



Cost Effectiveness of New Diagnostics for TB

David Bishai, Megan O'Brien, David Dowdy
Johns Hopkins University

October 10, 2007

Outline

•Objectives

–What combinations of sensitivity and price would result in a new test being

- A) A better thing than smear in places that don't have smear?
- B) A worthwhile addition to smear in places that have smear

•Methods

–Decision tree analysis

–Parameters and Assumptions

•Results for South Africa, Kenya, and Brazil

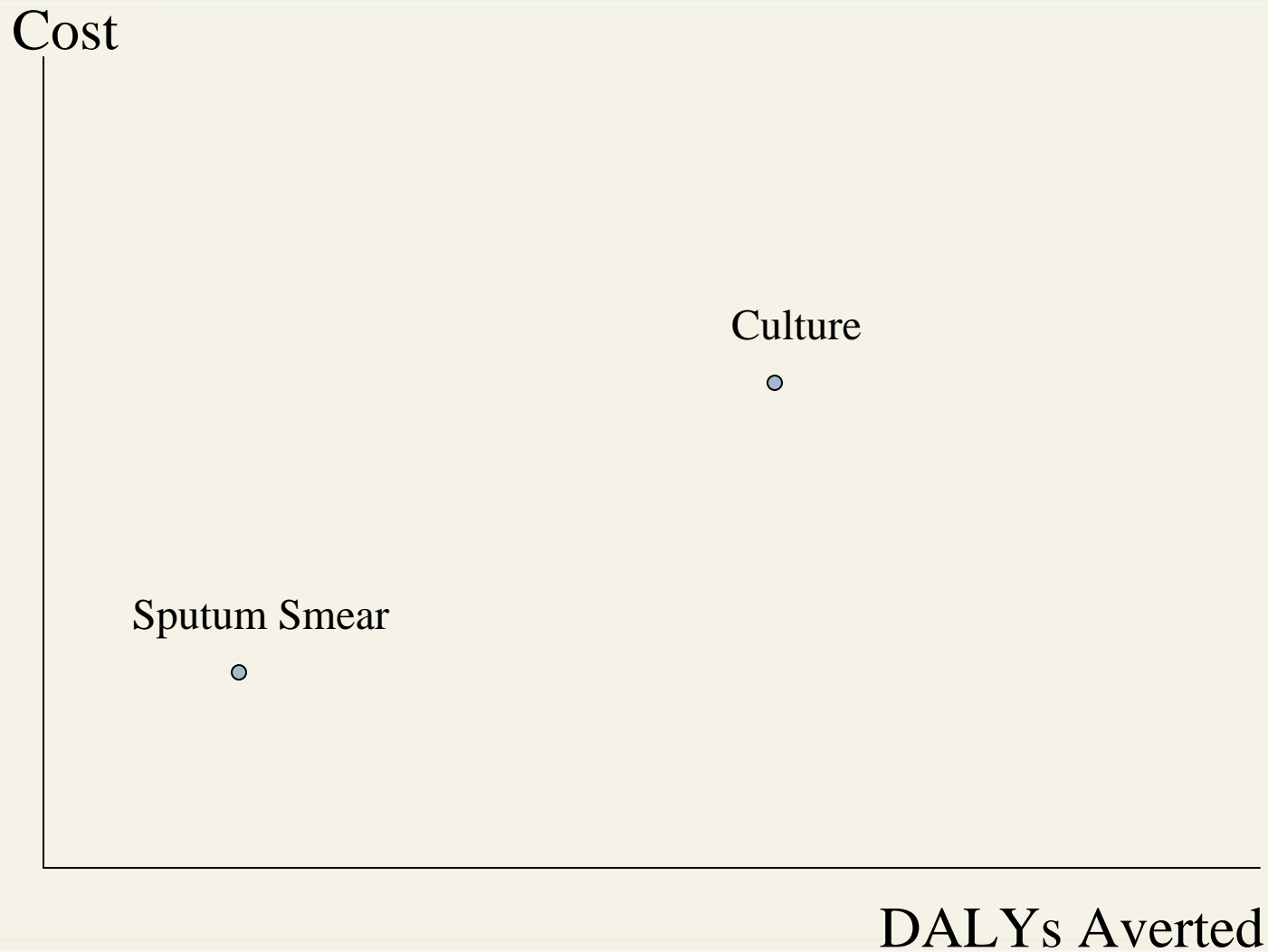
Rationale

- Sputum smear remains the principal diagnostic test in many low income countries
 - Smear sensitivity is low
 - Low sensitivity can delay diagnosis and lead to secondary spread
 - Smear cost is low
 - Low cost inhibits the introduction of new diagnostics
- New TB diagnostics have to be at least as good as smear and have acceptable cost
 - What are the acceptable tradeoffs?

