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Basics of Economic Evaluation

With an emphasis to Tuberculosis Diagnostics Interventions

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Agenda

- ❖ Basic concepts of Economics
- ❖ 'Valuing' health
- ❖ Efficiency Frontier
- ❖ Types of Economic Evaluations in Healthcare
- ❖ A word of caution - a checklist in assessing economic evaluation studies

Economics

A study of human behavior around the idea of scarcity



* Alfred Marshall

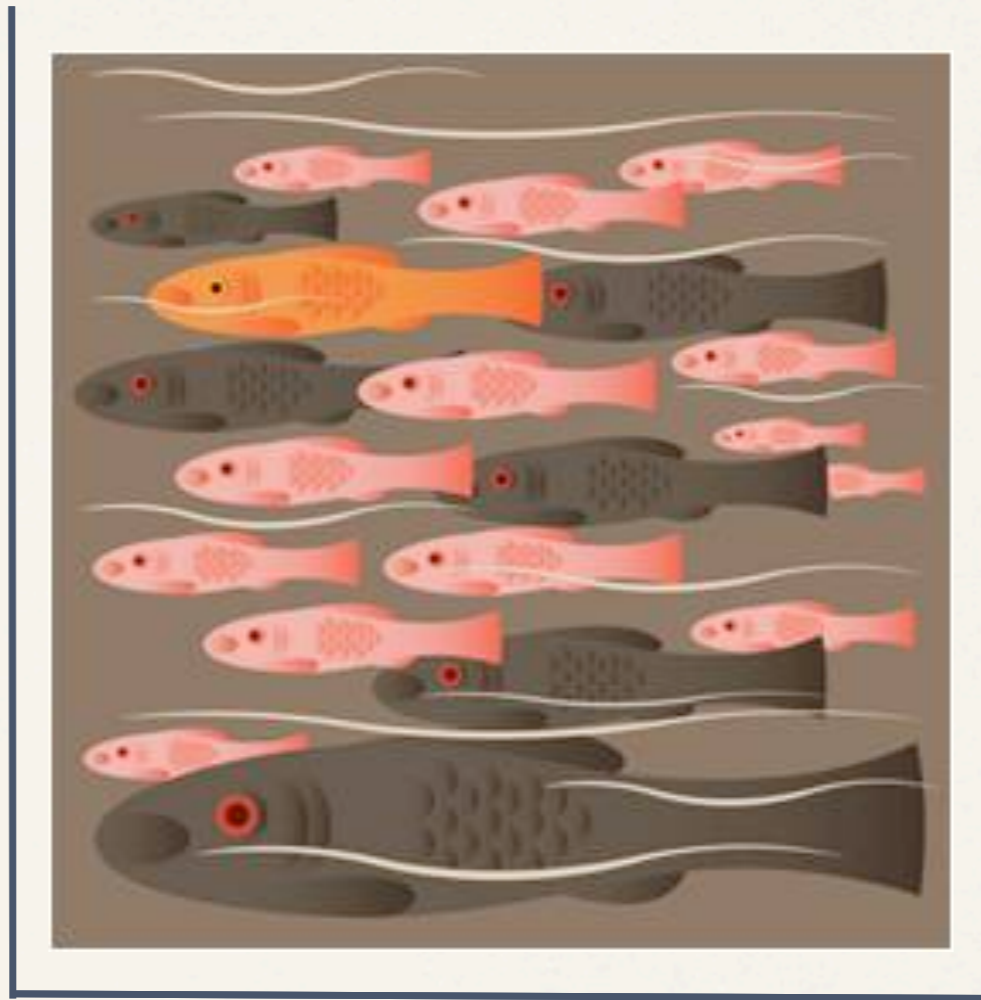
- * “A study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of wellbeing. Thus it is on one side a study of wealth; and on the other, and more important side, a part of the study of man”

* Lionell Robbins

- * “Economics is the social science that examines how people choose to use limited or scarce resources in attempting to satisfy their unlimited wants”

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, they provide enough structure to solve the problem



The issue of scarce resources

A fish example

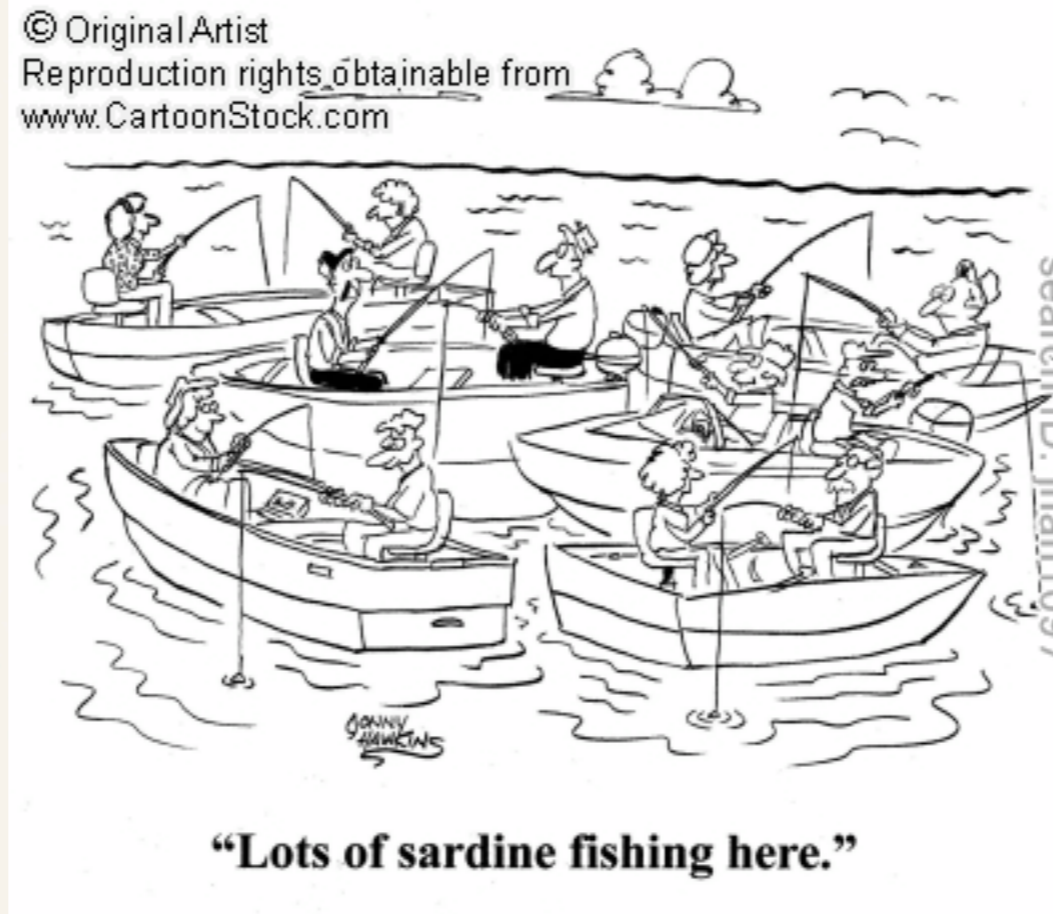
In What Situation Are We In TB?



