Uncertainty and its Consequences in Evidence-Based Decision Making

Dr. Matthew Jukes
Fellow & Sr. Education
Evaluation Specialist
RTI International

Dr. Anne Buffardi
Senior Research Fellow,
ODI

Overview

- Problem
- Thesis
- Consequences of Uncertainty
- Diagnosing Uncertainty
- Implications

Scope

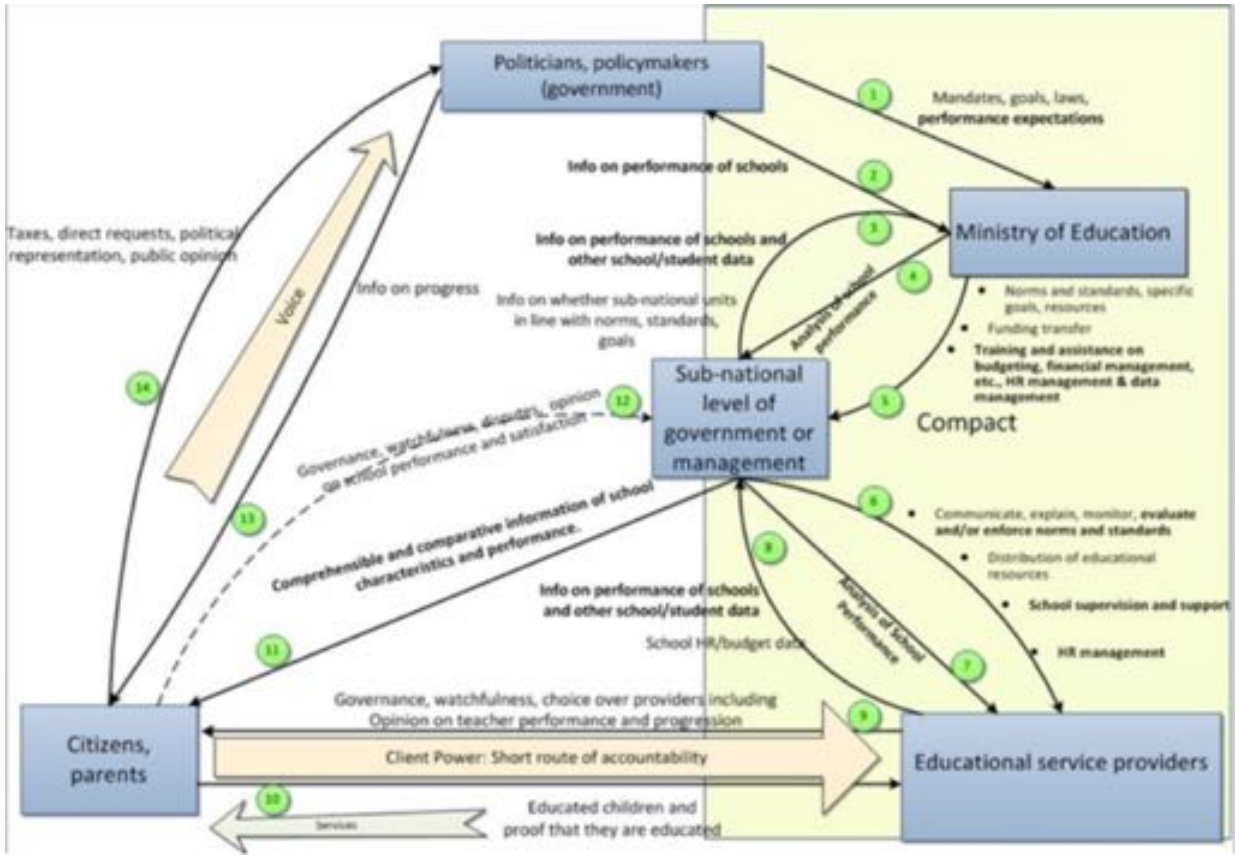
- All kinds of evidence-based decision-making
  - Evidence synthesis
  - Acting on evaluations
  - Designing evaluations or monitoring framework
- A normative framework
  - To guide what we should do, not to explain what we do
  - Aimed (mainly) at the pro-evidence

Scope

- Social policy
  - Human behaviour -> complicated, complex
  - Doesn’t systematically assess potential harm
- International development
  - Big goals, little information
  - “Incredible certitude”
    - “Ranges are for cattle – give me a number” - Lyndon B. Johnson (Manski, 2010)

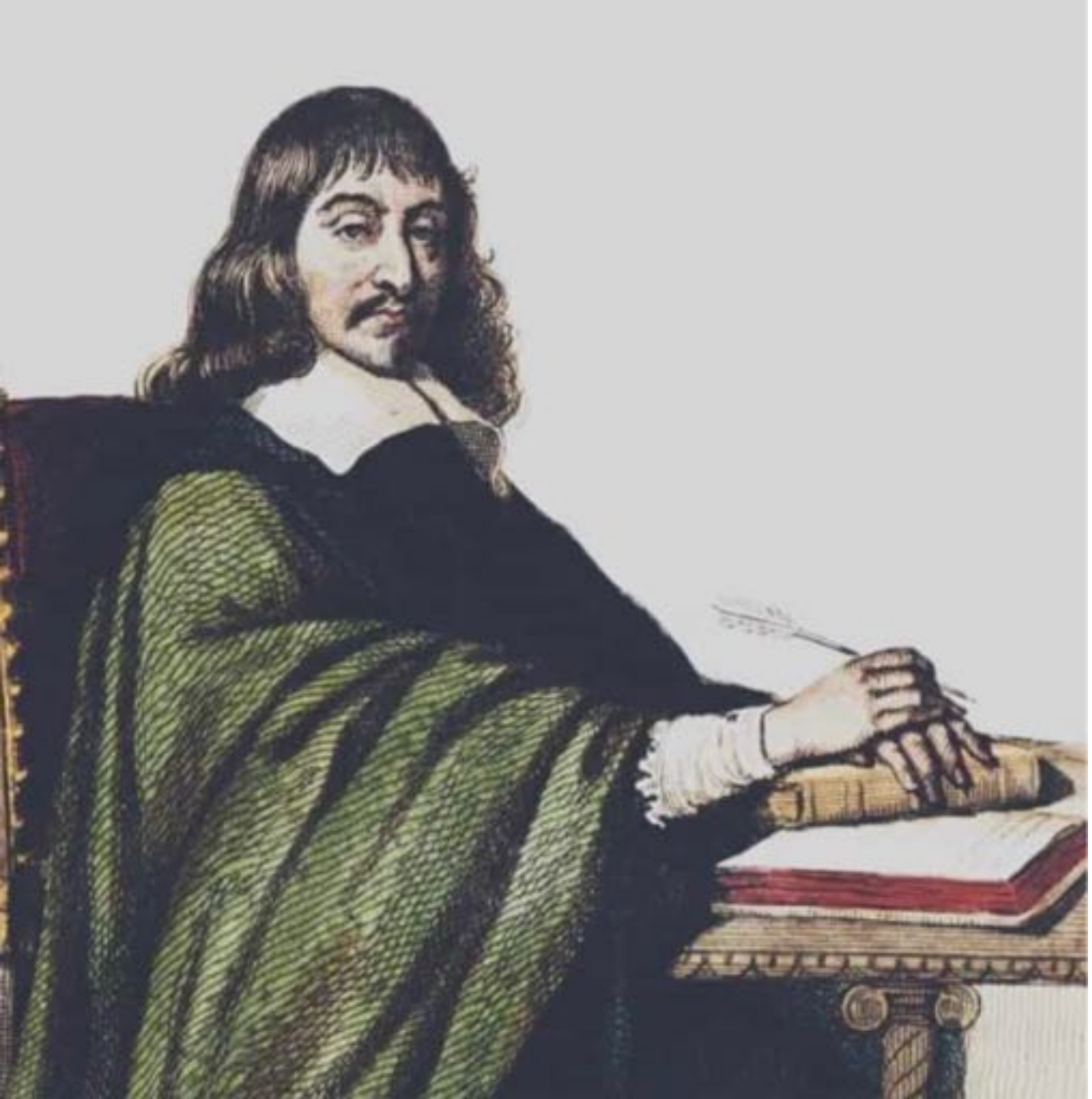
The Problem


Systematic
Review



RCTs feasible for few development interventions (Bamberger and White 2007; Stern 2012 citing DFID).