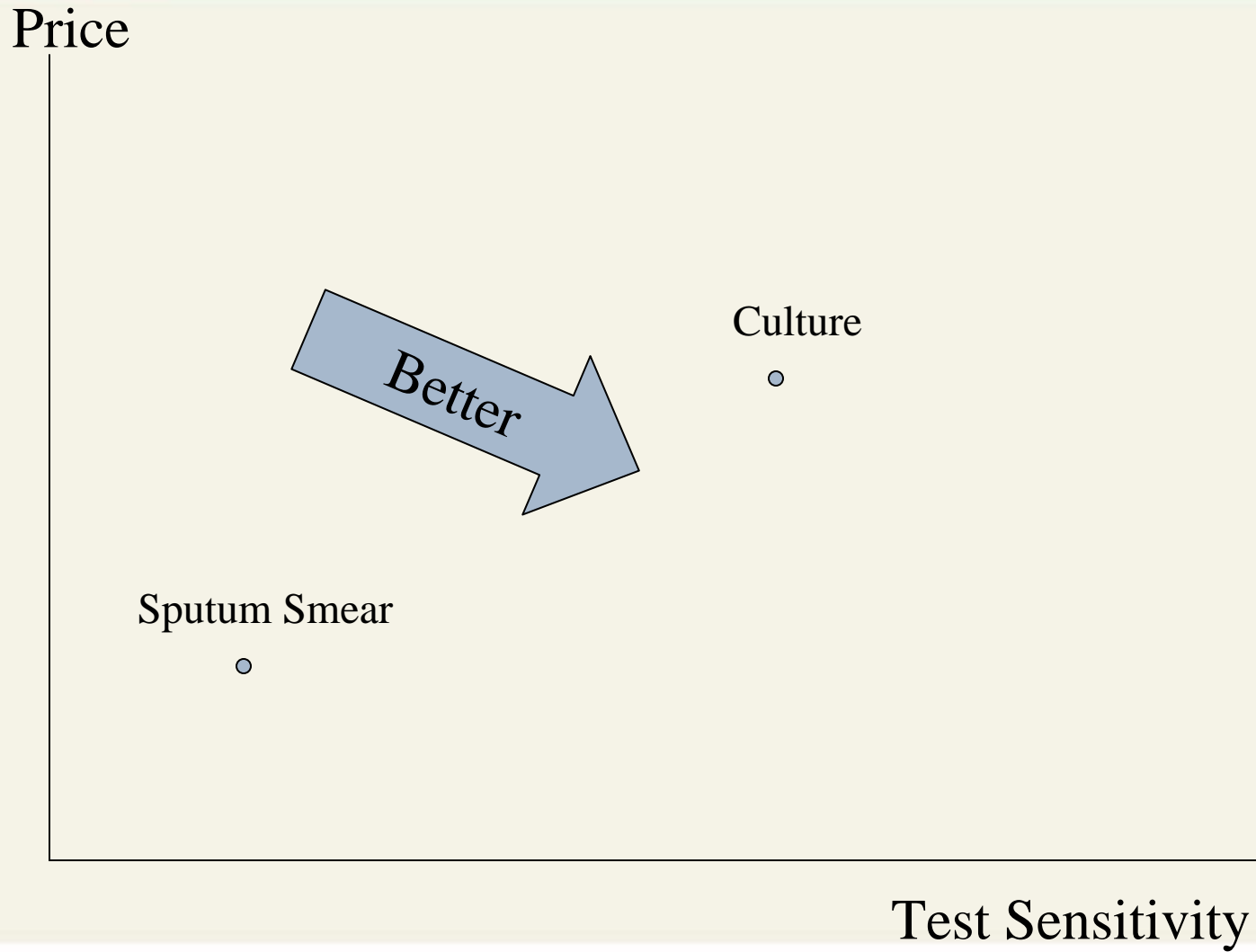
Methods

- Use decision tree analysis to estimate the number of disability adjusted life years (DALYs), secondary cases, and costs that would ensue from:
 - Trying to diagnose TB with no tests, not even smear
 - Smear
 - A hypothetical new test
 - Smear plus a new test
- Plot results in costs vs. effects space

