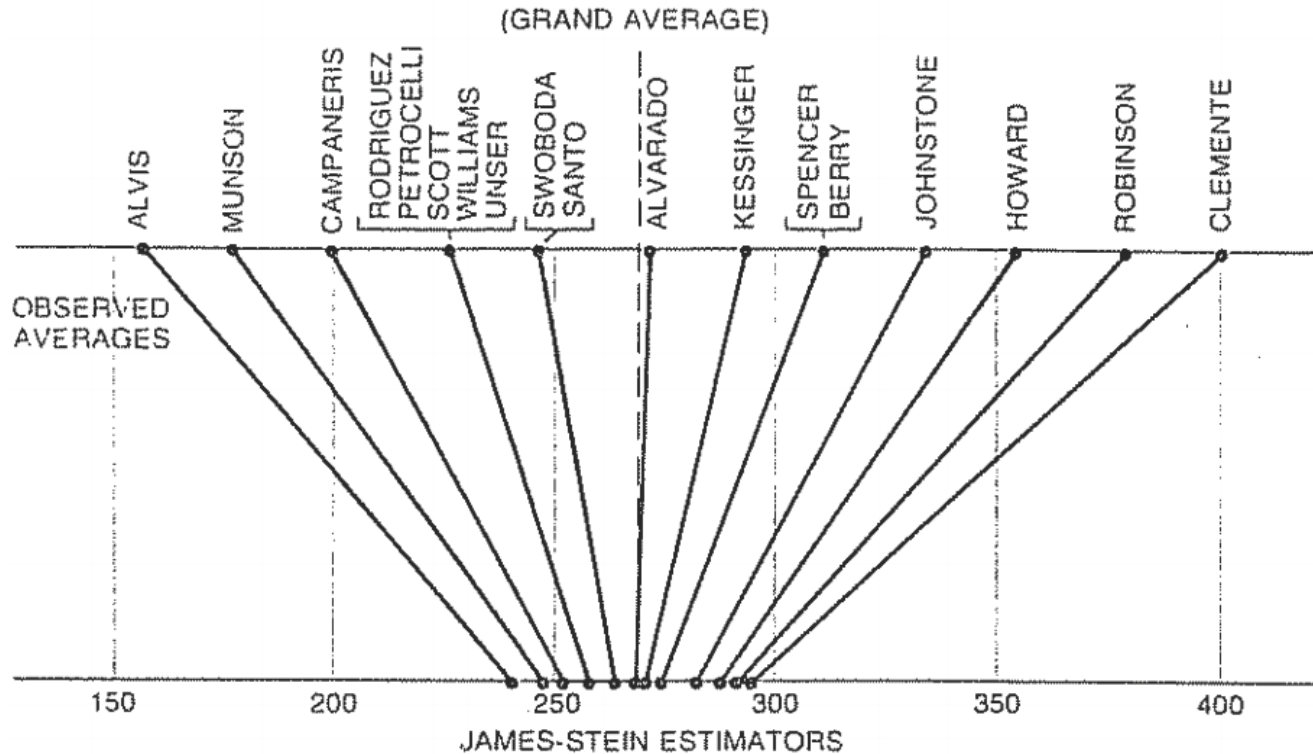
Hierarchical Bayes

Borrowing strength
Reliability adjustment
Stabilization
Random effects modeling
Shrinkage
Multilevel modeling
Empirical Bayes
Small-area estimation
Variance components
Partial pooling...