18
17
16
15



- Collaborating, Learning, and Adapting
- Agile M&E

What levels of certainty do we need for which kinds of decisions (and decision-makers)?

The framework

Evidence is judged on its contribution to the certainty with which we can predict the outcomes of a decision

1) Identify, quantify, and report sources of uncertainty and use evidence to reduce uncertainty
2) Identify consequences of all possible outcomes
3) Base decisions on uncertainty in consequences

Defining Uncertainty in Decision Making

- Parameter uncertainty
  - Imprecise estimates, measurement error
- Methodological uncertainty
  - Choice of methods, assumptions
- Variability in populations
  - From person to person, time to time, place to place
- Structural uncertainty
  - Uncertainty in the structure of the decision

Grutters, J. P. C., van Asselt, M. B. A., Chalkidou, K., & Joore, M. A. (2015). Healthy decisions: towards uncertainty tolerance in healthcare policy. *Pharmacoeconomics, 33*(1), 1-4. doi:10.1007/s40273-014-0201-7

Consequences of Uncertainty

Continuum of Consequences

We might kill people

We might waste money

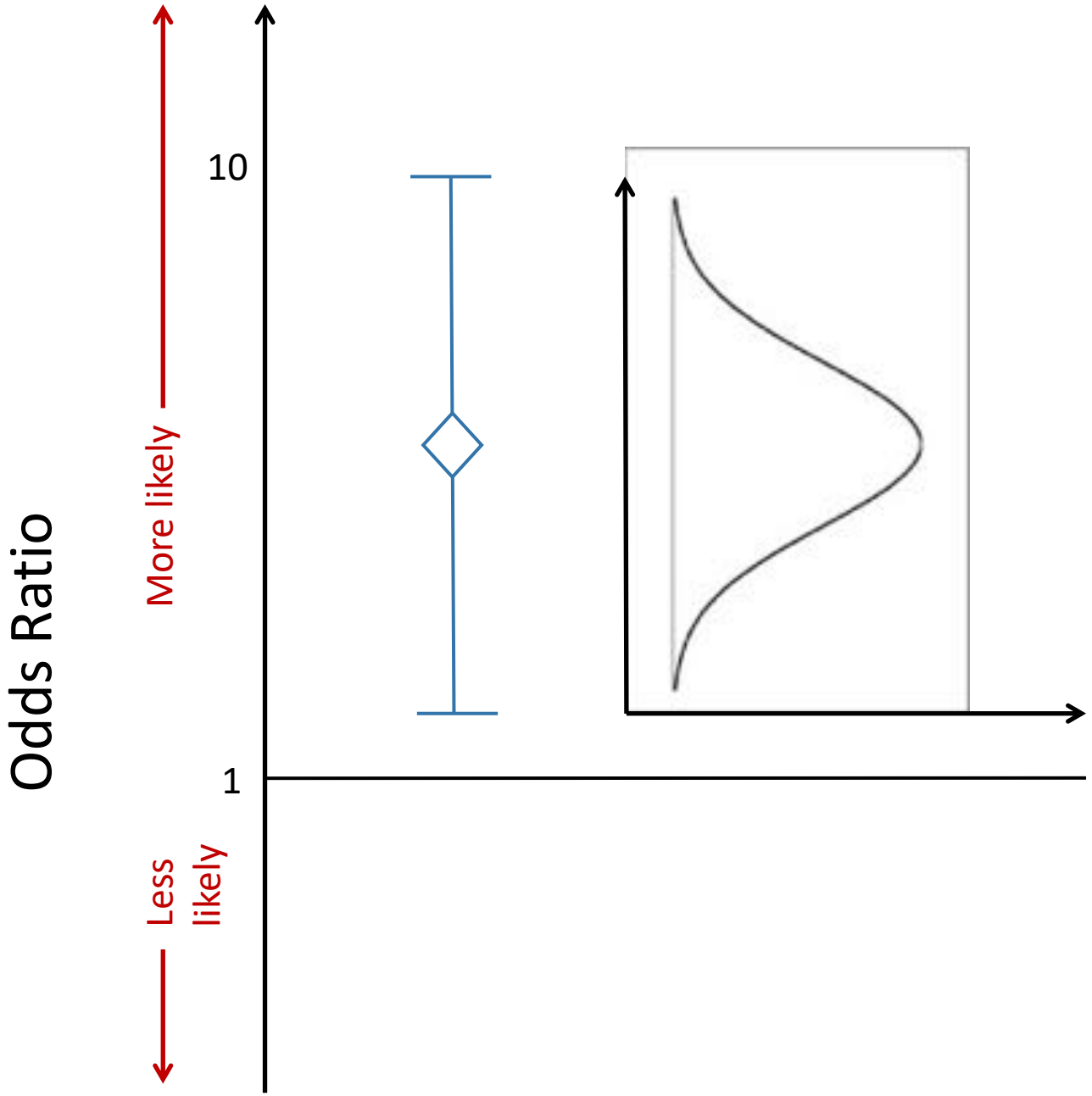
An arbitrary decision

Unequivocal evidence

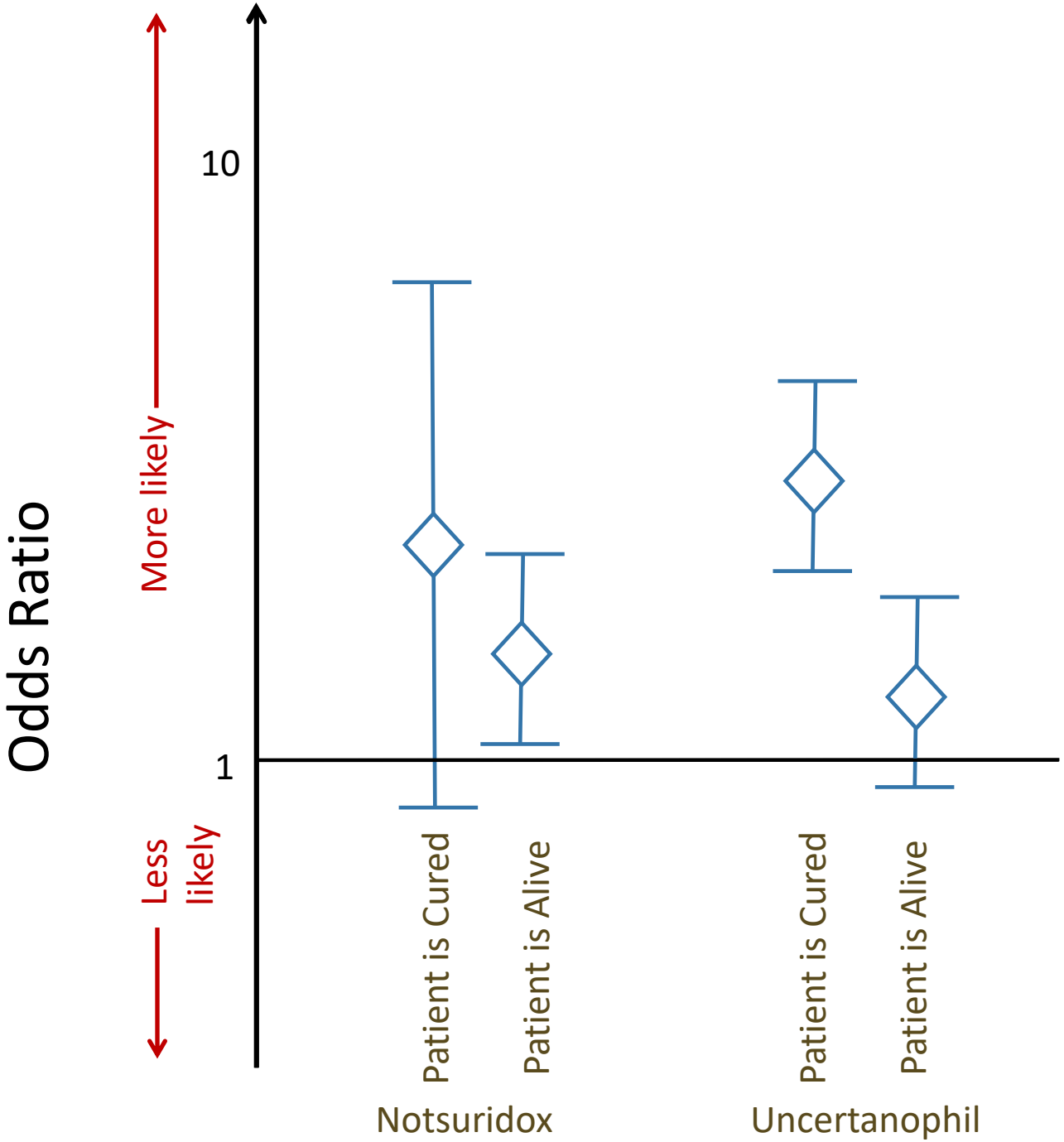
Assess imperfect evidence, act and measure

The Consequence of Uncertainty

Drug	Cure Rate	Death Rate
Notsuridox	0-70%	0%
Uncertanophil	40-50%	0-5%



This illustrates our level of certainty with an effect on one of the outcomes or consequences


Odds Ratio
More likely
Less likely
10
1
Patient is Cured
Patient is Alive
Patient is Cured
Patient is Alive
Notsuridox
Uncertanophil

Decision Theory

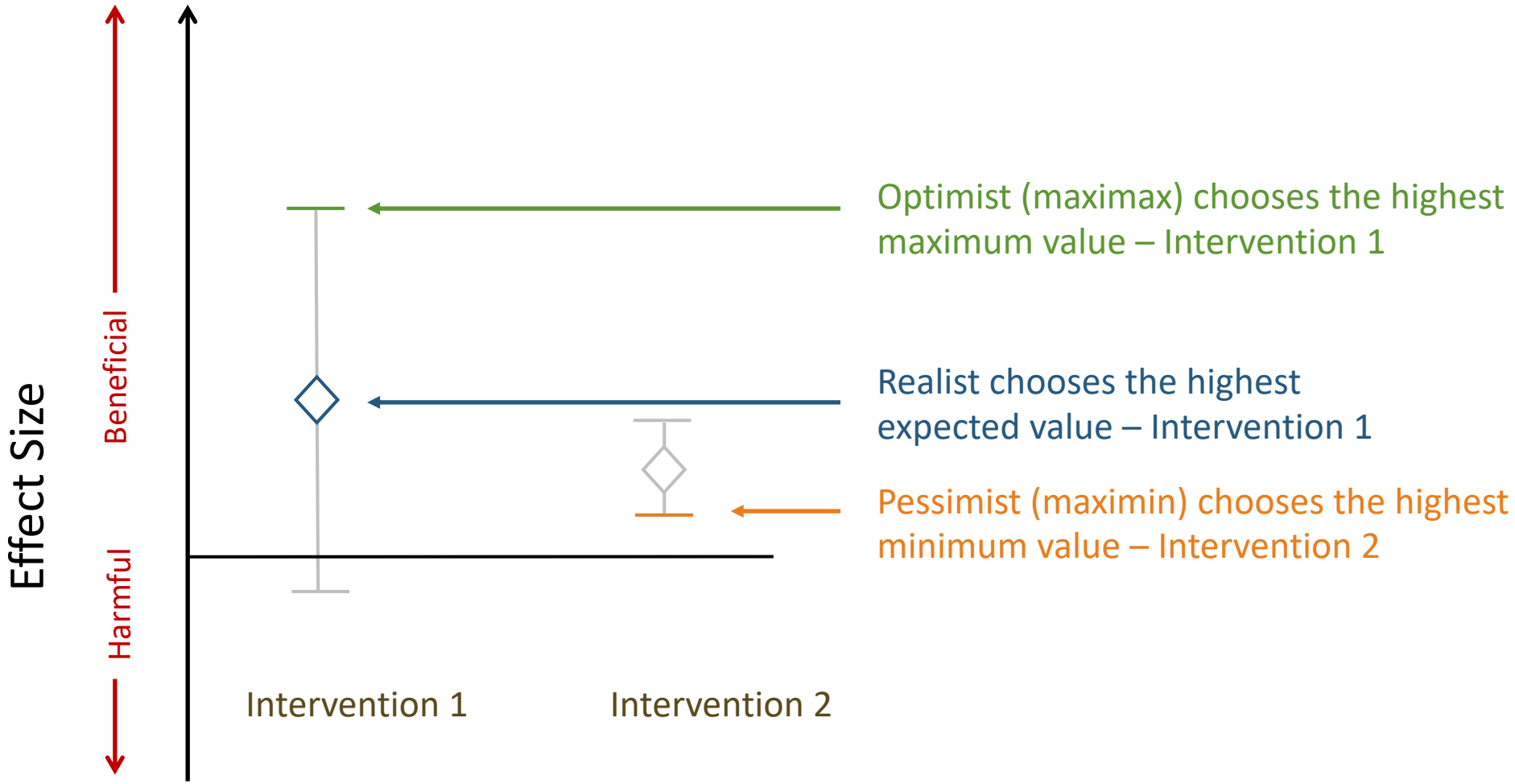
Expected Value
(realist)

Maximax
(optimist)

Maximizing the maximums
(best of the best)

Maximin
(pessimist)

Maximum of the minimums
(best of the worst)



Make this real example?

