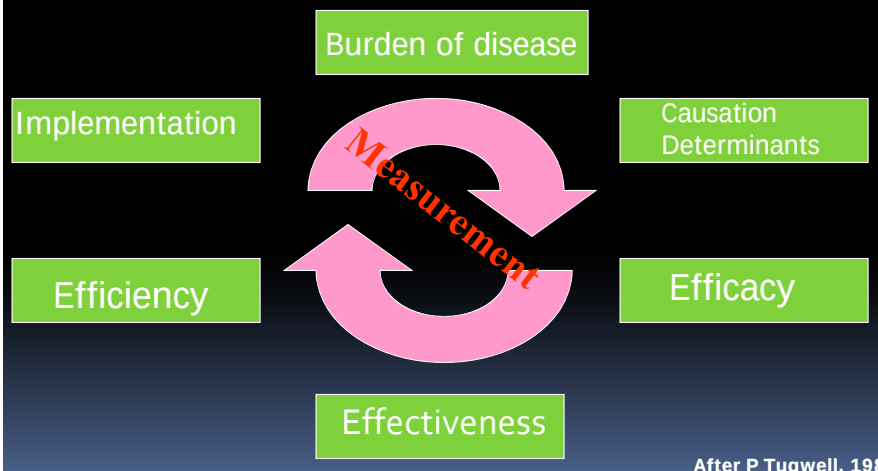
How do we value health and health interventions?

ECONOMIC EVALUATIONS IN HEALTH CARE

Hojoon Sohn, MPH
McGill University
dhjsohn@gmail.com

The Research Cycle



After P Tugwell, 1985

Agenda

- Basics of economics
- Types of economic evaluations & Concepts
  - 5 types of evaluations
- Epidemiology & Economics go hand in hand
  - Epinomics?
  - Person-level cost-effectiveness analysis
- A word of caution
- Questions?

1 OF 5

BASICS OF ECONOMICS

IT'S ABOUT CHOICES WE MAKE!

- **Economics**
  - The study of the **allocation of scarce resources** among alternative uses
- **Microeconomics**
  - The study of the economic choices individuals and firms make and how those choices create markets
- **Macroeconomics**
  - The study of the aggregate economic activity (performance, behavior, structure) of a nation or region

ECONOMIC MODELS

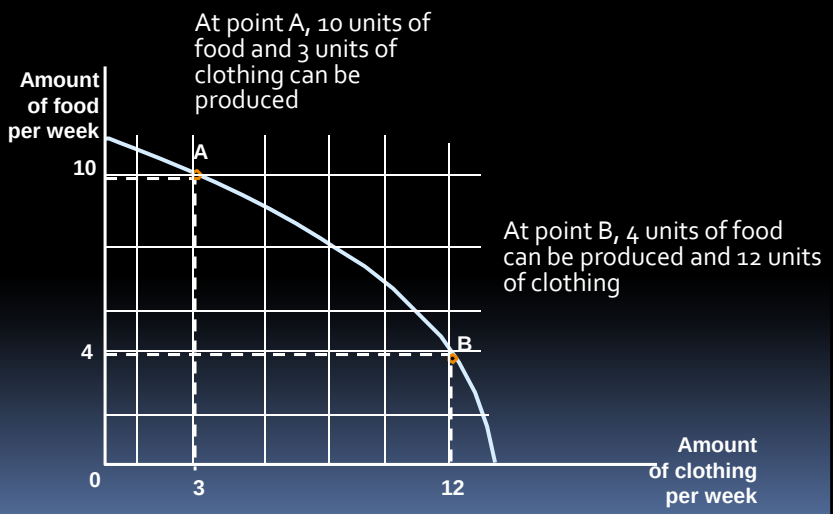
- Simple theoretical descriptions that capture the essentials of how the economy works
  - Used because the "real world" is too complicated to describe in detail
  - Models tend to be "unrealistic" but useful
    - While they fail to show every detail (such as houses on a map) they provide enough structure to solve the problem (such as how a map provides you with a way to solve how to drive to a new location)

HOW DO WE VALUE THINGS IN EOCNOMICS?