The issue of scarce resources

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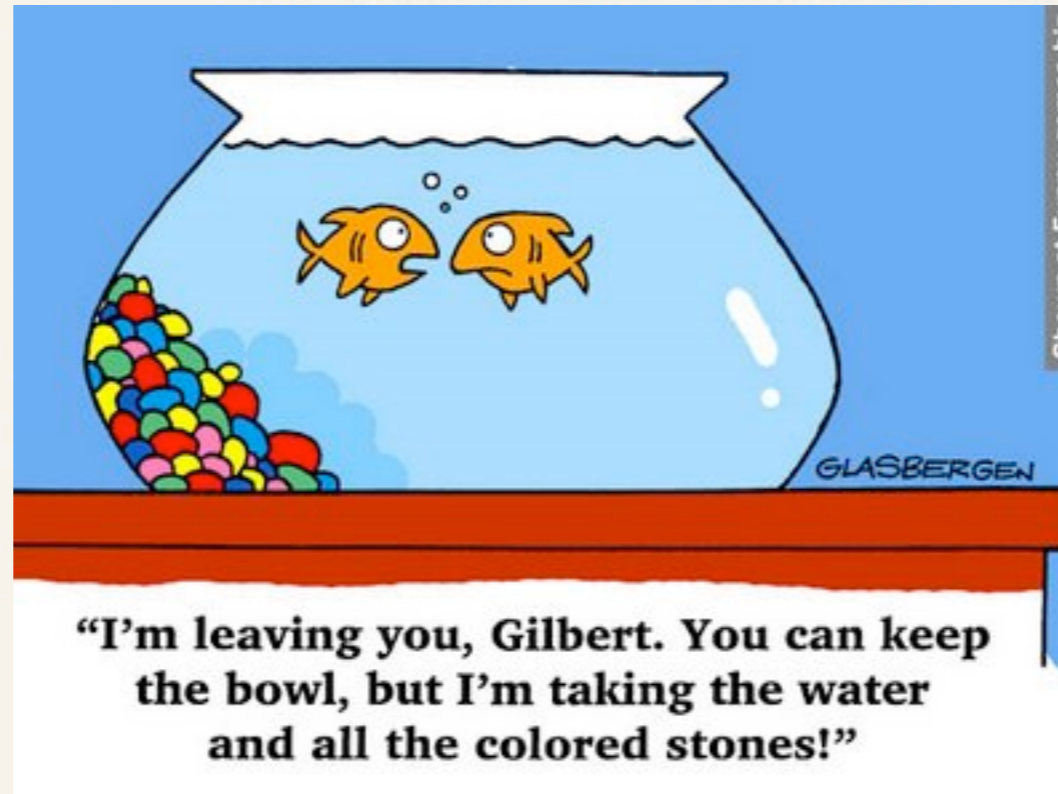
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The issue of scarce resources

A fish example

In What Situation Are We In TB?



The issue of scarce resources

A fish example

In What Situation Are We In TB?

It's about choices we make!

- ❖ Re-defining Economics

- ❖ The study of allocation of scarce resources among alternative uses

- ❖ Microeconomics

- ❖ The study of economic choices individuals make and how those choices create markets

- ❖ Macroeconomics

- ❖ The study of aggregate economic activity (performance, behavior, structure) of a nation or region