Utility

Expected utility = $\sum p(outcome)\ x\ value$

Utility Example – Folic Acid and Neural Tube Defect

Expected utility = $\sum p(outcome)\ x\ value$

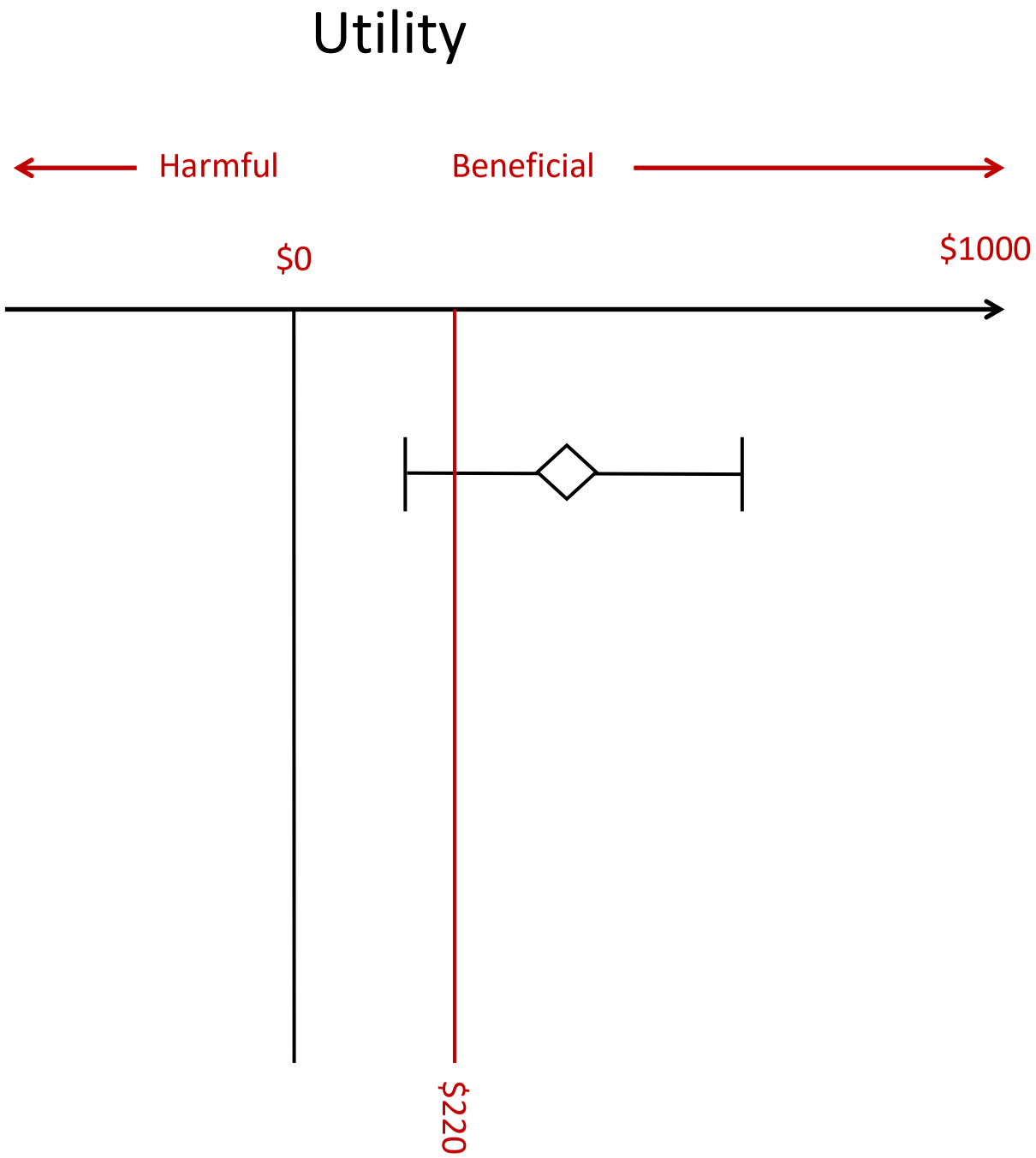
Without folic acid = 3.49% chance of NTD x $100k = $3,490

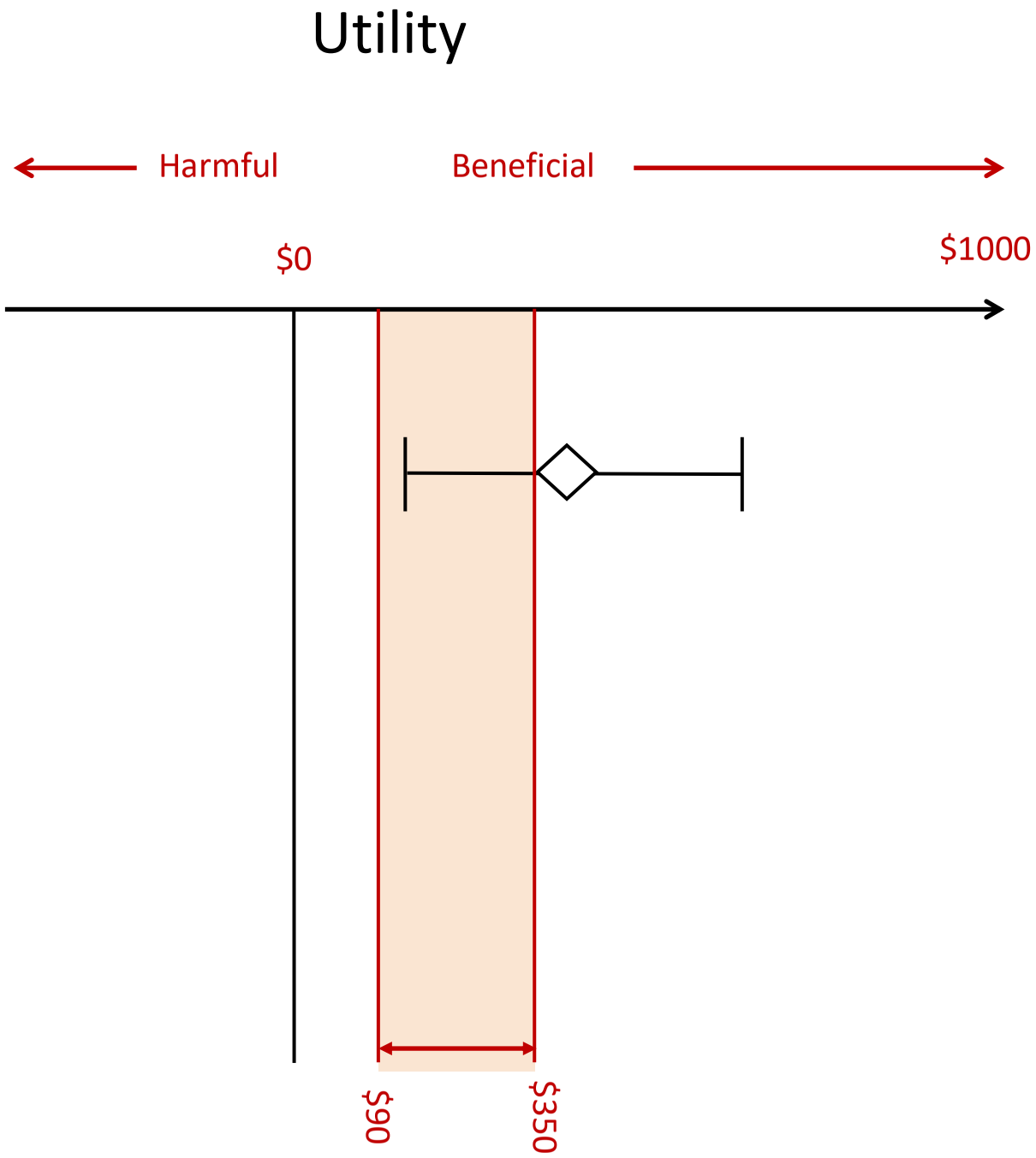
With folic acid = 1.01% chance of NTD x $100k = $1,010

$2,480

Taking folic acid is a rational decision if it costs less than $2,480

Ashby, D., & Smith, A. F. M. (2000). Evidence-based medicine as Bayesian decision-making. Statistics in Medicine, 19, 3291-3305.