- **PRODUCTION POSSIBILITIES FRONTIER**
  - A graph showing all possible combinations of goods that can be produced with a fixed amount of resources

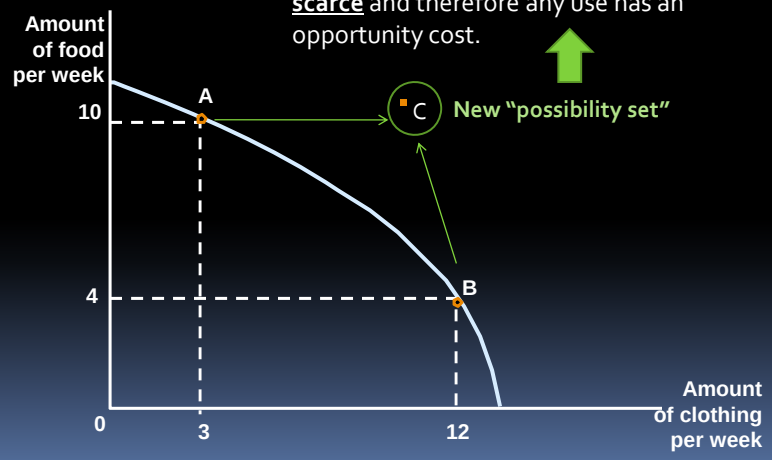
PRODUCTION POSSIBILITIES FRONTIER

What is A worth in terms of B?



PPF continued…

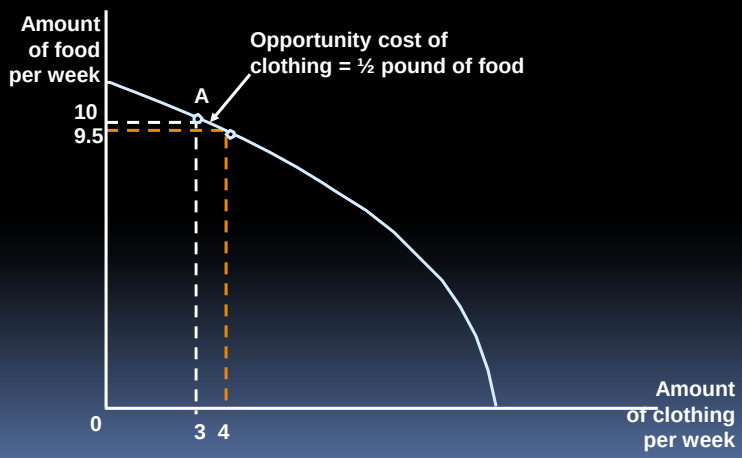
Without **more resources,** points outside the frontier, e.g., C, are **unattainable.** This demonstrates a basic fact: **resources are scarce** and therefore any use has an opportunity cost.



Opportunity Cost

- The cost of a good or service as measured by the alternative uses that are foregone by producing the good or service.
  - For example, if the economy produces one more unit of clothing beyond the 10 that it produces at point A, the amount of food produced decreases by 1/2 from 10 to 9.5. Thus, the **opportunity cost** of one unit of clothing is 1/2 unit of food at point A