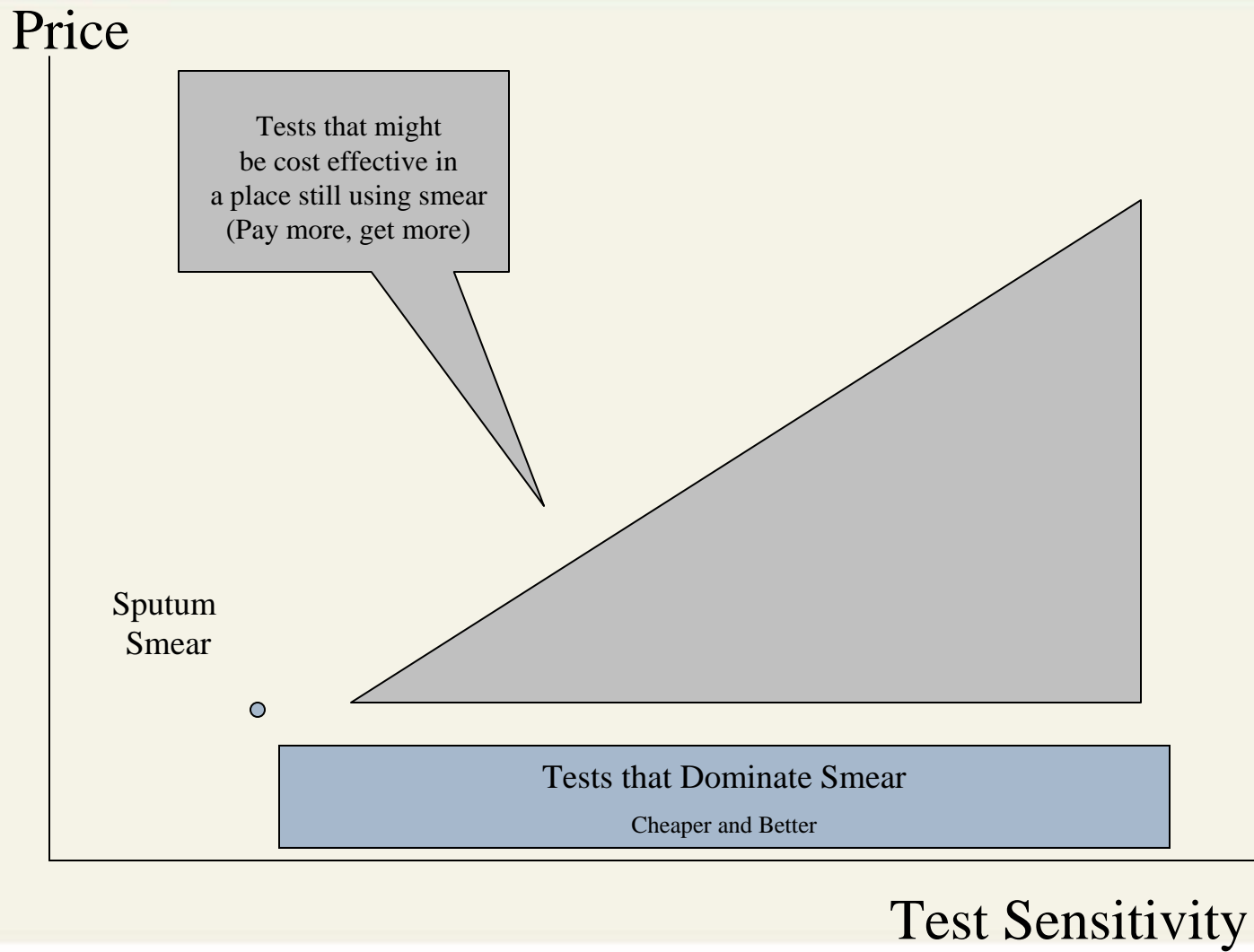
Cost-Effects Space



Price-Sensitivity Space



Price-Sensitivity Space



Model Assumptions I

WHO country-specific estimates of:

Case detection and treatment success, by smear status

HIV prevalence in TB patients

TB mortality rates, treated and untreated

Cost of treating one TB case

Model Assumptions II

ASSA survival estimates for HIV-positives

TB suspects have equal life expectancy to newly-diagnosed Stage IV

1.83 years (no ART), 7.30 years (on ART)

UNAIDS estimates of HIV prevalence, antiretroviral access

Standard DALY weights for HIV and TB, add 0.1 for being on TB therapy

Murray CL, Lopez AD (1996) The global burden of disease. Boston: Harvard School of Public Health.

Actuarial Society of South Africa (2005) ASSA2003 AIDS and Demographic Model.

<http://www.assa.org.za/aids/content.asp?id=1000000449>.

Joint United Nations Programme on HIV/AIDS (UNAIDS) 2006 Report on the global AIDS epidemic. Geneva: UNAIDS.

Assumptions about New Test

- Point-of-care new TB diagnostic test
- No infrastructure requirements
- Sensitivity 50-90%
- Specificity 90-100%
- Price \$1-\$20/test



Scenario	Sensitivity of Full Diagnostic Algorithm for Tuberculosis					
	South Africa		Brazil		Kenya	
	<i>Highly Infectious</i>	<i>Less Infectious</i>	<i>Highly Infectious</i>	<i>Less Infectious</i>	<i>Highly Infectious</i>	<i>Less Infectious</i>
<i>Interventions in Areas with No Sputum Smear</i>						
Reference Standard, No Smear	0.67	0.67	0.69	0.69	0.52	0.52
New Test, No Smear	0.83-0.97	0.83-0.97	0.84-0.97	0.84-0.97	0.76-0.95	0.76-0.95
Sputum Smear, Newly-Implemented	0.91	0.67	0.92	0.69	0.87	0.52
<i>Interventions on a Country-Wide Basis</i>						
Reference Standard, Country-Wide	1.0	0.67	0.89	0.69	0.46	0.52
New Test, Country-Wide	1.0	0.83-0.97	0.94-0.99	0.84-0.97	0.73-0.95	0.76-0.95
TB Culture, Country-Wide	1.0	0.87	0.96	0.88	0.79	0.81

“New Test vs. Smear” Analysis

Incremental Cost per DALY averted compared to trying to make the diagnosis with clinical judgment alone:

Smear:

\$86 RSA, \$130 Brazil, \$37 Kenya

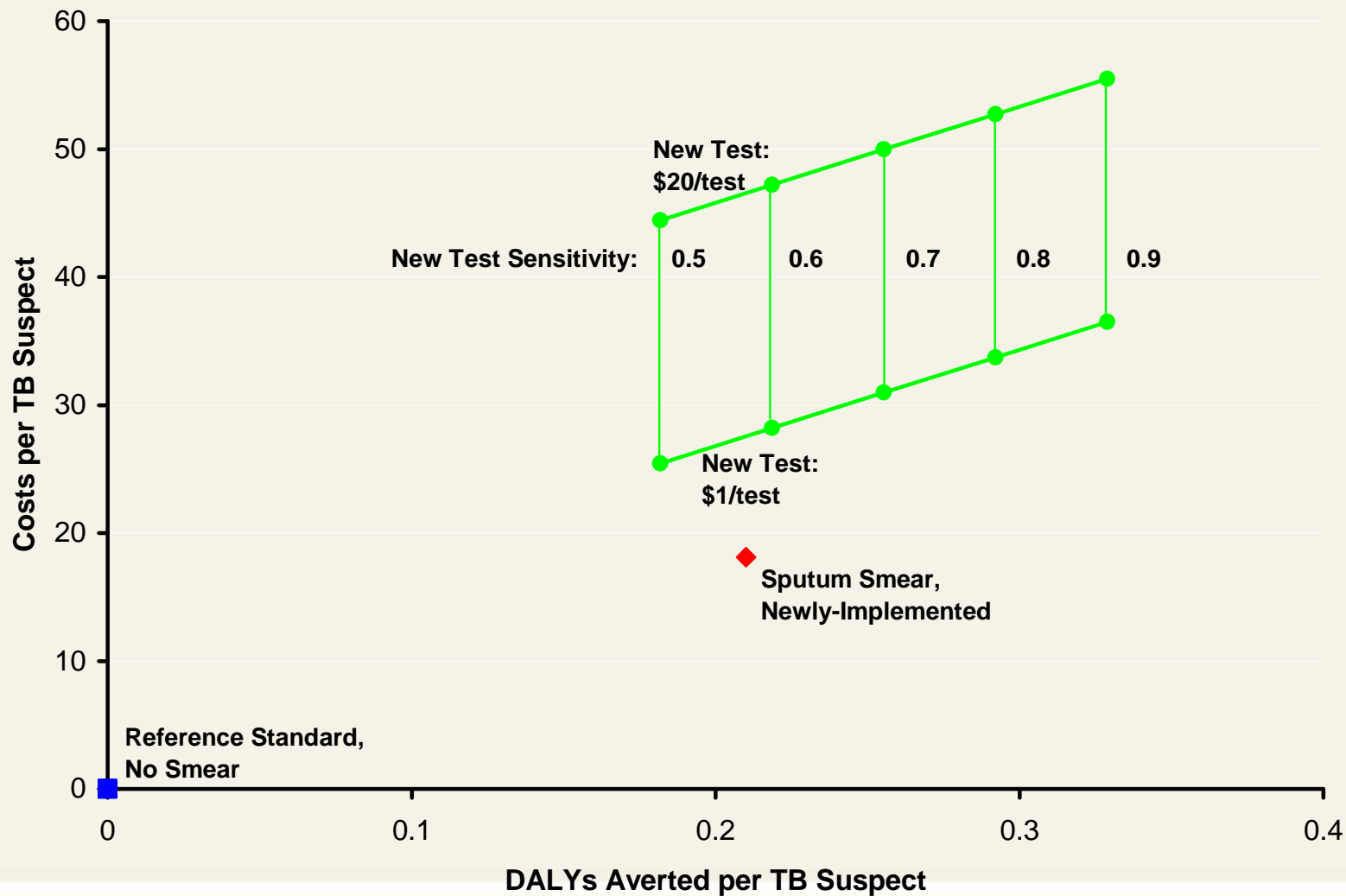
New Test (90% Sn, 95% Sp, \$1/test):

\$111 RSA, \$149 Brazil, \$48 Kenya

Improving sensitivity by 10%

costs \$36-75 per DALY averted

New Test: Pay more get more



Results:

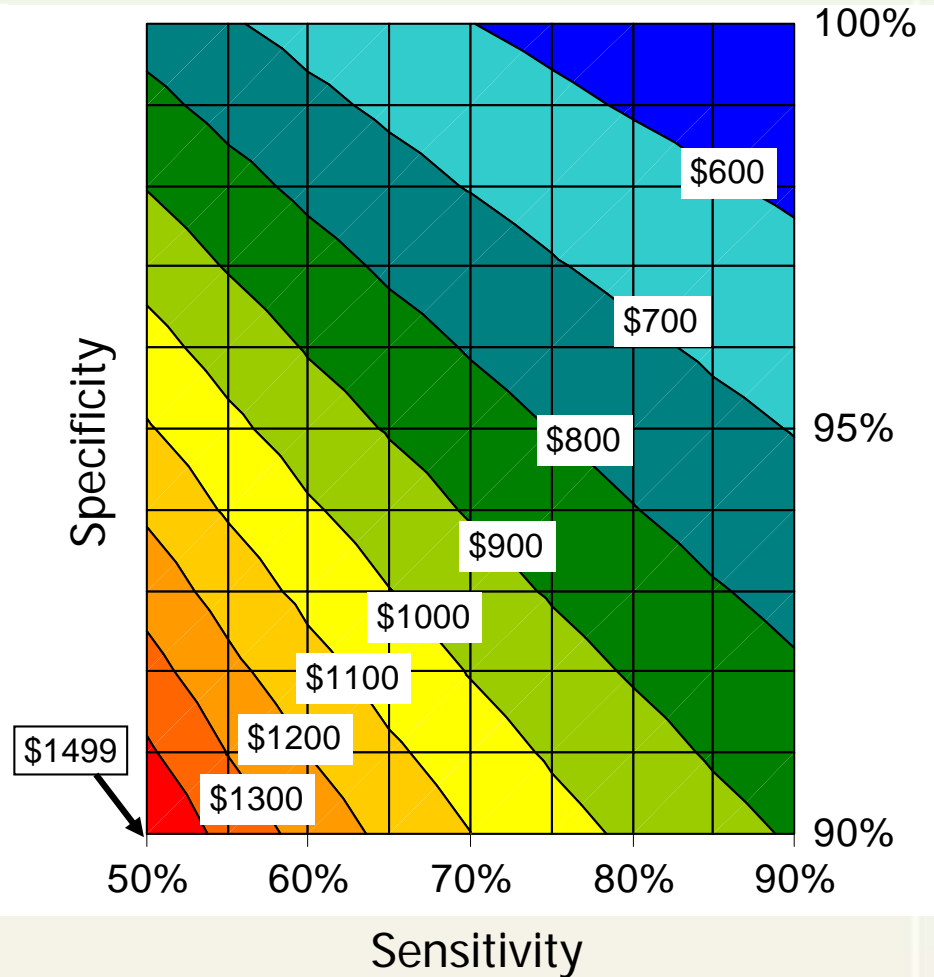
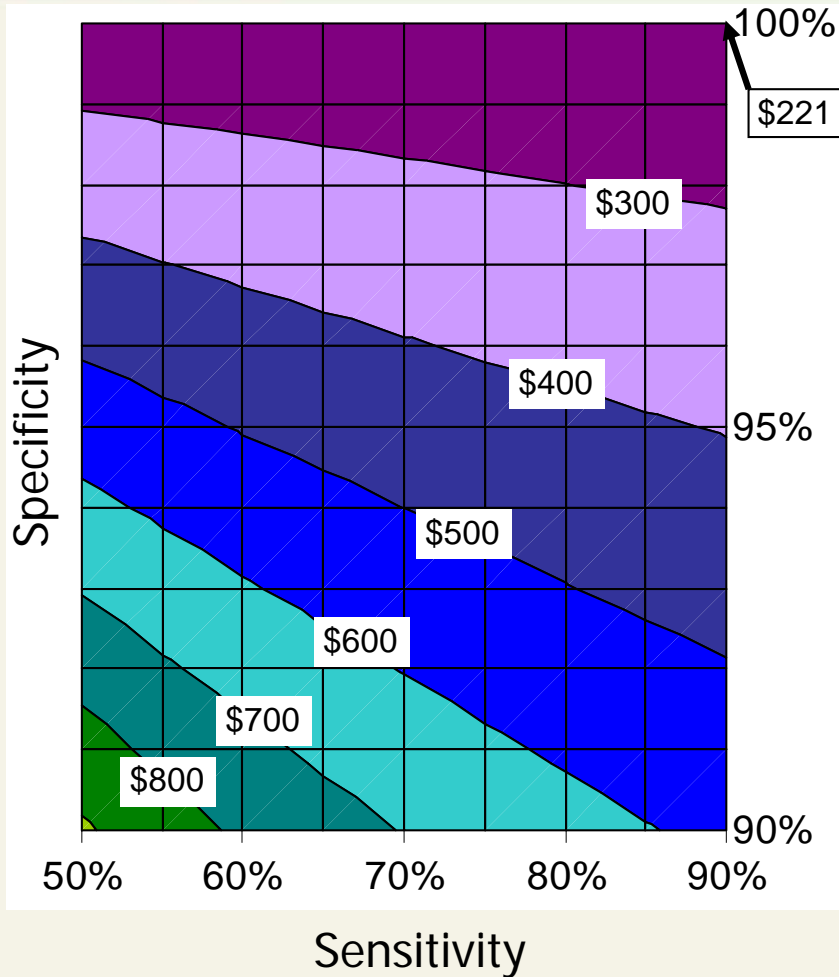
Adding New Test to Current Strategies