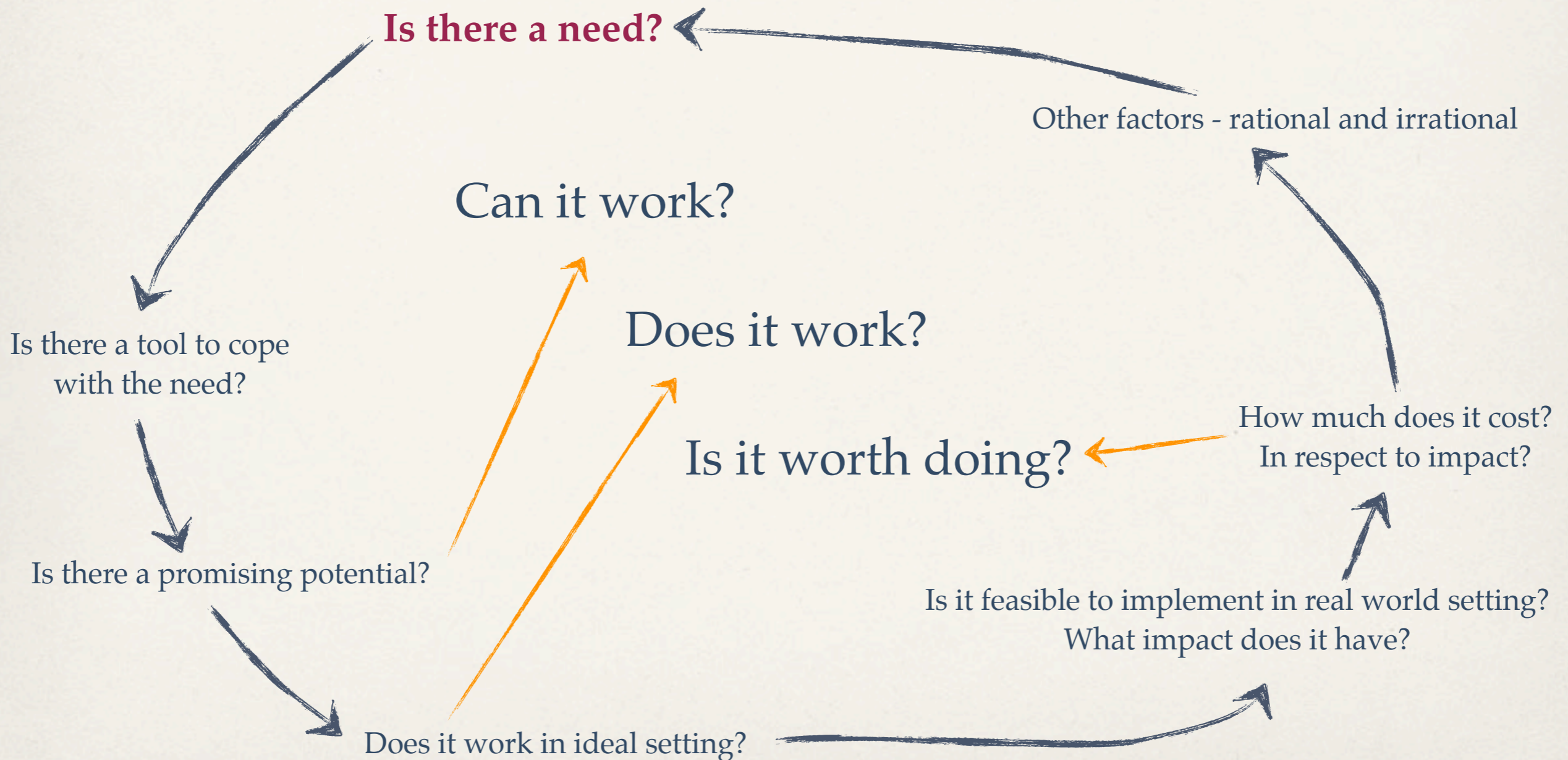
Economic Evaluation

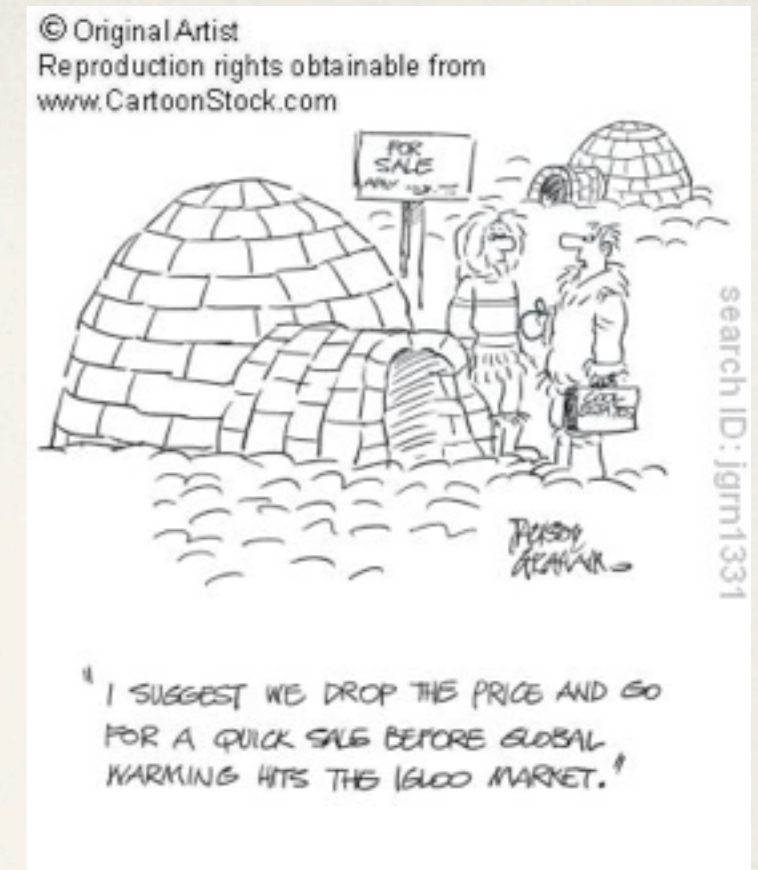
- ❖ The comparative analysis of **alternative** courses of action in terms of both their **costs and their benefits**

‘How do we value one thing compared to another’

Process of Economic evaluation

A valuation process





How do we value things?

Features of Economist's Approach

1. All consequences are valued in the same units
2. A new use is only considered against the best alternative
3. "Uses" are directly compared and traded-off
4. Consequences apply to the decision maker
5. Market establishes value

Desired properties of the units of value

Money is not an intrinsic value, but a representation of value

- ❖ **Comprehensive** - applicable to all the consequences one wants to value
- ❖ **Universal** - not personally defined
- ❖ **Constant** - cardinal scale: equal intervals on the scale have an equivalent interpretation