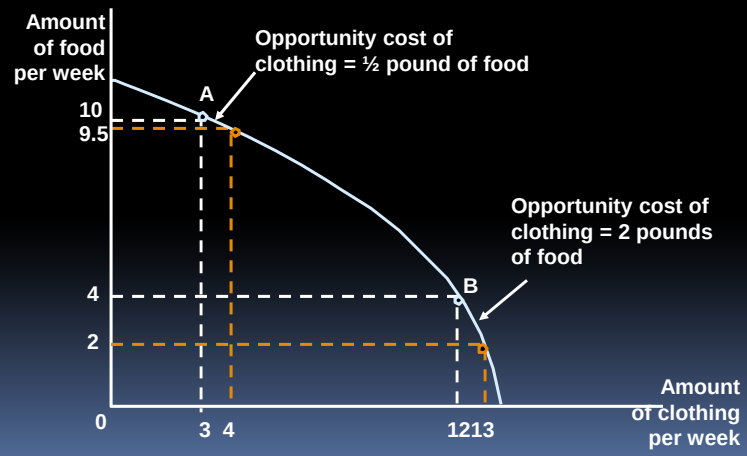
Production Possibility Frontier



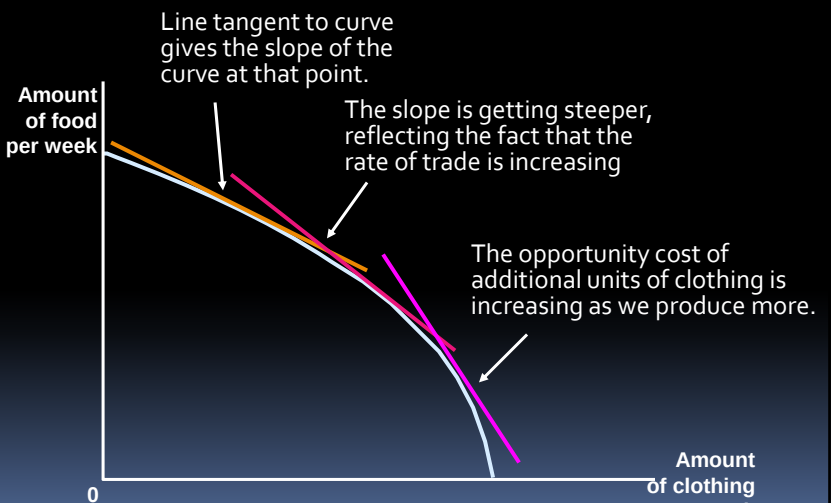
Opportunity Cost Example

- The opportunity cost of producing another unit of clothing is much higher at point B (1 unit of clothing costs 2 units of food)
  - The increasing opportunity costs of producing even more clothing is consistent with the idea of increasing marginal cost

Production Possibility Frontier



Production Possibility Frontier



Short Summary

- Economics a study about making choices
- Valuation of one good is always expressed in terms of another
  - Simple example is putting a $ sign to everything
  - Another way is to examine in terms of other goods
    - This is not simple in health care settings as many aspects of health is often difficult to assess in terms of a monetary value
      - Many often use DALY or QALY against the cost (cost per DALY or QALY)
      - We shall see how we calculate DALY or QALY shortly!
- Opportunity Cost is a way of expressing a value of one good in terms of another
- Simple production possibilities frontier curves allow us to illustrate the rate of 'trade' between the two goods evaluated given that we have:
  - Fixed value 'set' – e.g. budget
  - Expected opportunity cost of one good in terms of another is determined by PPF
- Economic evaluations in health care takes these basic concepts of economics to the next level to determine which intervention brings the most 'bang for buck'

2 OF 5

TYPES OF ECONOMIC EVALUATIONS

Economic evaluations

"The comparative analysis of alternative courses of action in terms of both their costs and their benefits."

Drummond et al., 1996

Generalization of Economic Evaluations

(2 x 2 table or the concept of the quadrant)

	Less Effective	More Effective
More Cost	Do not adopt	Is the increased in effect worth the cost?
Less Cost	Is decreased in effect worth the savings?	Definitely Choose

5 Types of Economic Evaluations

1. Cost Minimization Analysis
2. Cost-Effectiveness Analysis
3. Cost-Utility Analysis(QALY vs. DALY)
4. Cost-Benefit Analysis
5. Cost-Consequence Analysis

1. Cost Minimization Analysis

- What is the least costly way to get a given health outcome ?

Rare (because effectiveness, utility and safety of interventions **must be identical**)

Cost-Minimization Analysis

A subset of cost analysis

Examples in TB diagnostics (mostly limited to laboratory settings):

- Various iLED microscopies – which instrument is the most cost minimizing one for large scale up in the NTP?
- Choosing between two types of Interferon Gamma Release Assays (QFT vs. TB Spot Gold)
- Homemade LJ vs. Commercially prepared LJ?

2. Cost-Effectiveness Analysis

- **Cost $ / Effectiveness**
- What does it cost to get a given health outcome (or diagnostic performance)?:
  - **To gain a year of life**
  - **To prevent treatment with wrong regimen**
  - **To prevent secondary TB infection**
  - **To increase case detection**
  - **Etc.**

Cost Effectiveness Analysis

- Most common type of analysis
- Incremental Cost Effectiveness Ratio (ICER) most informative for competing intervention
- Examples:
  - Drug-eluting stents: prevention of revascularization interventions (angioplasty & CABG) =+/- 20K$
  - Screening for breast cancer 50-69: $5700/ life year gained (LYG)
  - Screening for prostate cancer (CETS) or down syndrome (AETMIS, 2004)
  - Prevention of vaccine-preventable diseases, STDs, HIV and AIDS
- Limitation : one indicator at a time in analysis

3.Cost Utility Analysis

- Cost per health utility measure (QALY or DALY)
- QALY vs. DALY, which one to choose?