Utility
Harmful
Beneficial
$0
$1000
$220


Utility
Harmful
Beneficial
$0
$1000
$90
$350

Implications

- Systematically consider all positive/negative intended/unintended outcomes of a policy (e.g., BetterEvaluation.org)
- Tolerate uncertainty in positive outcomes when you can rule out large negative effects / when costs are low
- Invest in improving certainty about the worst possible / most important outcomes
- Better cost estimates (less uncertainty in costs)

Attitude to Uncertainty

The Decision

- ‘Focusing Events’ and Policy Windows
- Emergencies
- What is the Alternative?

How Feasible is Better Evidence?

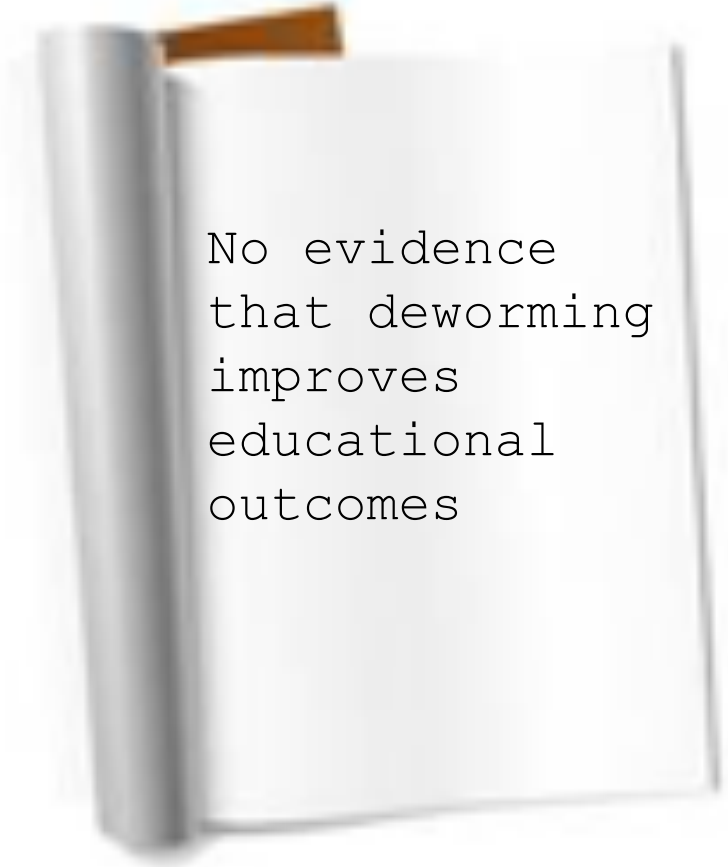
- Complexity
- Ethics

Attitude to Uncertainty

The Decision-maker

- Science vs. policy
- Attitudes to risk
- How much are you willing to pay for greater certainty?

The Impact of Deworming on Education



Cochrane Review

J-PAL

Consequences of School-Based Deworming

- Deworming - > Improved education — Less certain
  - Causal model: worms - > anemia -> poor concentration
  - Context dependent
  - Impact for sub-groups in RCTs (high worm loads, stunted)
- Deworming - > No serious side effects — Certain
- Deworming - > Improved health — More certain
- Deworming - > Low cost — More certain

(But relatively easy to evaluate)

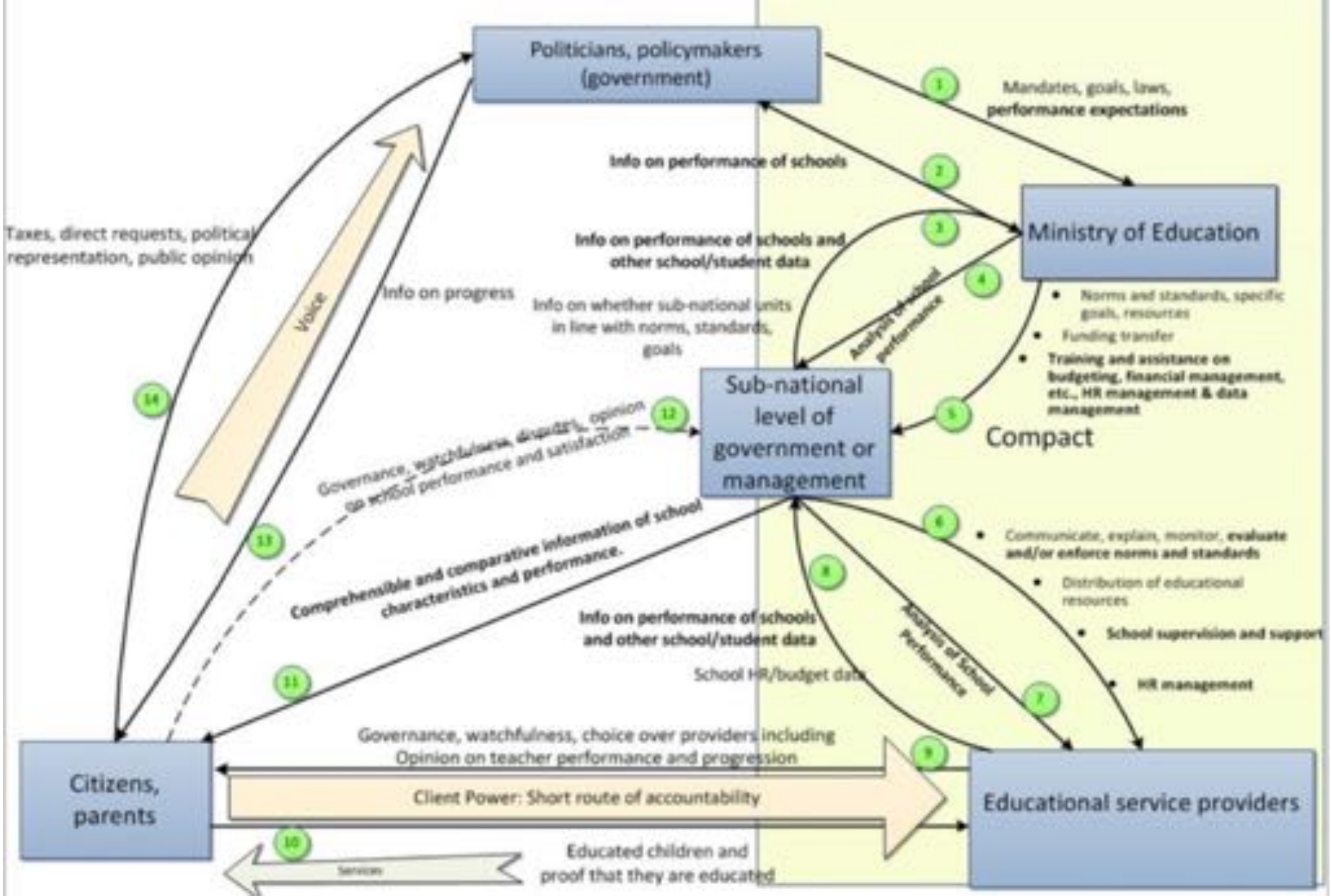
Bundy, Kremer, Bleakey, Jukes & Miguel (2009). Deworming and development: asking the right questions, asking the questions right.