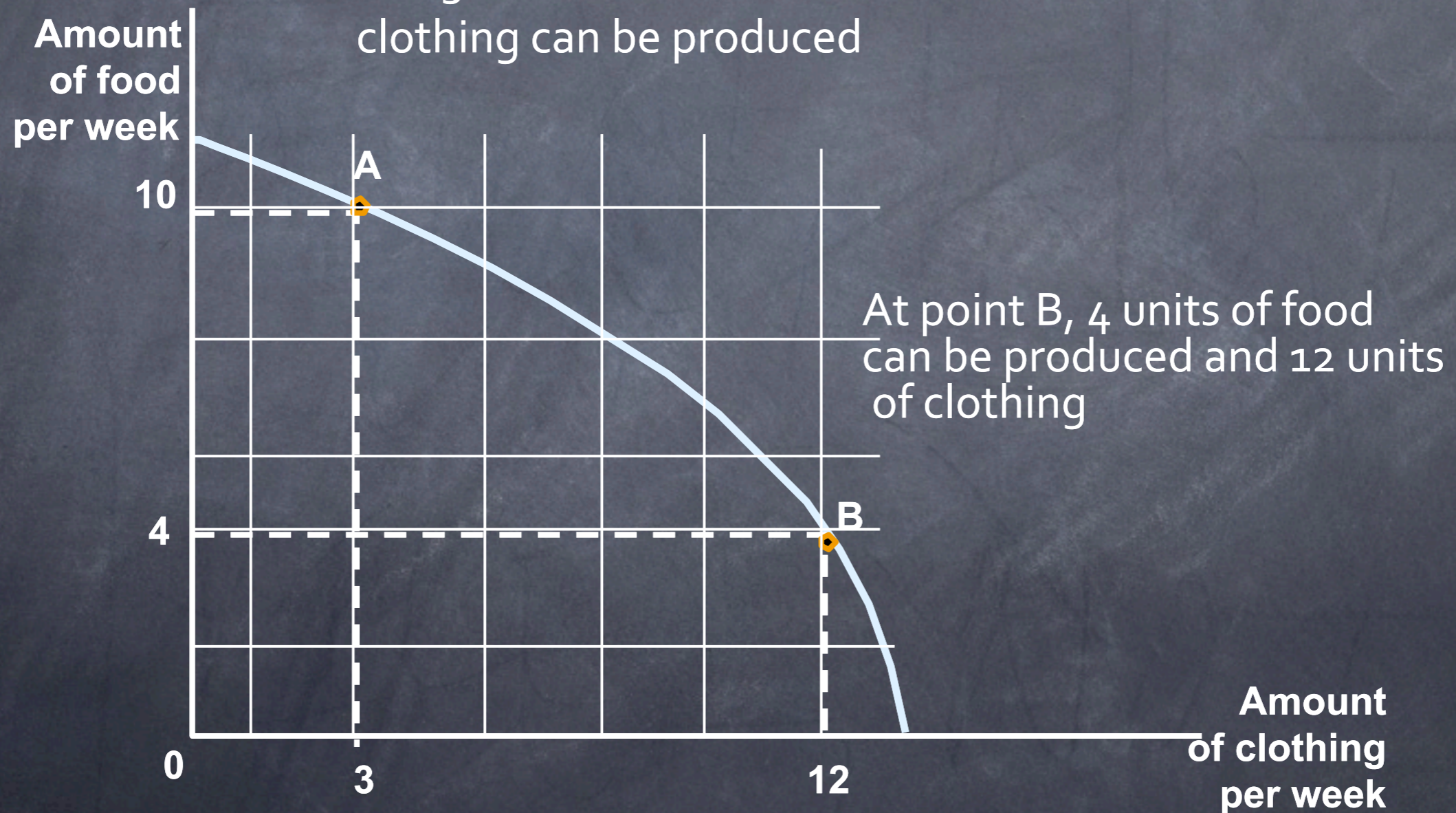
Valuation process in economics

- ❖ Production possibilities frontier
 - ❖ A graph showing all possible combinations of goods that can be produced with a fixed amount of resources
- ❖ Supply and demand
 - ❖ Economic model of price determination in a market

Production Possibilities Frontier

What is A worth in terms of B?