Goals for Today

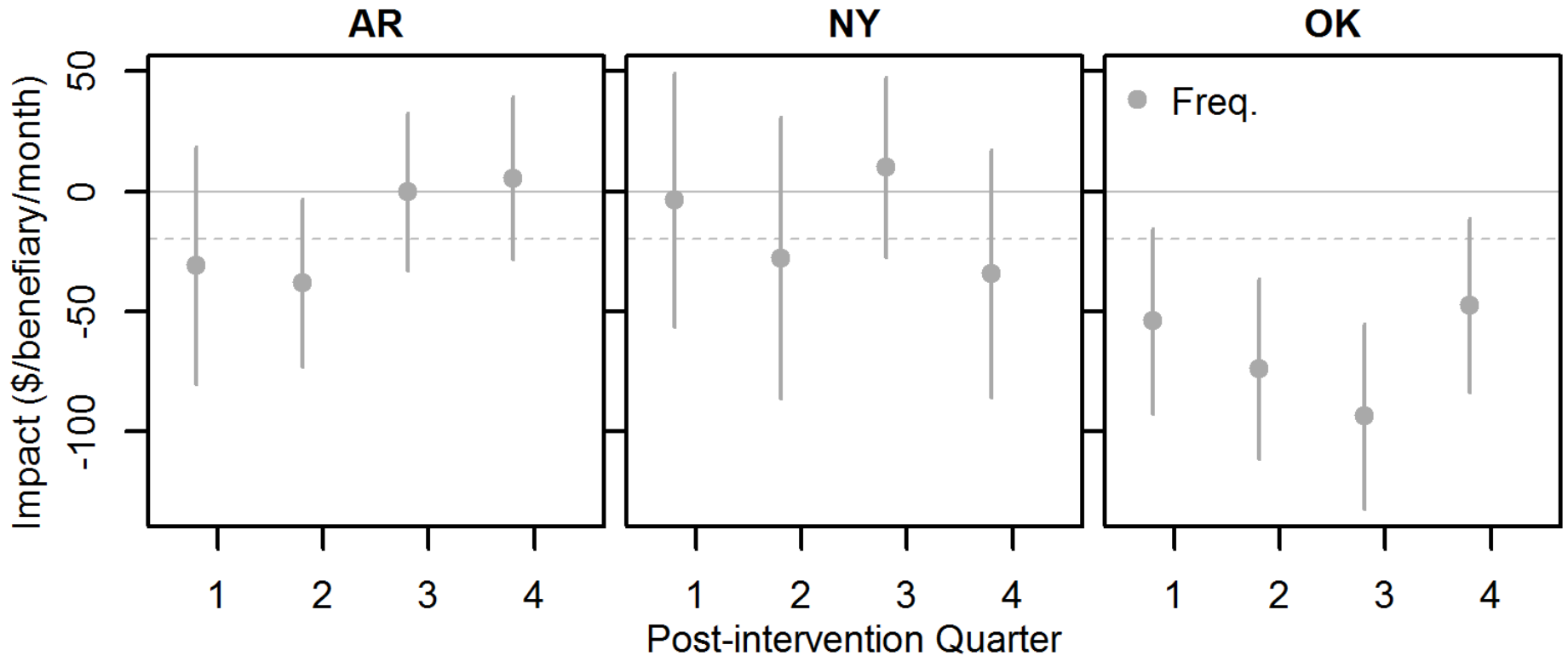
- **Why Hierarchical Bayes?**
 - Baseball
 - Health policy impact evaluation