Quality-adjusted life years (QALYs)

- Measure of disease burden that includes both the quality and the quantity of life lived
- Utility independent, risk neutral and constant proportional tradeoff behavior
- Number of years of life that would be added if intervention is implemented
- Perfect health year = 1.0 and death = 0.0

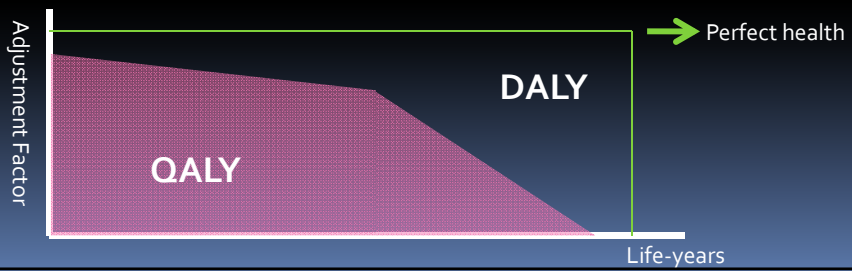
QALY continued…

Weighting

- **Time-trade-off (TTO):** life longer with disability or shorter life with full health?
- **Standard gamble (SG):** remain in ill health status for a given time vs. intervention with a chance to restore perfect health (but with a probability of death)
- **Visual analogue scale (VAS):** rate sate of ill health (0-100, 0: death | 100: perfect health)
  - Easiest to ask, but most subjective

Disability Adjusted Life Years (DALY)

- A measure of mortality and morbidity
- A modified method of QALY (negative QALY)
  - Quality of life reduced due to a disability
  - Lifetime lost due to premature mortality



Weighting in DALY

- **Disability weights**
  - **Two different Person Trade-Off (PTO) questions to expert panels**
  - **PTO1 : disabled vs. healthy people**
  - **PTO2: cures for illness**
- **Discounting (PV >> FV: NOW vs. Later)**
  - **Current value of life (1 year of life now) exceeds the value of life in the future (1 year of life 10 years later)**
- **Age weighting**
  - **The value of life years as child is greater than that of an elderly**

QALY vs. DALY

- Though both seem complementary to one another, they way weights are calculated for same disease is different
  - Different interpretation
  - Different values
    - Most differences are explained by:
      - Age weighting
      - Discounting
- Both methods have validity problems – how can one accurately assess health status over different ages, etc.?
  - Disable person's life worth less than a health person?
  - Future health benefit? → DALY's discounting weights seem to address this, but not perfectly

4. Cost Benefit Analysis

Evaluating desirability of a given intervention

- Theoretically the most complete method, but in practice the most difficult and most criticized.
- Appraise/assess the case for a project, program or policy proposal
- An approach to making economic decisions
- Benefits and costs expressed as monetary terms and adjusted for time-value of money → allows for projection of cost and benefit over time
  - CEA + economic impact analysis are part of CBA
  - Inputs are measured in terms of opportunity costs
  - Initial ongoing expenses vs. expected return

Cost Benefit Analysis

- Limitations
  - Focus on gaining productivity (human capital method)
  - Ethical problems with value of a human life
  - Requirements for data
  - Conflict: economic vs. public health perspective
    - (i.e.: smoking & death at retirement)

5. Cost Consequence Analysis

- Given the numerous limitations of CUA and CBA, just present a table comparing the various outcomes & let the decision-maker weigh the options

Coast, BMJ, 2004

Example: MGIT vs. LJ for DST

	MGIT	LJ
Cost per DST	$50	$28
Cost per new case detected	$450 / case per 1000 screened	$ 200 / case per 1000 screened
Incremental yield	70%	30%
Drugs tests	SIRE, first line	SIRE + second line
Additional costs to scale-up capacity to screen 2000 MDR-TB suspects annually	$100,000 per BSL III lab	$2000 per BSL II lab
Time to diagnosis	4 weeks max	8 or more weeks
Contamination rates	10-12%	5-7 %

Cost Consequence Analysis

- **Pros**
  - **global perspective**
  - **Decision-maker evaluates what is important**
  - **Avoids inadequate hypotheses**
- **Cons**
  - **burden of analysis for hurried decision-makers**

Limitations of Economic Evaluation

- Efficacy vs. effectiveness
- Cost effectiveness directly influential on types of parameters included in the analysis
  - Subjective vs. Objective
  - Transparency is an issue (black box economic studies)
- How do we value the health effects?
  - i.e.: prevention vs. cure
  - QALY vs. DALY – what do these exactly measure?
- Which is worth more?
  - Routine intervention vs. Heroic intervention
  - Vaccines vs. saving premature infants