At point A, 10 units of food and 3 units of clothing can be produced



At point B, 4 units of food can be produced and 12 units of clothing

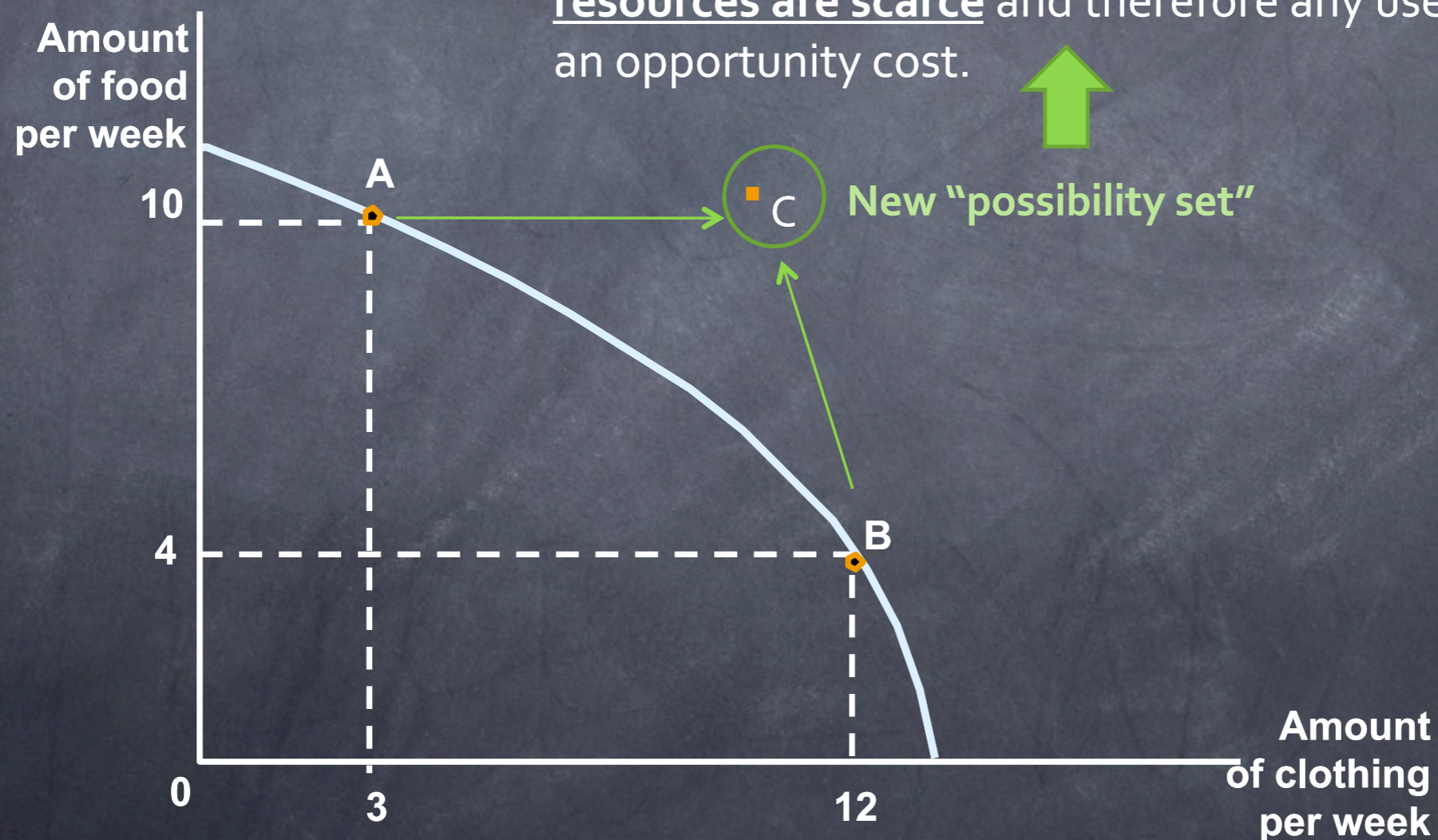
Production Possibilities Frontier

What is A worth in terms of B?

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.



Production Possibilities Frontier

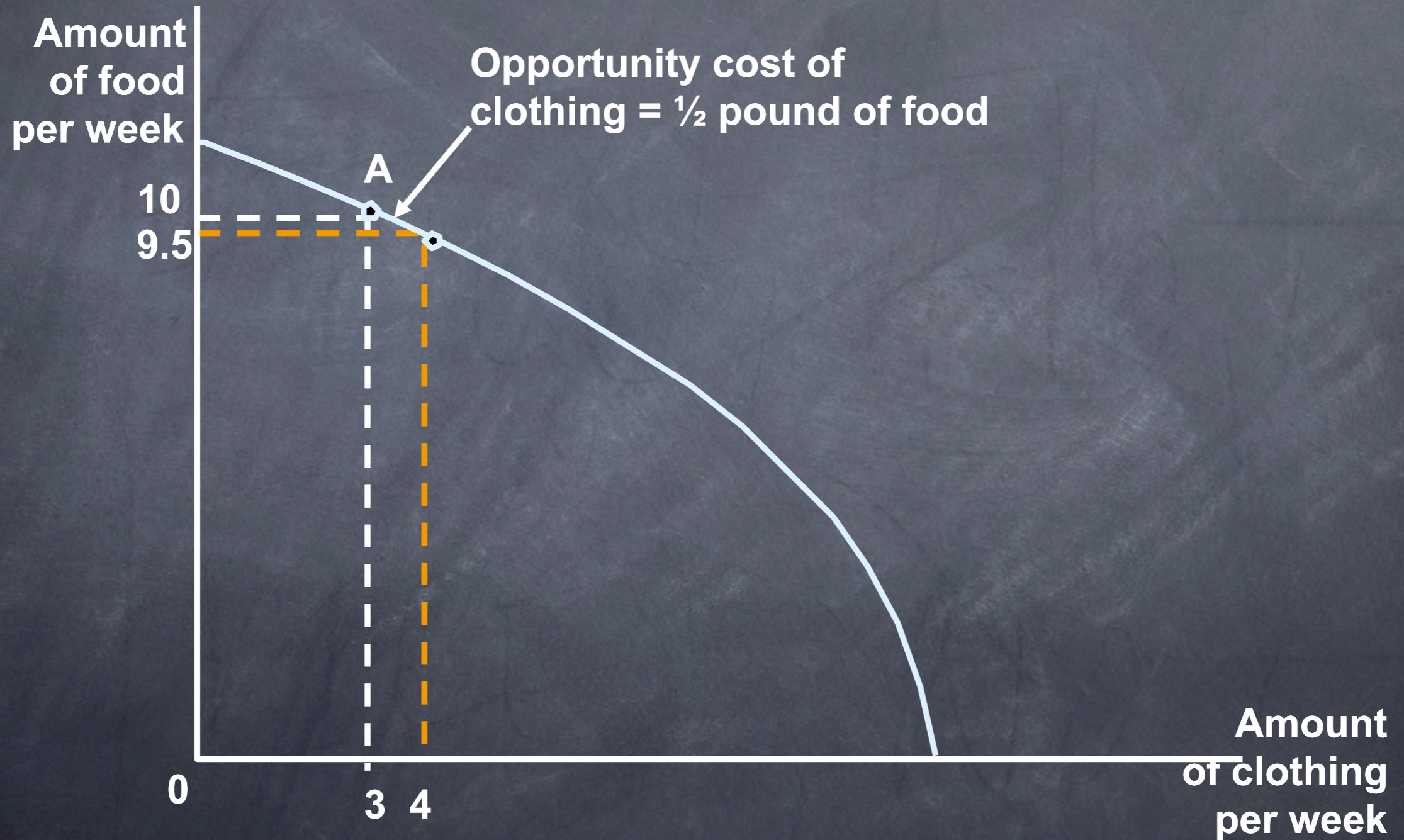
What is A worth in terms of B?

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 $\frac{1}{2}$ from 10 to 9.5. Thus, the **opportunity cost** of one unit of clothing is $\frac{1}{2}$ unit of food at point A