Baseball

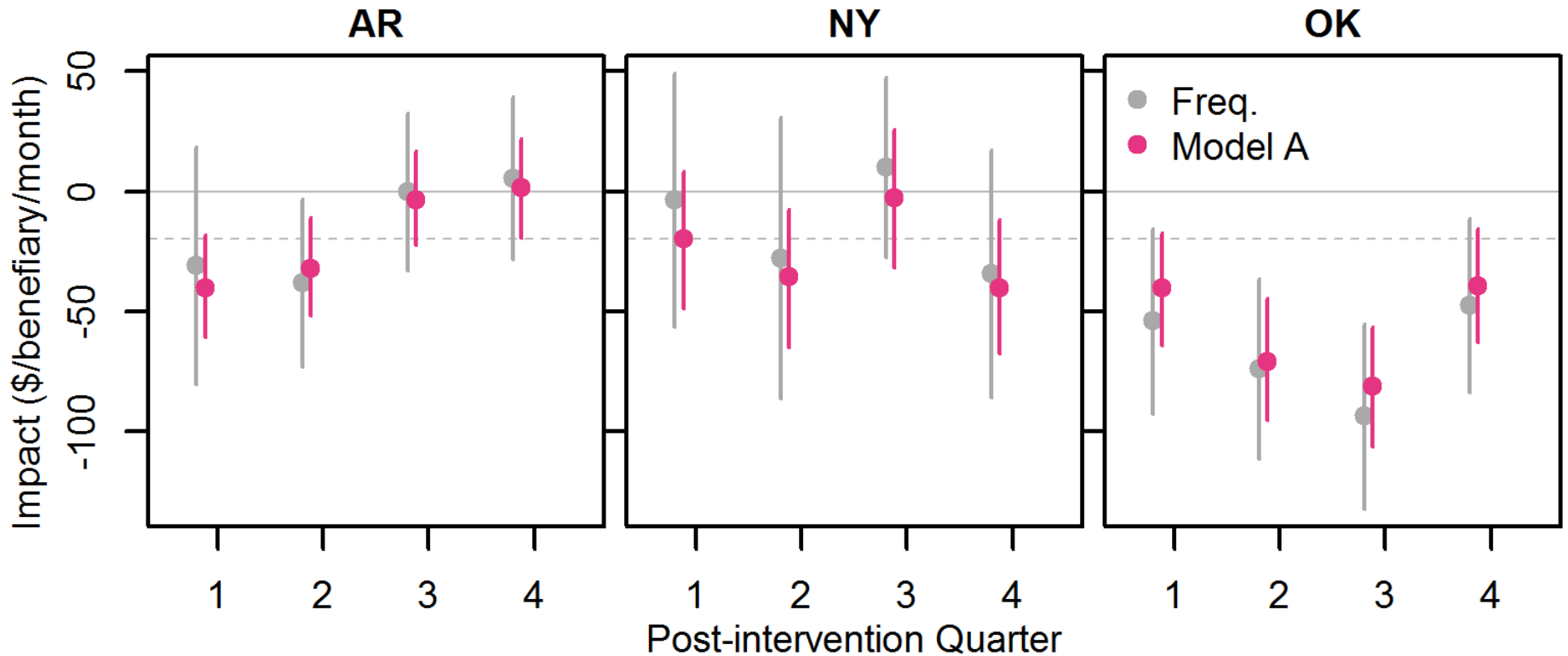


JAMES-STEIN ESTIMATORS for the 18 baseball players were calculated by “shrinking” the individual batting averages toward the overall “average of the averages.” In this case the grand average is .265 and each of the averages is shrunk about 80 percent of the distance to this value. Thus the theorem on which Stein’s method is based asserts that the true batting abilities are more tightly clustered than the preliminary batting averages would seem to suggest they are.

Health Policy Impact Evaluation



Health Policy Impact Evaluation



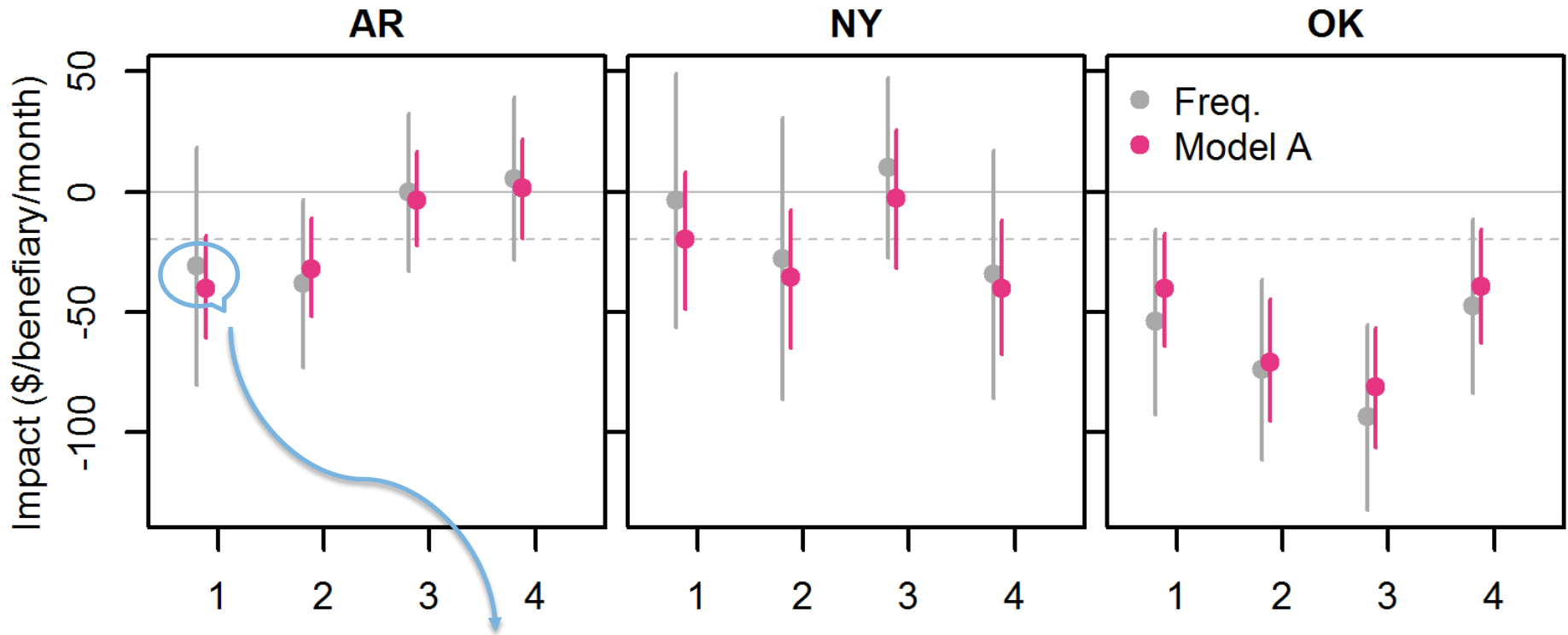
Problem:

Policymakers want more meaningful inferences than just whether they can reject the null hypothesis that a program had no effect

Solution:

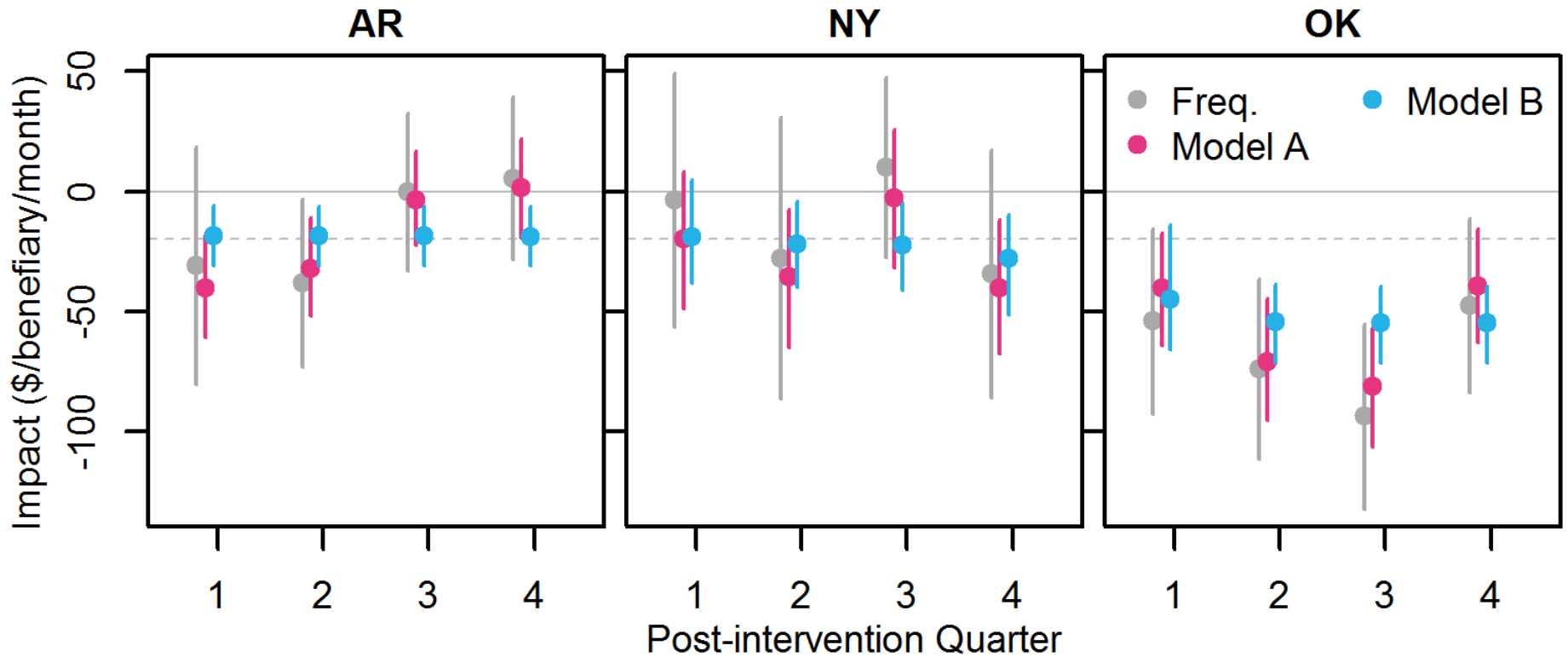
Bayesian models yield intuitive probabilistic inference—given the observed data, how likely is it that the true effect exceeds 0? Or 20% of the mean? Or the cost of the intervention?