Country	Cost, per 1000 TB Suspects	New TB Diagnoses	DALYs Averted	Secondary Infections Averted	Cost per DALY Averted	Cost per Infection Averted
South Africa						
New Test	\$25,014	45	64	124	\$396	\$201
Culture	\$25,280	31	42	62	\$604	\$408
Brazil						
New Test	\$32,230	21	117	128	\$276	\$251
Culture	\$33,555	14	78	73	\$430	\$461
Kenya						
New Test	\$40,875	129	892	850	\$46	\$48
Culture	\$35,428	88	604	497	\$59	\$71

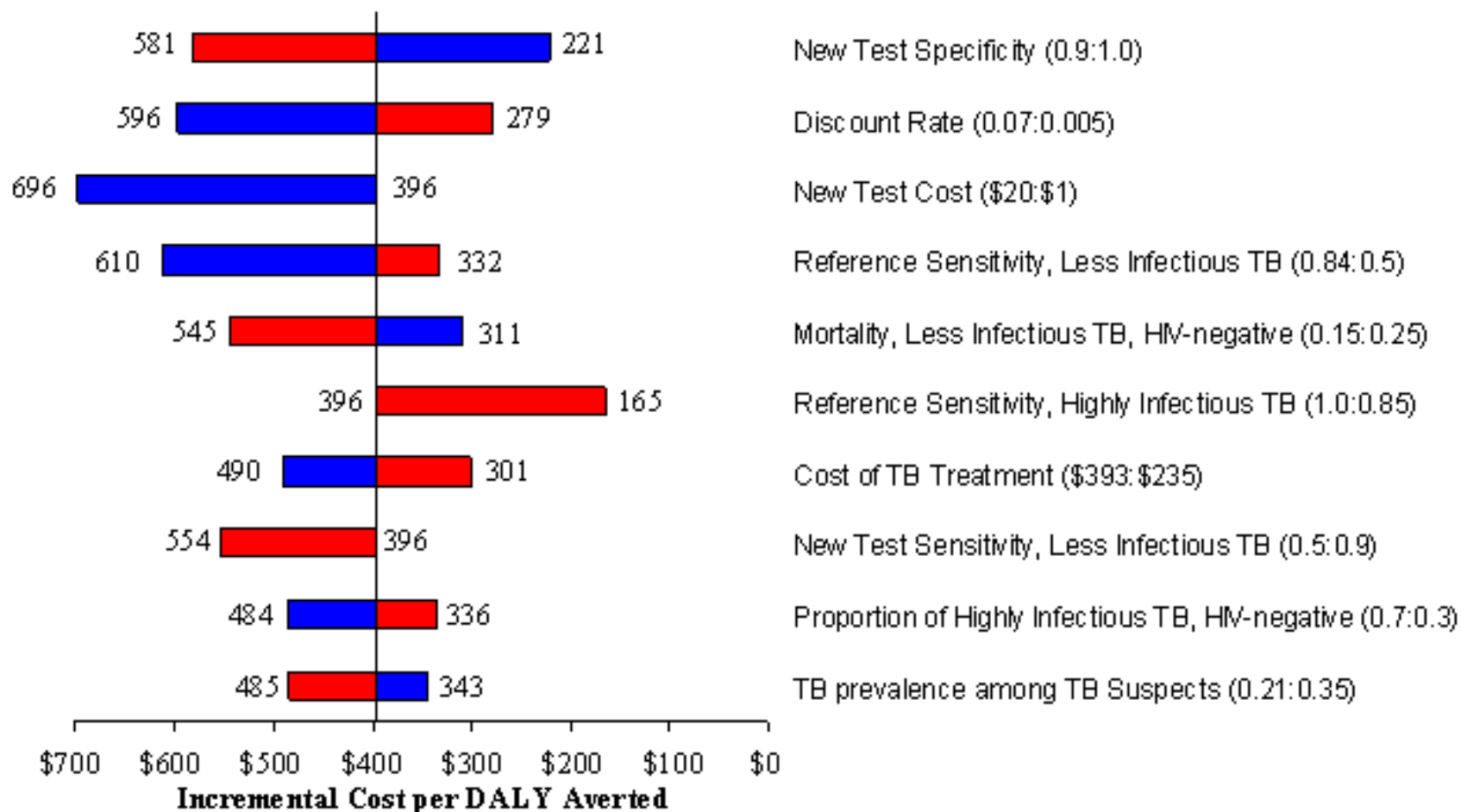
Variation with Sensitivity, Specificity, and Price