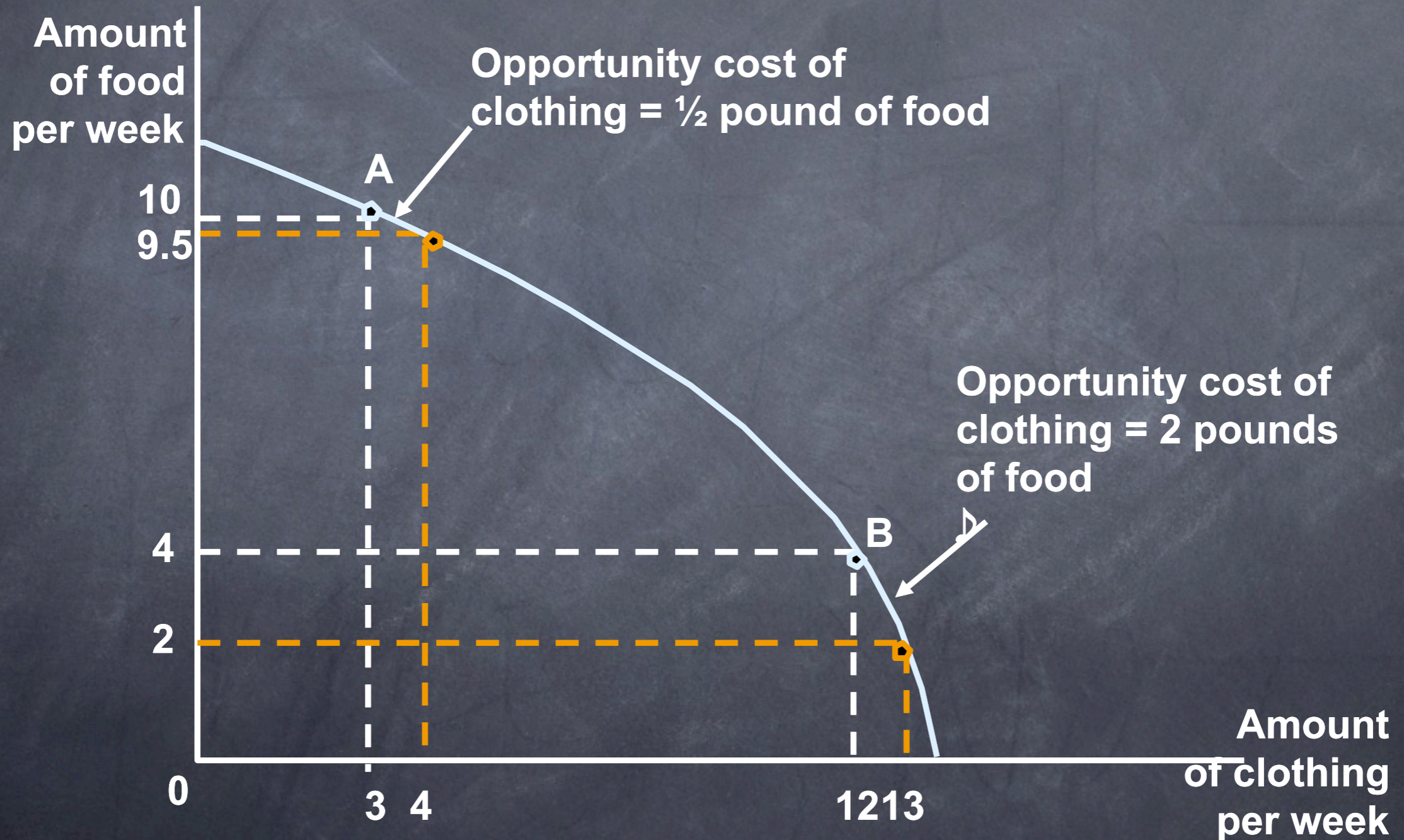
Production Possibilities Frontier

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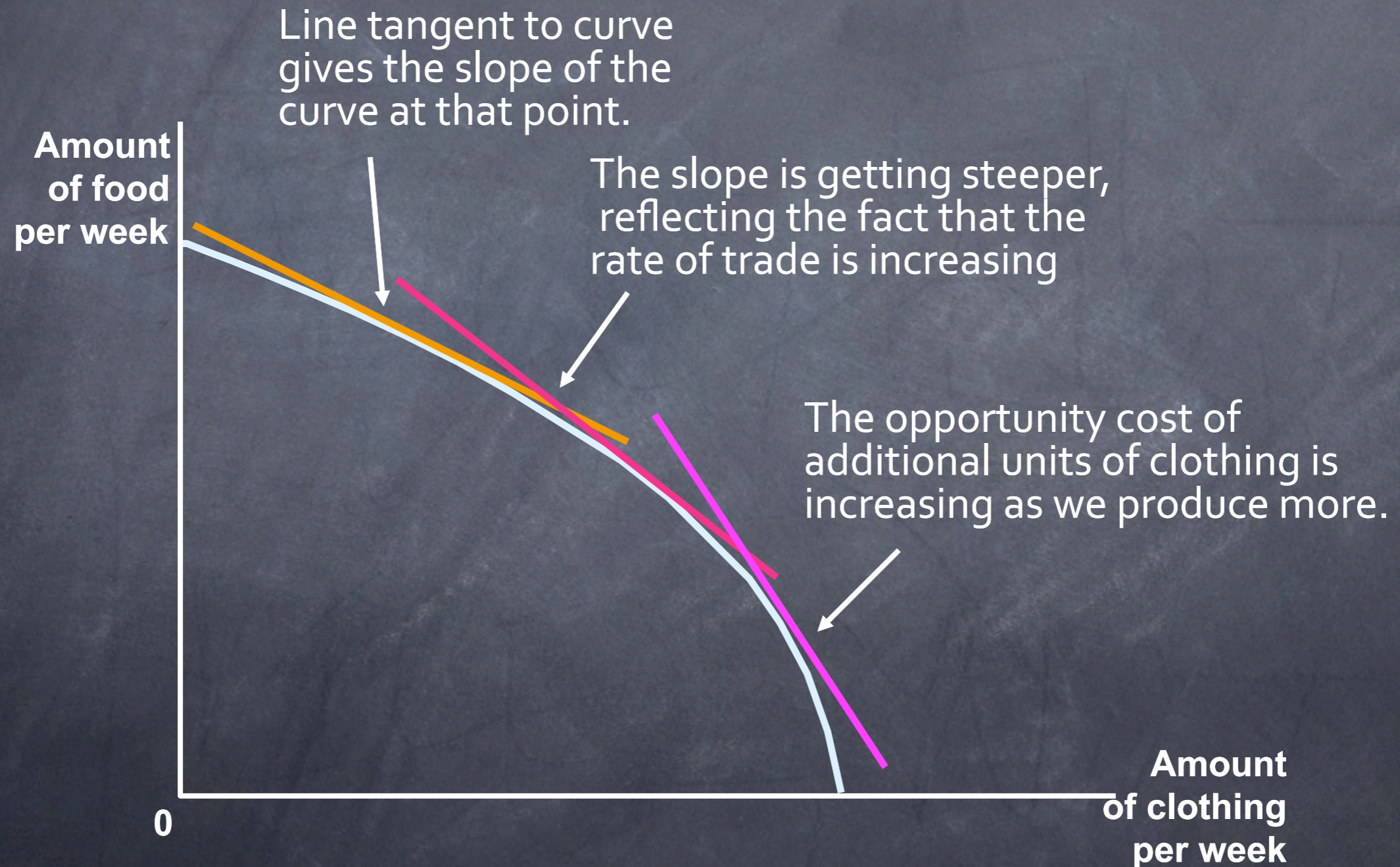
Production Possibilities Frontier

What is A worth in terms of B?