Health Policy Impact Evaluation

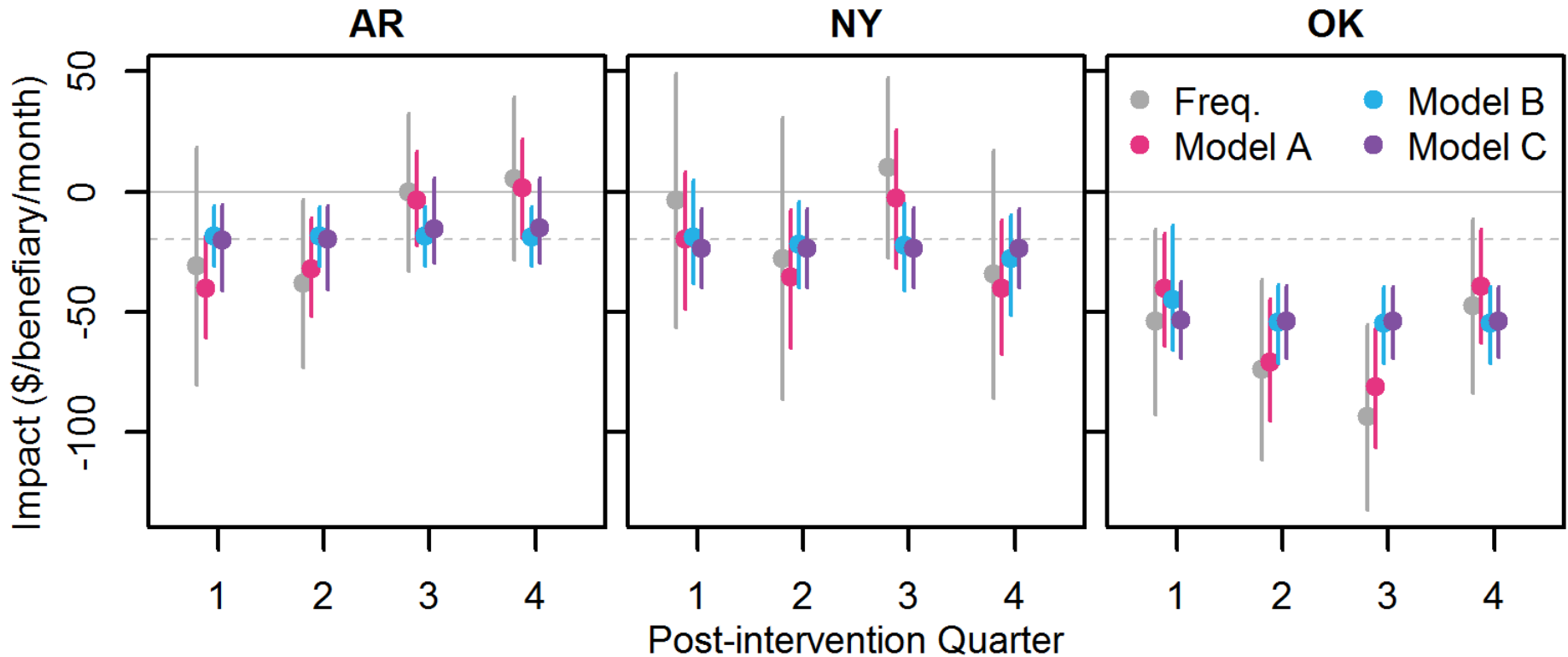


Frequentist	<p>Fixed: parameter</p> <p>Random: data</p>	<p>“There is a 13 percent chance of observing such an extreme reduction in costs if the program has no effect.”</p>
Bayesian	<p>Fixed: data</p> <p>Random: parameter</p>	<p>“There is a 97 percent chance that the program reduced costs enough to recover the \$20 fee.”</p>