Sources of Uncertainty

Sources of Uncertainty

- Identify them
- Quantify them
- Report them

The efficacy of a future policy decision cannot be described by a single parameter estimate


Politicians, policymakers (government)
Mandates, goals, laws, performance expectations
Info on performance of schools
Ministry of Education
Info on performance of schools and other school/student data
Taxes, direct requests, political representation, public opinion
Voice
Info on progress
Info on whether sub-national units in line with norms, standards, goals
Analysis of school performance
Norms and standards, specific goals, resources
Funding transfer
Training and assistance on budgeting, financial management, etc., HR management & data management
Sub-national level of government or management
Compact
Governance, watchfulness, disputes, opinion on school performance and satisfaction
Comprehensible and comparative information of school characteristics and performance.
Communicate, explain, monitor, evaluate and/or enforce norms and standards
Distribution of educational resources
School supervision and support
HR management
Analysis of School Performance
Info on performance of schools and other school/student data
School HR/budget data
Governance, watchfulness, choice over providers including Opinion on teacher performance and progression
Citizens, parents
Client Power: Short route of accountability
Educational service providers
Services
Educated children and proof that they are educated

Uncertainty in Scaling

Efficacy studies

p(program works at scale) = p(pilot program works)
x p(pilot conditions replicated at scale)

Effectiveness studies

Uncertainty in Scaling

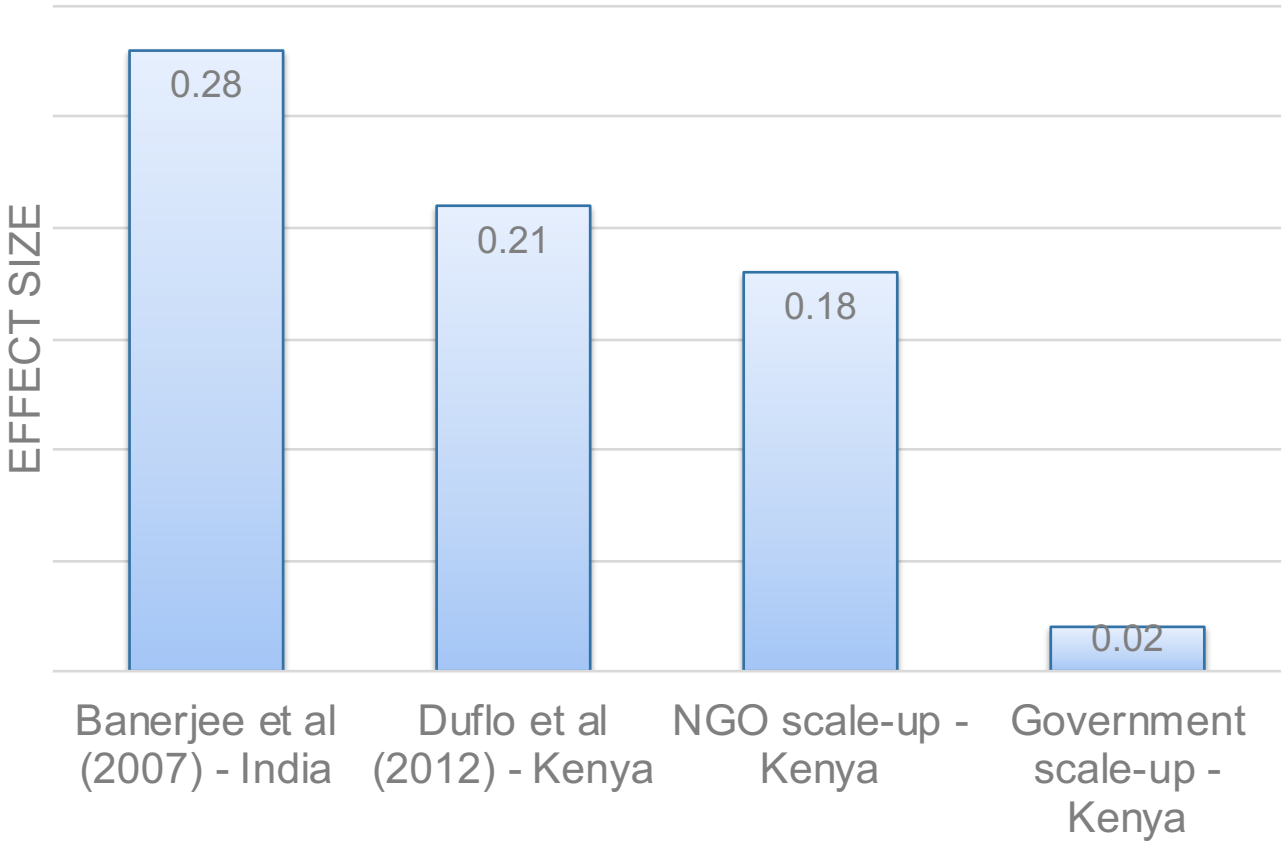
p(program works at scale) = p(pilot program works)

x p(pilot conditions replicated at scale)

?

Efficacy Vs. Effectiveness

The impact of hiring contract teachers on student achievement



Bold et al, 2018

Uncertainty in External Validity

$$ for precision, high bar for evidence

p(program works here) = *p*(program worked there)

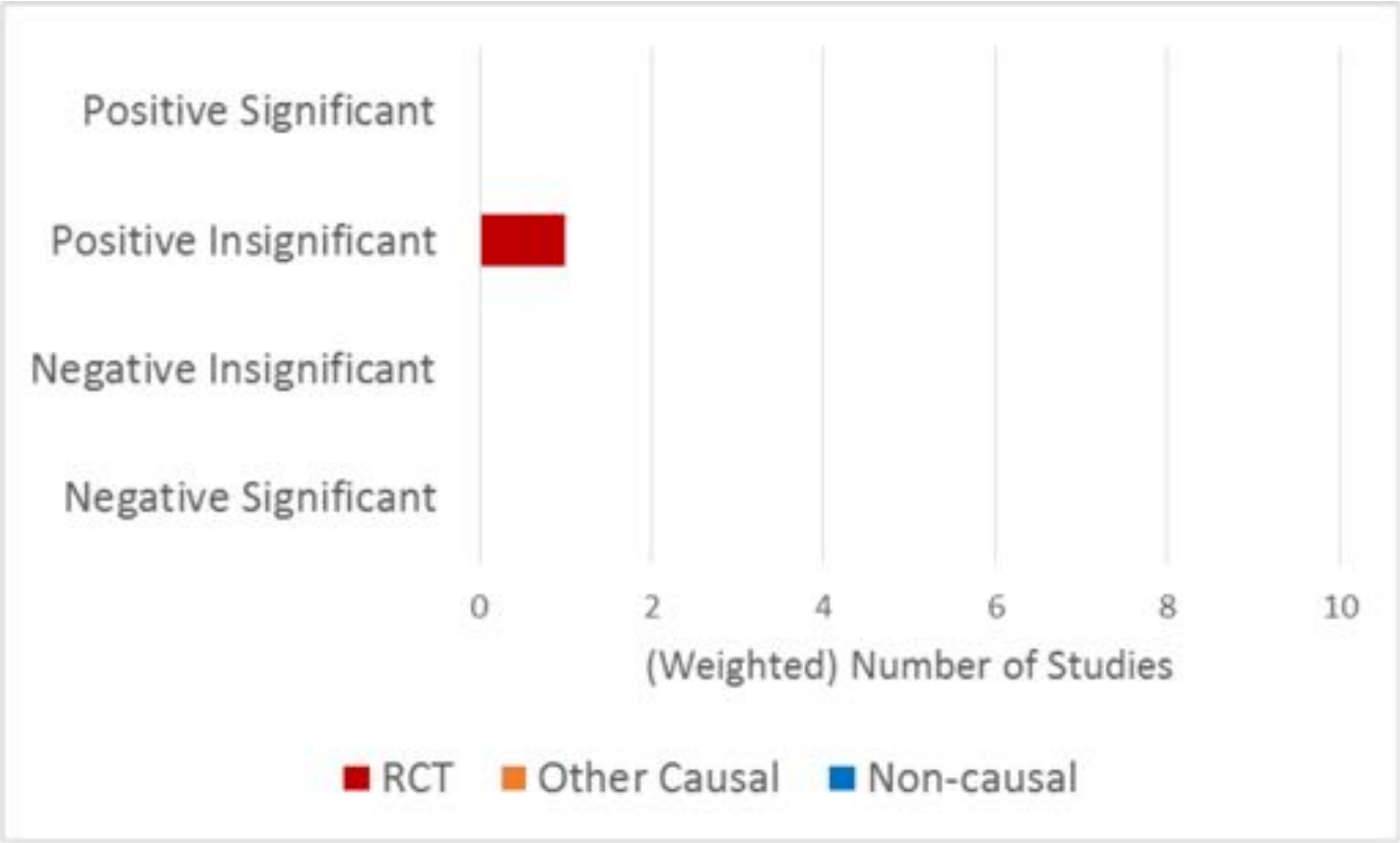
x *p*(here is similar to there)