Production Possibilities Frontier

What is A worth in terms of B?



What is health economics?

- ❖ “Health economists are concerned with the organization of the market for health services and the net yield of investment in people for health. The *optimum use of resources* for the care of the sick and the promotion of health defines the special field of inquiry”

Mushkin 1958

A problem

- ❖ “The logic and limitations of ideal competitive (a.k.a. laissez-faire solution) behavior under uncertainty force us to recognize the incomplete description of reality supplied by impersonal price system”

Arrow, 1963

Health Economics - The scope

In the context of Gene Xpert

-
- ❖ What influences health? (other than health care)

Does improvement in time to treatment via influencing clinical decision making process improve TB patient's health outcome?

- ❖ What is health and what is its value?

What is the (societal/healthcare provider's/patient's) value of reducing time to treatment initiation?

- ❖ The demand for health care

What is the society's/healthcare provider's/patient's marginal value for additional day reduced in treatment initiation?

- ❖ The supply of health care

What is the marginal cost to the health care provider in reducing one additional day in treatment initiation?

- ❖ Micro-economic evaluation at treatment level

Cost-effectiveness & benefit analysis of alternative ways of delivering care at all phases (detection/diagnosis/treatment, etc.)

- ❖ Market equilibrium

Money prices, time, prices & non-price rationing systems as equilibrating mechanisms and their differential effects

- ❖ Evaluation at whole system level

In what setting does Xpert make most economic sense - comparison of cost and performance in various settings

- ❖ Planning, budgeting and monitoring mechanisms

What is the cost of scaling up and its feasibility (budgeting, workforce allocation, norms, regulations, etc.)

Valuing 'health' outcomes

- ❖ Highly controversial and comes with many caveats!
- ❖ Generic preference-based measures of health (DALY and QALY)
- ❖ Choice-based valuation techniques (Visual Analogue Scaling, Time Trade-off, Standard Gamble)

Does this all matter to evaluating diagnostic tests?

Valuing Health -

revisit desired properties of value

Can we find a measure that can fulfill these requirements?

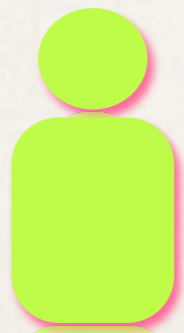
- ❖ Comprehensive?
- ❖ Universal?
- ❖ Constant?



Valuing Health - The QALY/DALY debate

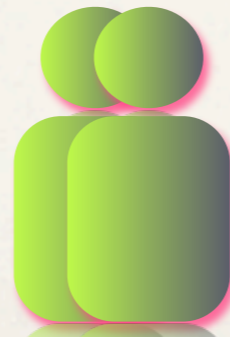
Quality Adjusted Life Years

- ❖ A QALY combines both quantity and health-related quality of life into a single measure of health gain
- ❖ The amount of time spent in a health state is weighted by the quality of life score attached to that health state
- ❖ Quality of life score 'should' reflect peoples' preferences over health
- ❖ Quality of life is usually scored with 'perfect health' = 1 and 'death' = 0



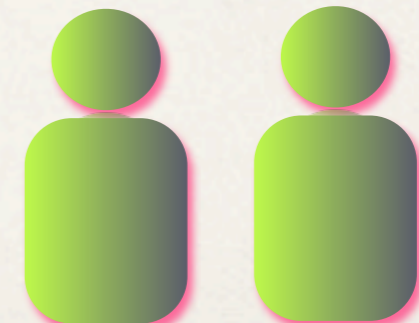
1 yr. of perfect health for 1 person

=



2 yrs. of 0.5 QoL for 1 person

=



1 yr. of 0.5 QoL for 2 person(s)

Issues of equity and weighting

- ❖ An additional QALY has the same weight regardless of the other characteristics of the individuals receiving the health benefit
- ❖ 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 state of ill health (0 - 100, 0: death | 100: perfect health) - easiest to ask, but most subjective

Other issues

- ❖ The value of a health state is the same regardless of the length of time in the state and where it lies in a sequence of states - it is assumed that you can add the utilities from constituent health states (additive independence between health states)
- ❖ Constant proportional time trade off assumption - individuals are willing to sacrifice a constant proportion of his or her remaining life years in order to achieve a given improvement in health, irrespective of the number of life years that remain

More issues - EQ-5D vs. SF-6D

ORIGINAL ARTICLE

Comparing Cost-Utility Estimates Does the Choice of EQ-5D or SF-6D Matter?

Tracey H. Sach, PhD,*†‡ Garry R. Barton, PhD,† Claire Jenkinson, BSc,‡ Michael Doherty, MD,§
Anthony J. Avery, MD,‡ and Kenneth R. Muir, PhD‡

Background: A number of different measures can be used within cost-utility analyses, we compared results according to both the EQ-5D and SF-6D.

Methods: A randomized trial was conducted to compare 4 options for people with knee pain. Over the 2 year trial period, the change in cost to health-service was estimated, and both the EQ-5D and SF-6D were used to estimate the change in quality-adjusted life years (QALYs). Using a complete case analysis, the cost-utility (incremental cost-effectiveness ratio [ICER]) of each option, according to both the EQ-5D and SF-6D, was calculated and assessed in relation to the cost-effectiveness threshold of £20,000 per QALY.

Results: Of the 389 participants, 247 had complete cost, EQ-5D and SF-6D data. According to the EQ-5D, option 1 had an estimated ICER of £10,815 (compared with option 4), option 2 was dominated by option 1, and option 3 was subject to extended dominance. Conversely, according to the SF-6D, option 3 had an ICER of £9999 (compared with option 4), option 2 had an ICER of £36,883 (compared with option 3), and option 1 was subject to extended dominance.