Price: \$1/test

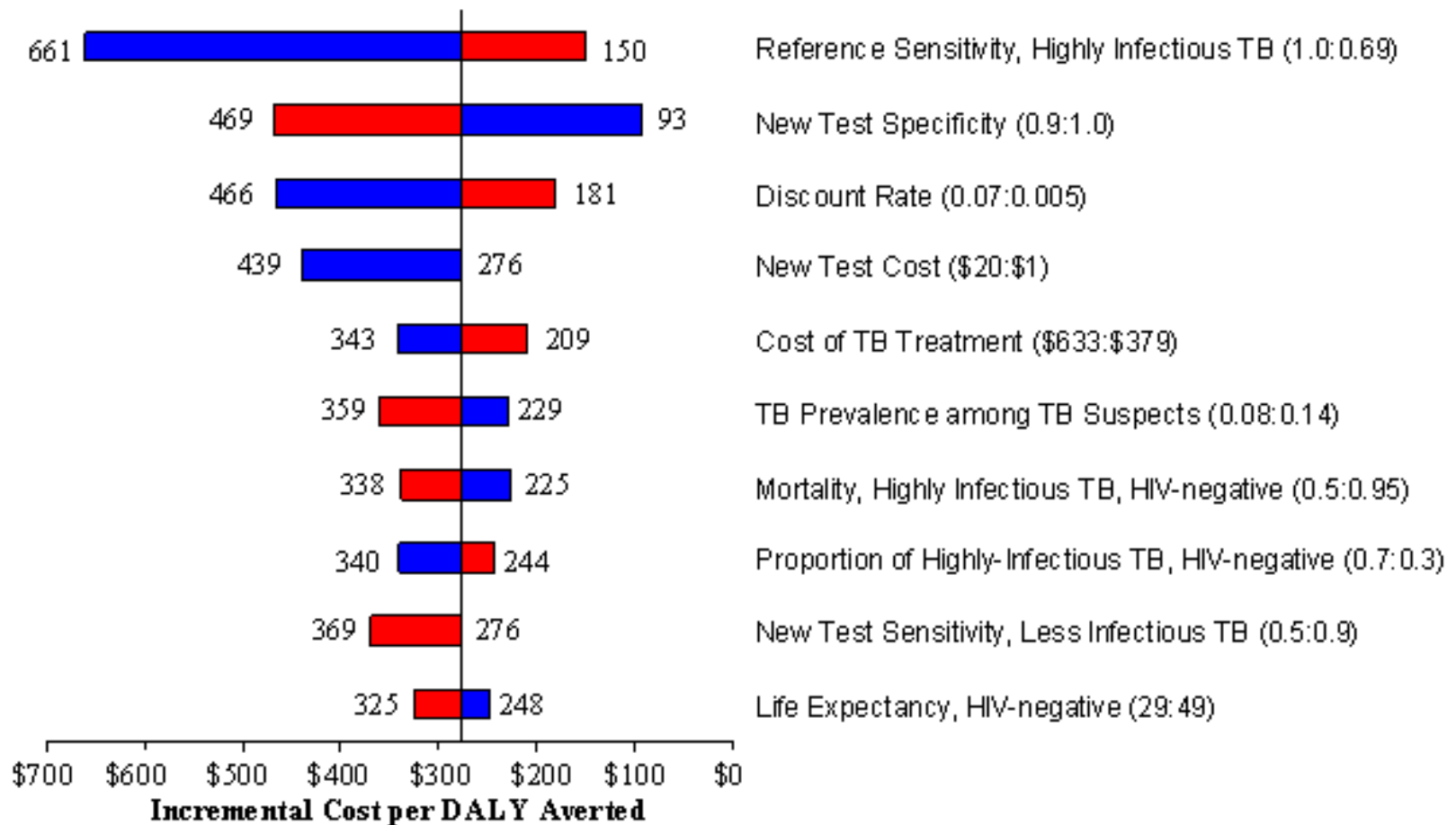
Price: \$20/test



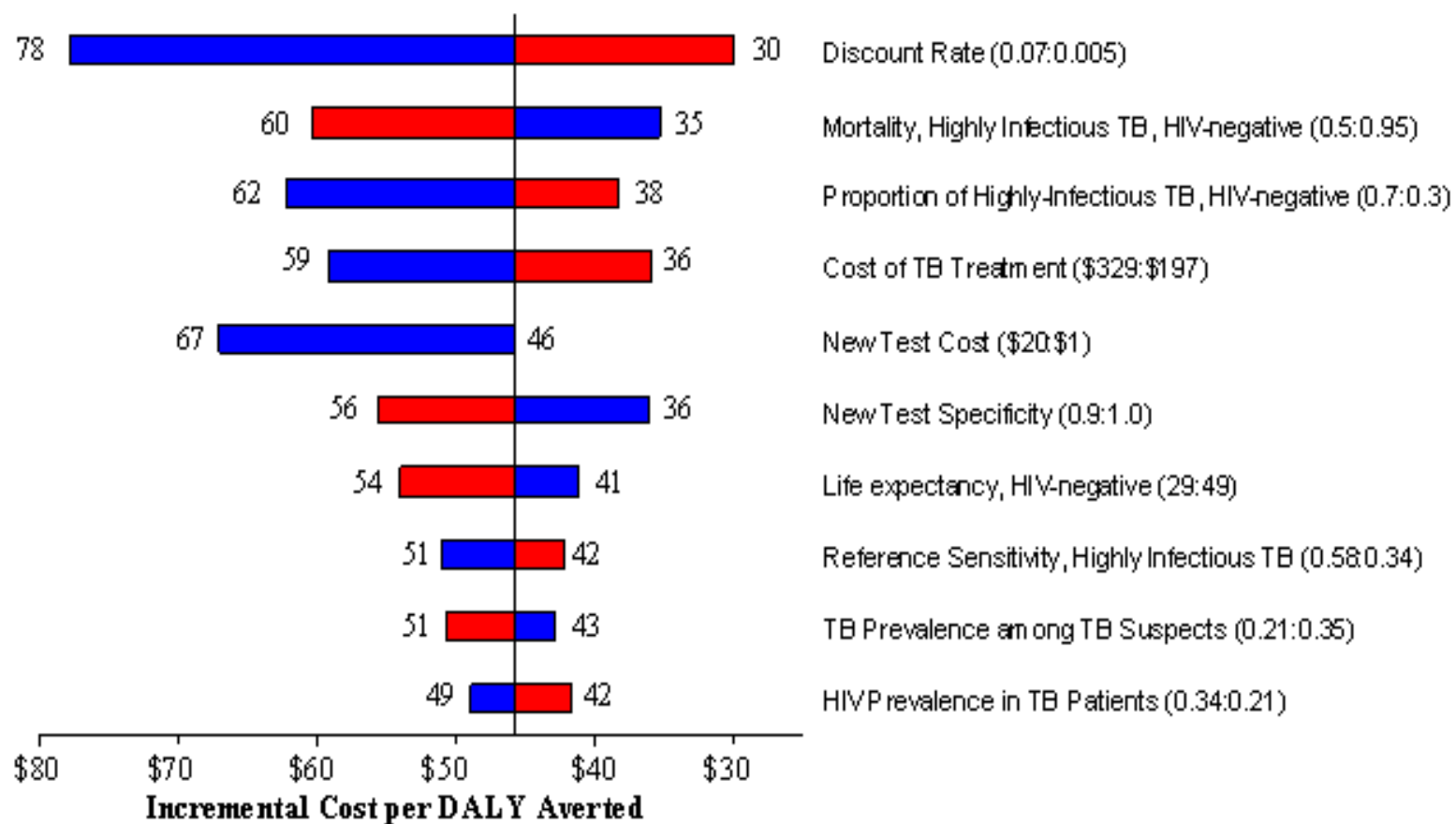
Sensitivity Analysis: South Africa



Sensitivity Analysis: Brazil



Sensitivity Analysis: Kenya



New Test vs. Smear

- Smear is more cost-effective...
 - Excellent specificity
 - Identifies “highest-yield” patients
 - New test needs >95% Sp, plus either >90% Sn or similar “auto-triage” property
- ...but new tests add value.
 - \$50-\$150 per DALY averted
 - Markedly increase number of TB diagnoses

Sensitivity vs. Specificity

- Point for point, specificity is more important to cost-effectiveness.
 - Especially if new tests are cheap
- Important to measure sensitivity in current false-negatives
 - Not just a lab measure

Is It Cost-Effective?

- Compare incremental cost effectiveness ratio (ICER) per DALY averted by new TB test to GDP/capita