?

"by identifying the *mechanisms* by which the intervention works and characteristics of the *context* that will trigger or enable the mechanism to work"

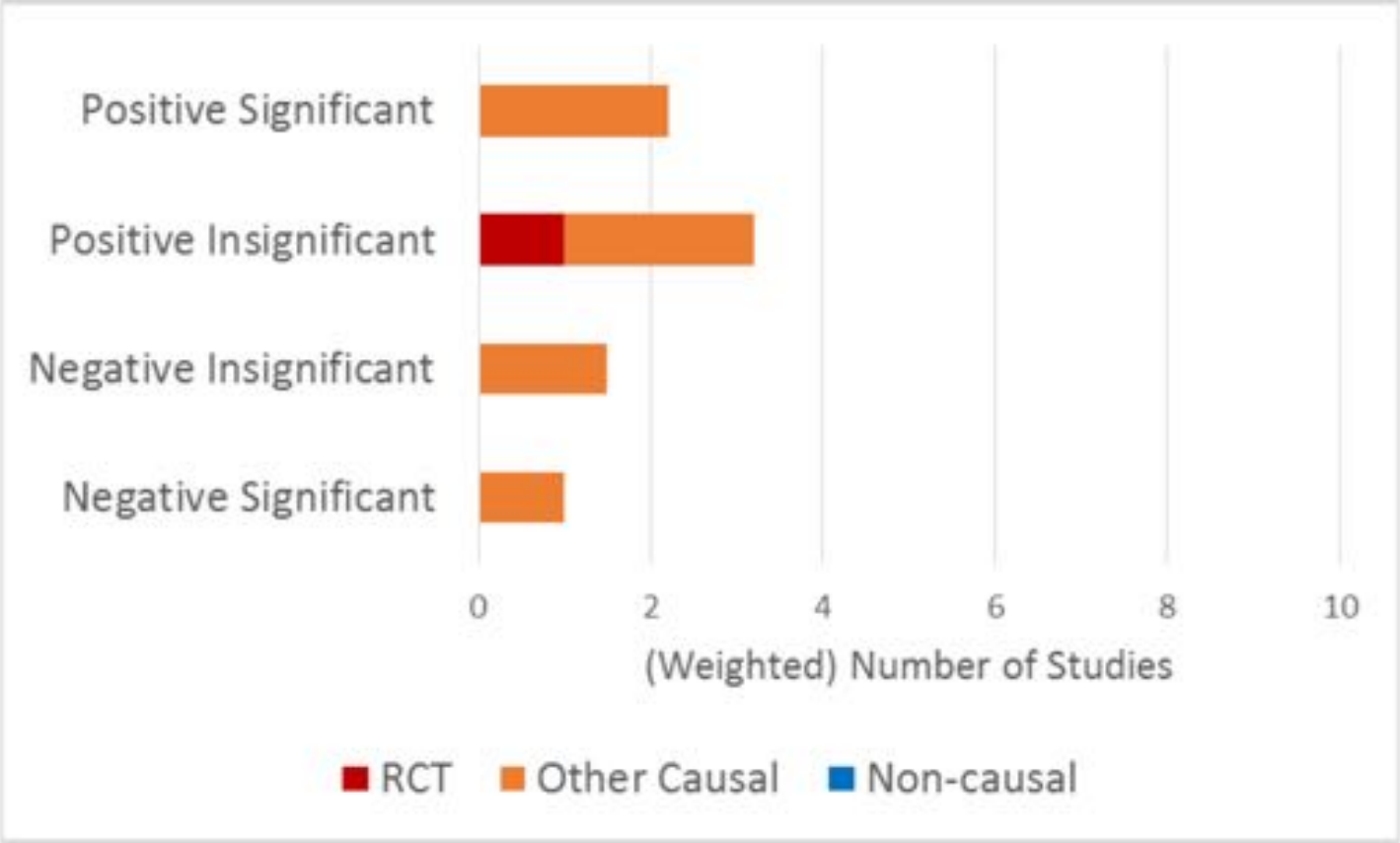
Davey, C., Hargreaves, J., Hassan, S., Cartwright, N., Humphreys, M., Masset, E., . . . Bonell, C. (2018). Designing evaluations to provide evidence to inform action in new settings. Paper presented at the CEDIL (Centre for Excellence in Development Impact and Learning) Inception Paper Launch, London, UK.