Beware…

- **Some arbitrary values for <cost-effective>**
- **Cost-effective compared to what?**
- **Cost-effective ≠ cost-saving**
- **Health care generally costs money**

3 OF 4

JOINING EPIDEMIOLOGY WITH ECONOMICS

Solutions to the limitations

- Increase in transparency
  - Ingredients approach for models and clinical pathways explicit
  - Direct combination of epi analysis with cost effectiveness analysis
    - Person-level economic evaluations
- Test of the robustness of the model/analysis
  - Sensitivity analysis: impact of variation of input parameters on results

A need for multi-disciplinary approach

- Decision making process in public health must be a multi-disciplinary process
- Epidemiology is an essential component of co st and cost effectiveness study – Link Epidemi ology and Economics
- Modeling in cost effectiveness analysis that co mbines epidemiological, economical, and soci al factors allows complete evaluation of a publ ic health problem

Epidemiology and Economics

they come hand-in-hand

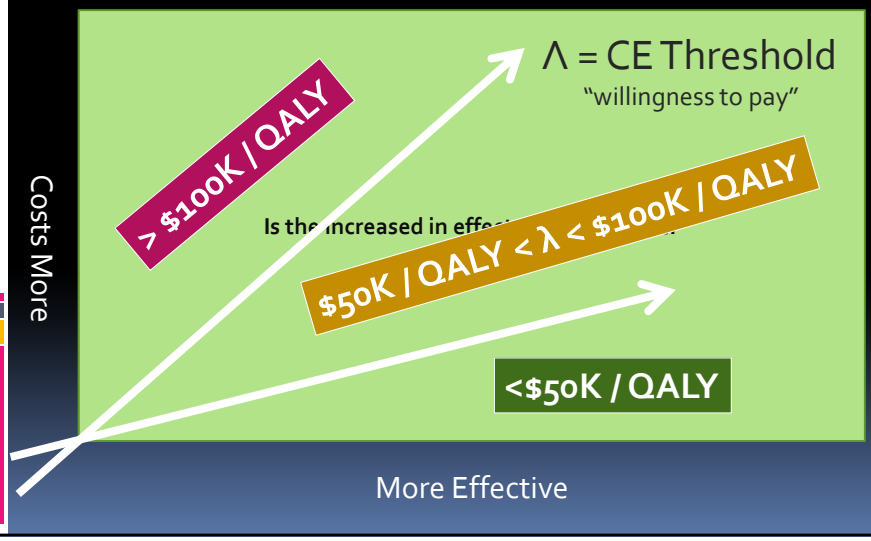
- Person-level economic evaluation or person-level cost effectiveness analysis (PLCEA)

Incremental Cost Effectiveness Ratio (ICER)

$$\frac{\text{Cost (New Intervention)} - \text{Cost (Compared / Routine Intervention)}}{\text{Effectiveness (New Intervention)} - \text{Effectiveness (Routine)}}$$

Making decisions based on ICER

Depends on the "willingness to pay"



Getting started with PLCEA

- You have
  - 2 Comparators
  - Want to do a CUA or CEA
  - Individual person-level data (from RCT, clinical trial, cohort study, etc.)
    - Patient receiving new intervention (TX = 1)
      - Each person's cost and effect
    - Patient receiving routine intervention (Tx = 0)
      - Each person's cost and effect

How PLCEA is relevant to Epi analysis?

- ICER can be estimated from regression analysis (TX = 1 vs. TX = 0)
  - Cost = $a_0 + a_1TX$
  - Effect = $b_0 + b_oTX$
  - NB (ICER) = Cost / Effect = $\beta_0 + \beta_1 * TX$
- Parameters included in regression can be variables used in Epi regression analysis!
  - Can include other parameters:
    - NB (ICER) = $\beta_0 + \beta_1 * TX + \beta_2 * Age$
    - NB (ICER) = $\beta_0 + \beta_1 * TX + \beta_2 * Age + \beta_3 Age * Sex$