 - ICER: \$396 (RSA), \$276 (Brazil), \$46 (Kenya)
 - GDP: \$13,000 (RSA), \$8,600 (Brazil), \$1,200 (Kenya)
- New Test most cost-effective where existing infrastructure is weakest

Limitations

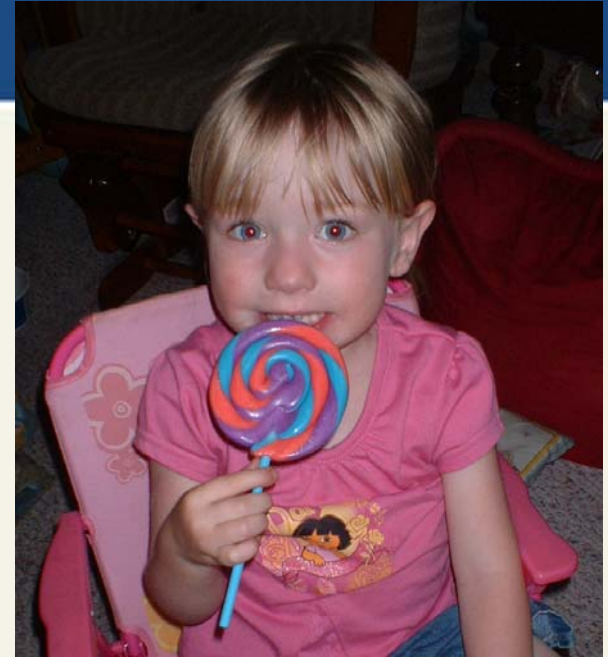
- **Analysis is not a societal perspective**
 - Neglects hospital costs, MD visits, etc.
- **Heterogeneous implementation**
 - Best facilities first?
 - Won't help if MD doesn't think of TB
- **Static model**
 - Neglects cumulative effects over time

Two Take-Home Messages

1. New TB diagnostic tests are likely to be highly cost-effective, even if not perfect.
2. Specificity, price, and existing level of infrastructure are key considerations.



Thanks!



BD Corporation

David Durack, Krista Thompson, Carole Jefferson, Bob Pearson,
Salman Siddiqi