Effect of Reducing Class Size on Achievement



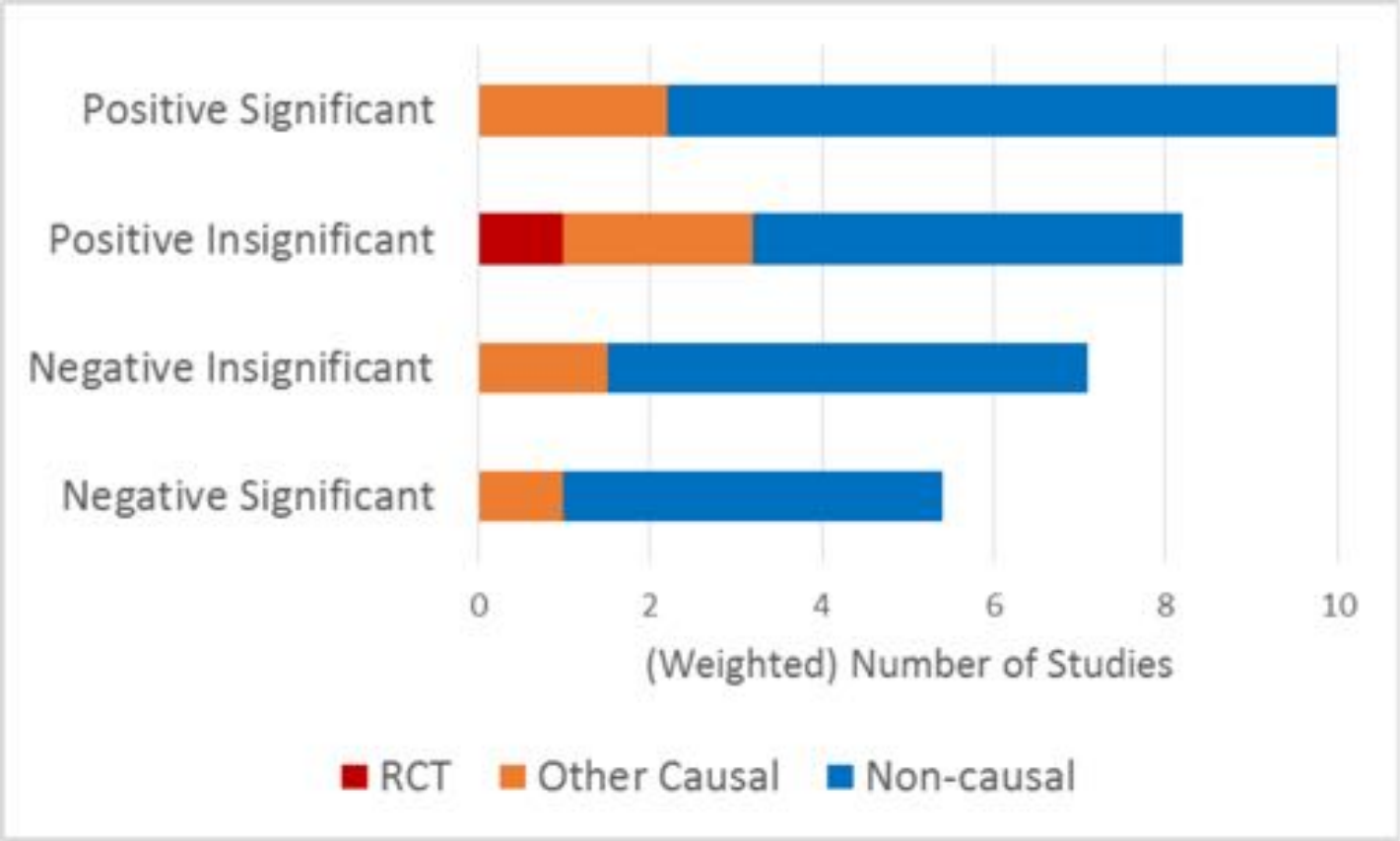
Pritchett and Sandefur (2013)

Effect of Reducing Class Size on Achievement



Pritchett and Sandefur (2013)

Effect of Reducing Class Size on Achievement



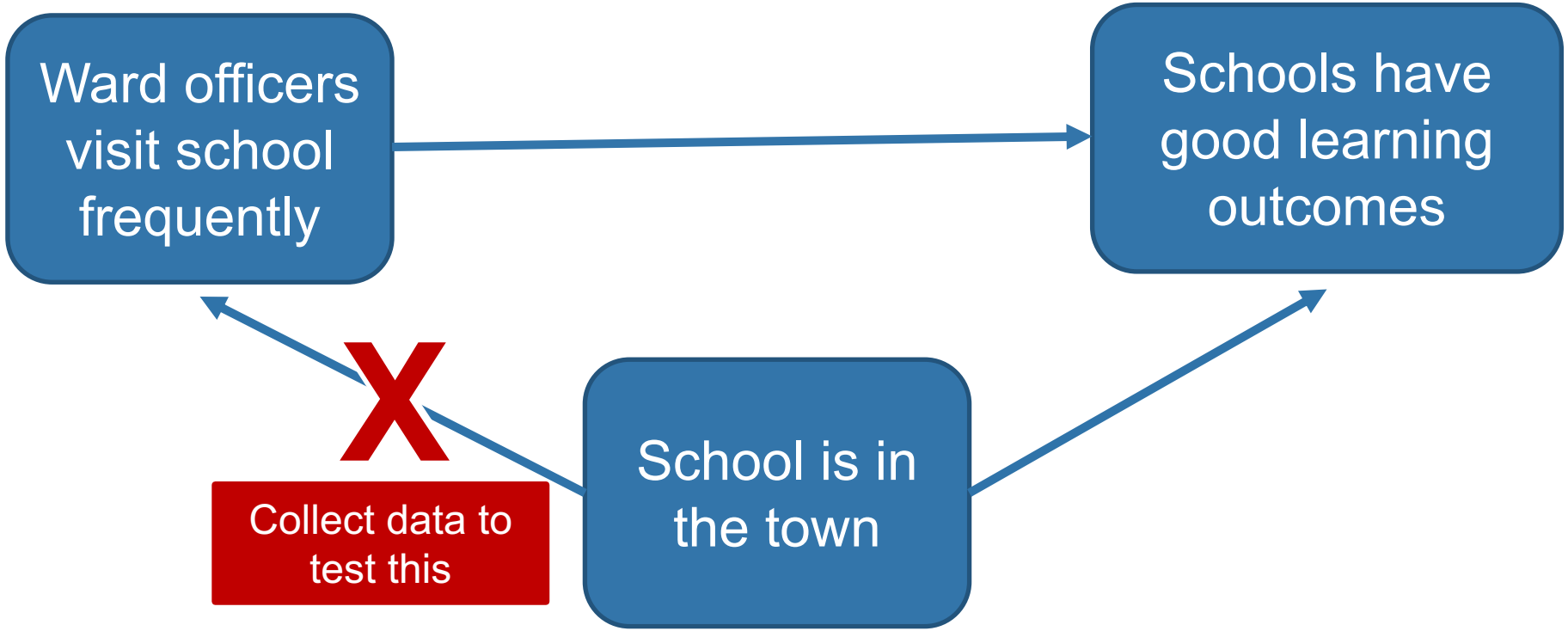
Pritchett and Sandefur (2013)

Does Reducing Class Size Improve Student Learning?

"A bad estimate from the right place is better than a good estimate from the wrong place"

Pritchett and Sandefur (2013)

Uncertainty from Methods/Assumptions



See, e.g., process tracing; also Cook, T. D., and Campbell, D. T. *Quasi-Experimentation*. Boston: Houghton Mifflin, (1979).

Testing Assumptions

Effect of Ward officer visits on outcomes

= Estimated effect x *p*(assumptions are true)

Bayesian Methods to Combine Uncertainty Estimates

Methods exist:

1. to produce quantitative uncertainty estimates from qualitative data
2. to combine uncertainty estimates from difference sources

Straw in the wind

Smoking gun

Hoop

Doubly decisive

Humphrys & Jacobs (2015). Mixing Methods: A Bayesian Approach. *American Political Science Review*

Implications

Language of Uncertainty

- Diagnose and deconstruct
- Quantify
- Report

Evidence Reviews to Inform Action

- Contexts for action on inconclusive evidence
  - Timebound decisions
  - Evidence difficult to improve
- Certainty about important, negative outcomes
- Quantify and communicate uncertainty about positive outcomes

Evaluations to Inform Evidence Base

- Aim to reduce uncertainty in a policy decision / program effectiveness – especially where there are large consequences

Caveats

- Evidence that something doesn’t work vs. ‘inconclusive evidence’
- Not about lowering the bar, but making better use of what’s underneath the bar
- How feasible is it to quantify uncertainty? More examples needed…

Taking Action

- Policy Diversification
- Small Bets
- Problem-driven iterative adaptation (PDIA)

Manski, C. (2013). Public Policy in an Uncertain World.

Andrews, M., Pritchett, L., & Woolcock, M. (2012). Escaping Capability Traps through Problem-Driven Iterative Adaptation (PDIA).

Monitoring Programs

- Focus on where a data provide the most information (addressing the biggest unknowns with the largest consequences)

- Bayesian approach – start with a prior, update with data

“is evidence informative?”

Thanks!

mjukes@rti.org

@matthewchjukes