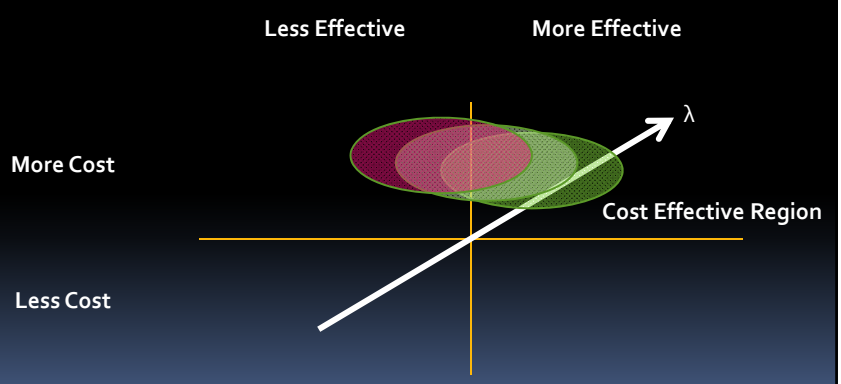
Main issues in CEA

- How to know if ICER < " Willingness to Pay" given ICER varies and "Willingness to Pay" is not certain/unknown?

95% Confidence Interval (Ellipse)

Sensitivity Analysis (Change "Willingness to Pay"

95% Confidence Intervals - Ellipse



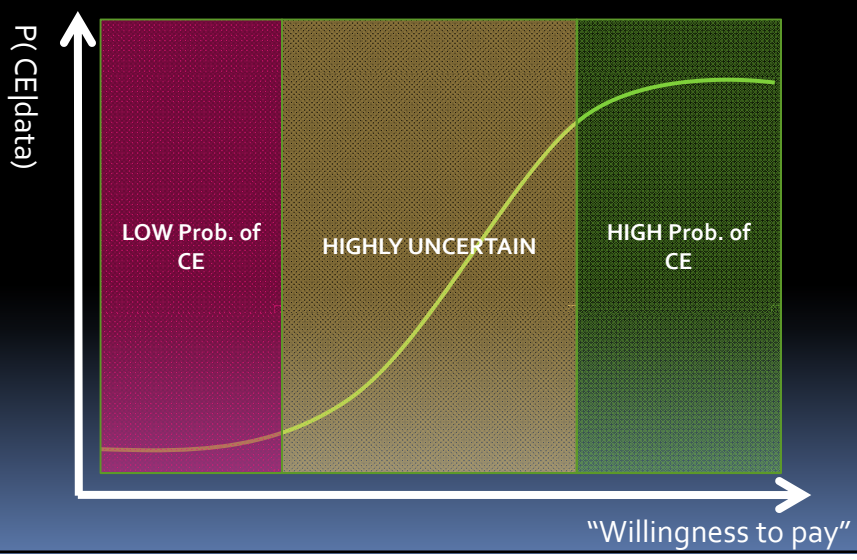
Why an Ellipse?

- Outcome of interest (measurement) is a ratio rather than a straight out number
  - Must taken account for:
    - Variances in each cost and effectiveness parameters
    - Covariances of both parameters
    - Correlation between Cost and Effectiveness
      - More correlation, ellipse will be more twisted left (-) or right (+)
- Building one (parabola approach)
  - Use density function and variance covariance matrix

Cost Effectiveness Acceptability Curve (CESC)

- Main objective – vary "willingness to pay" and test against ICER
- Vertical axis – p (Tx = CE)
  - $P(ICER < \lambda) = P(\Delta E * \lambda - \Delta C > 0) = P(\Delta NB > 0)$
  - A bayseian approach
    - Given the data we have what is the probability of intervention being CE?
- 2 Options
  - If Bayesian assumption does not hold, use boot-straping approach

CEAC – what does it look like?



4 of 4

A NEED FOR CAUTION IN INTERPRETING RESULTS OF ECONOMIC EVALUATIONS

Checklist for evaluating Economic Evaluation Studies

1. Was the question properly asked?
2. Were alternative programs adequately described?
3. Has the program's effectiveness been validated?
4. Were all important & relevant costs & effects identified?
5. Were credible measures for cost and effectiveness selected?
6. Was an appropriate analysis carried out?
7. Were comparisons between programs properly adjusted for time?
8. Were the biases and direction of biases identified?

Critical Questions to ask

- Who paid for the study?
- What actually went into the study?
- How does the context of the study resemble and differ from your context?
- What is driving the model?
- What is likely to change
- Uncertainty… sensitivity of results to input parameters in model

The role of Economic Evaluations in Priority setting

- Not the only factor
- Timeliness, relevance to local context
- Quality and completeness vs. clarity and brevity for a busy decision-maker
- Importance of informal communication channels with experts

Thank you very much for your attention!

QUESTIONS?