Health Policy Impact Evaluation



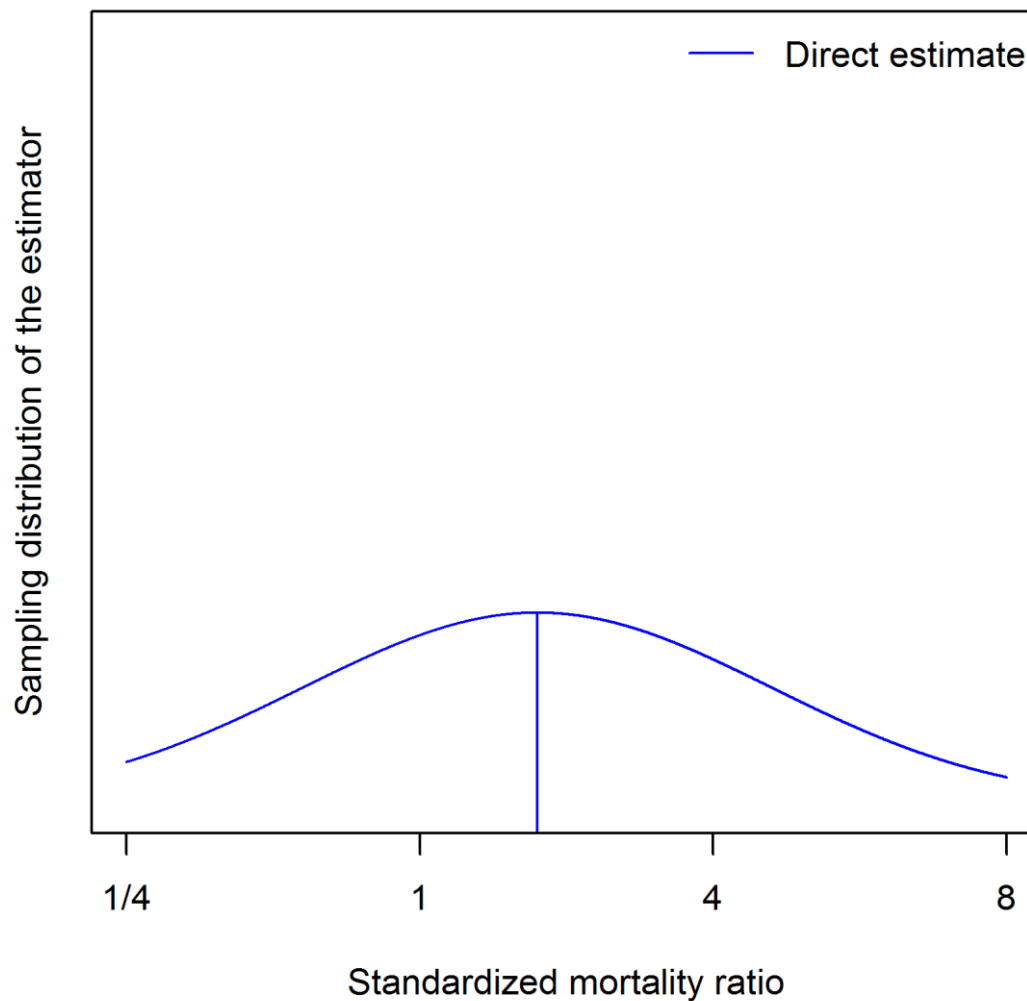
Health Policy Impact Evaluation



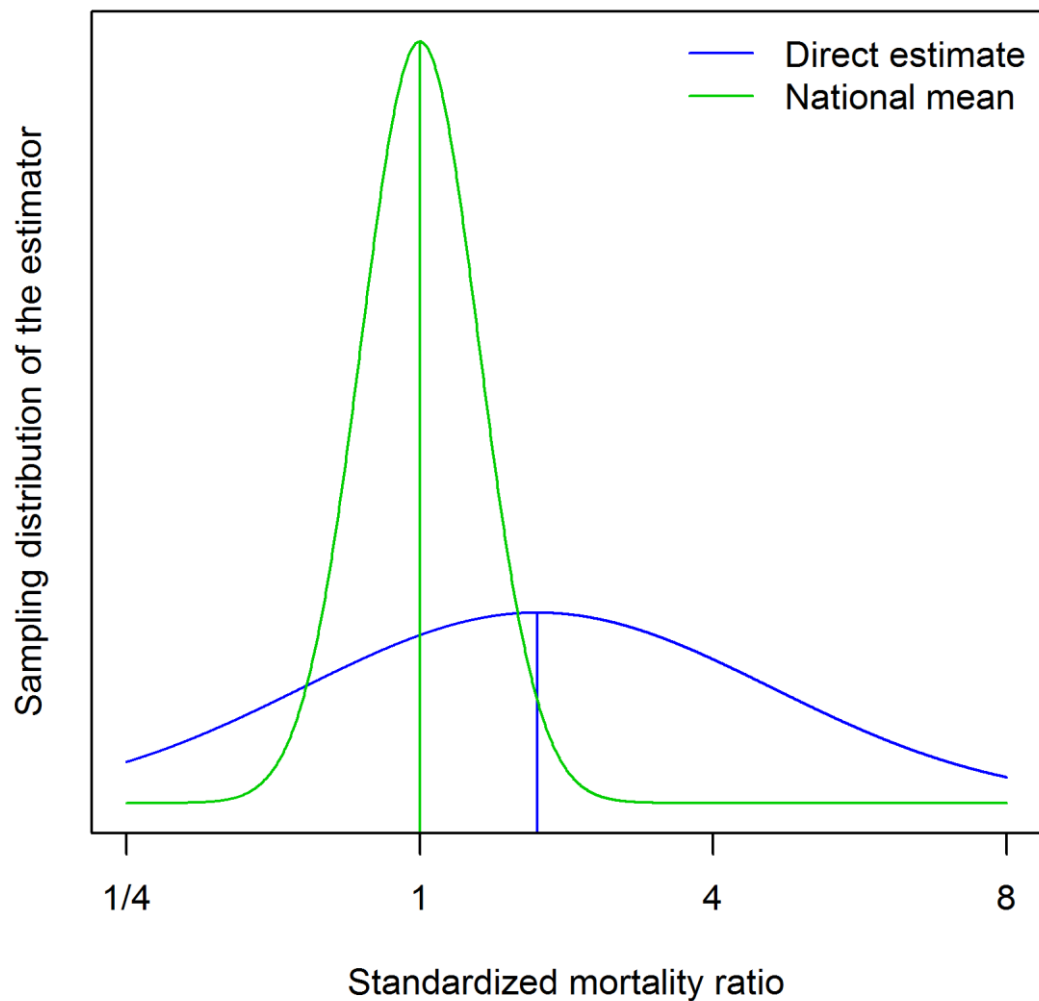
What's the catch?

- Absence of conventional standards of evidence could lead to greater adoption of ineffective programs
- Potentially confusing to policymakers and stakeholders
- Results depend on assumptions, which can introduce bias

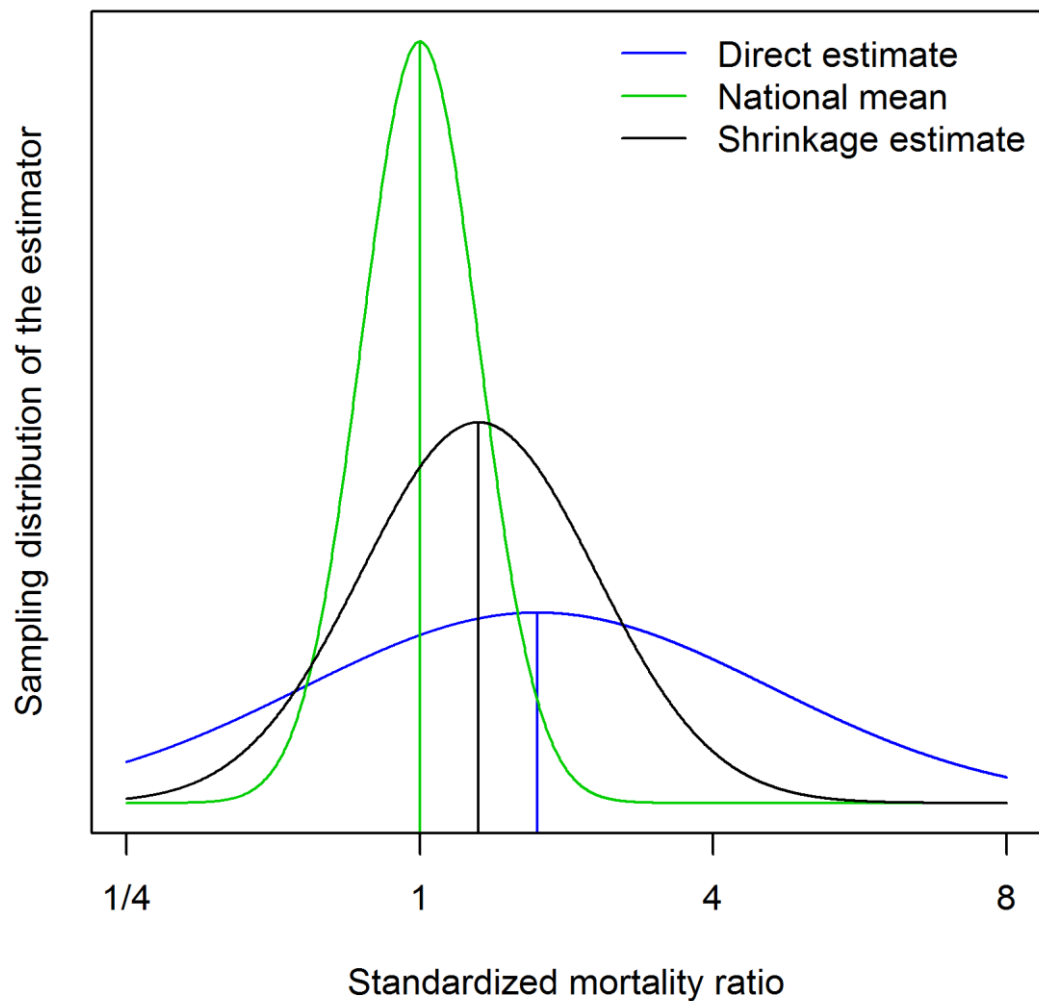
Appendix 1: Bias/Variance Tradeoff



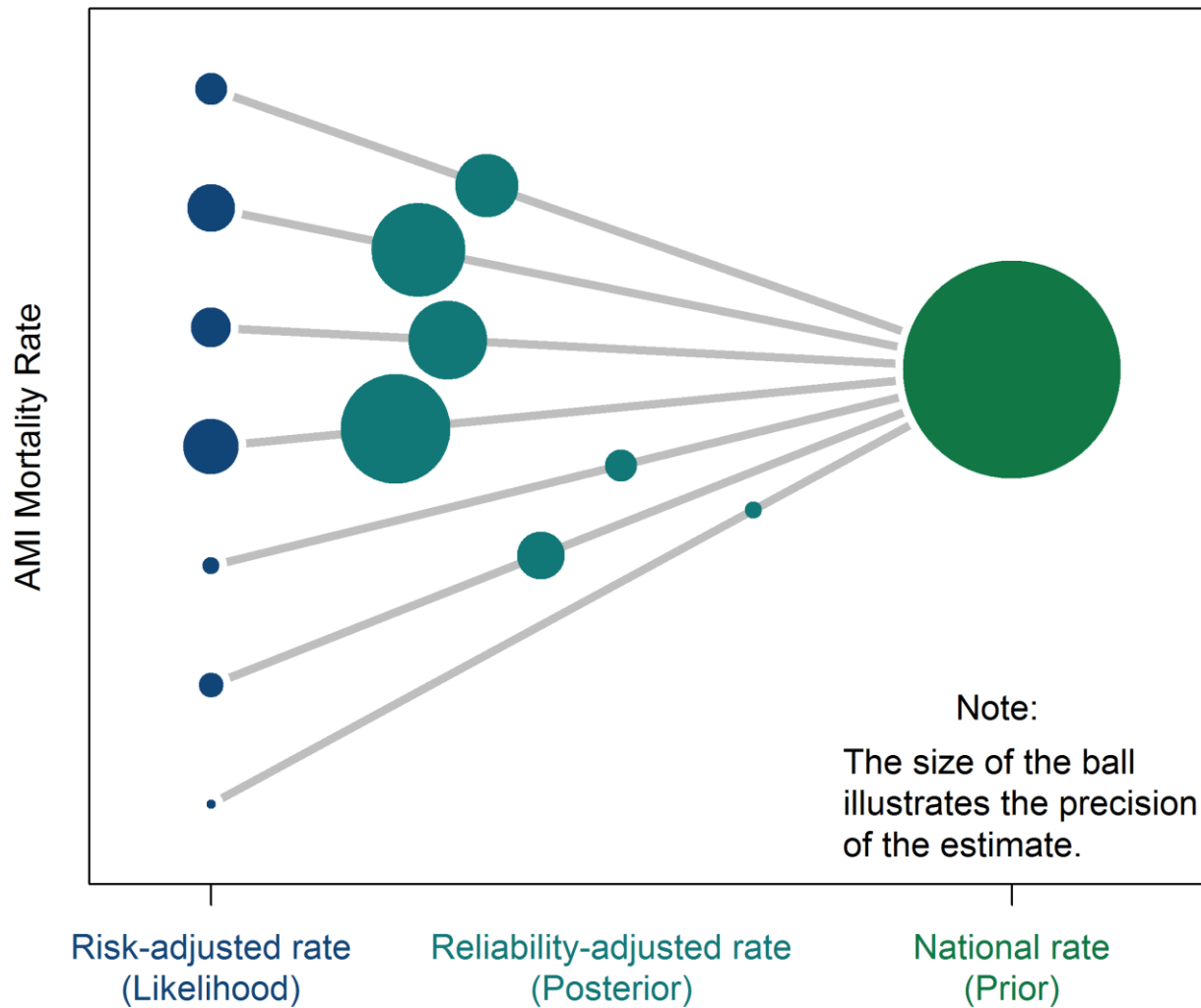
Appendix 1: Bias/Variance Tradeoff



Appendix 1: Bias/Variance Tradeoff



Appendix 2: Hospital Performance Measurement



Appendix 2: Hospital Performance Measurement

STATISTICAL ISSUES IN ASSESSING HOSPITAL PERFORMANCE

Commissioned by the Committee of Presidents of Statistical Societies

The COPSS-CMS White Paper Committee:

Arlene S. Ash, PhD; Stephen E. Fienberg, PhD; Thomas A. Louis, PhD
Sharon-Lise T. Normand, PhD; Thérèse A. Stukel, PhD; Jessica Utts, PhD

Original report submitted to CMS on November 28, 2011

Revised on January 27, 2012

“CMS seeks to report on systematic differences in patient outcome due to hospital quality... Inherent randomness causes directly estimated hospital effects to vary more than the systematic effects that are to be identified. Large reductions in reported variation [via shrinkage] are appropriate for hospital performance measures.”