Conclusion: The EQ-5D and SF-6D estimated that different options (1 and 3, respectively) were cost-effective at the £20,000 per QALY threshold, demonstrating that the choice of measure does matter.

Key Words: cost-utility, cost-effectiveness, EQ-5D, SF-6D

(*Med Care* 2009;47: 889–894)

different health state descriptive measures such as the EQ-5D,² health utilities index,³ or SF-6D.⁴ However, as these measures are based on both different health state descriptions,⁵ and valuation techniques,⁶ they have been shown to produce different utility scores for the same group of patients.^{7–11} Though a number of studies have compared the utility scores produced by different measures, few studies have assessed the impact that the choice of measure has on estimates of cost-utility, and it has been argued that further research is required in this area.^{12,13} This article aims to fulfil this remit by comparing cost-utility estimates for both the EQ-5D and SF-6D using data from a randomized trial which compared 4 options for overweight and obese people who had knee pain.

METHODS

Participants

All participants were taking part in the Lifestyle Interventions for Knee Pain (LIKIP) study—a randomized controlled trial which was designed to compare the effectiveness and cost-effectiveness of 4 different options (1) diet and strengthening exercise advice, (2) dietary advice, (3) strengthening exercise advice, and (4) leaflet provision (hereafter these options are referred to as 1, 2, 3, and 4 as the main focus of this article is methodological). All registered patients in 5 UK

- ❖ Each instrument different health dimensions / domains and number of health states
- ❖ Results discrepant based on what population is being questioned (EQ-5D: patients with mild health conditions vs. SF-6D: patients with worse health)

More issues - EQ-5D vs. SF-6D

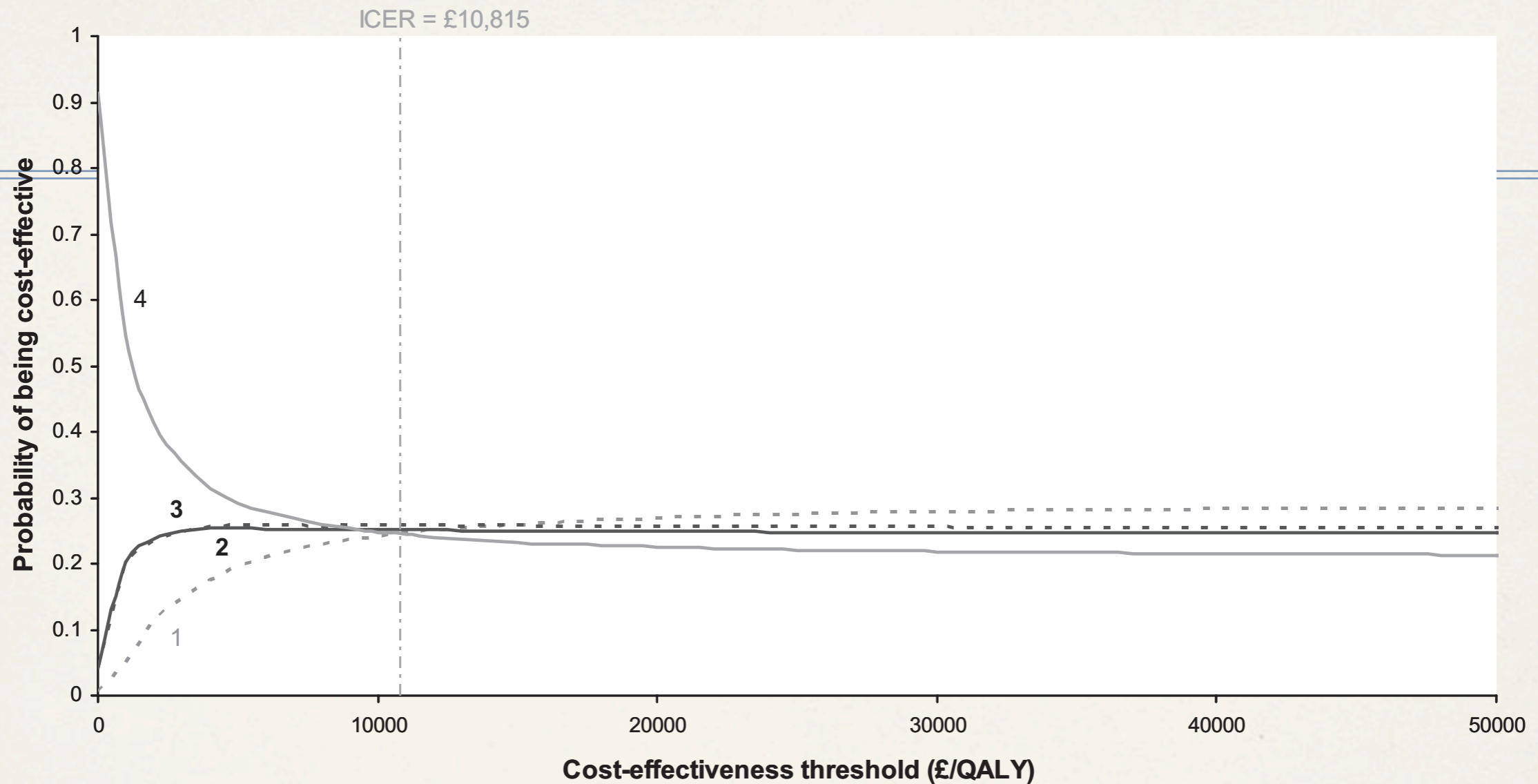


FIGURE 1. Cost-effectiveness acceptability curves (CEACs) for options 1 (light dashed line), 2 (bold continuous line), 3 (bold dashed line), and 4 (light continuous line) constructed using the EQ-5D. The incremental cost-effectiveness ratio (ICER) for option 1 is denoted by the vertical dashed line, for λ values below this ICER option 4 was estimated to be cost-effective, compared with option 1 for higher values of λ .

- ❖ Each instrument different health dimensions / domains and number of health states
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More issues - EQ-5D vs. SF-6D

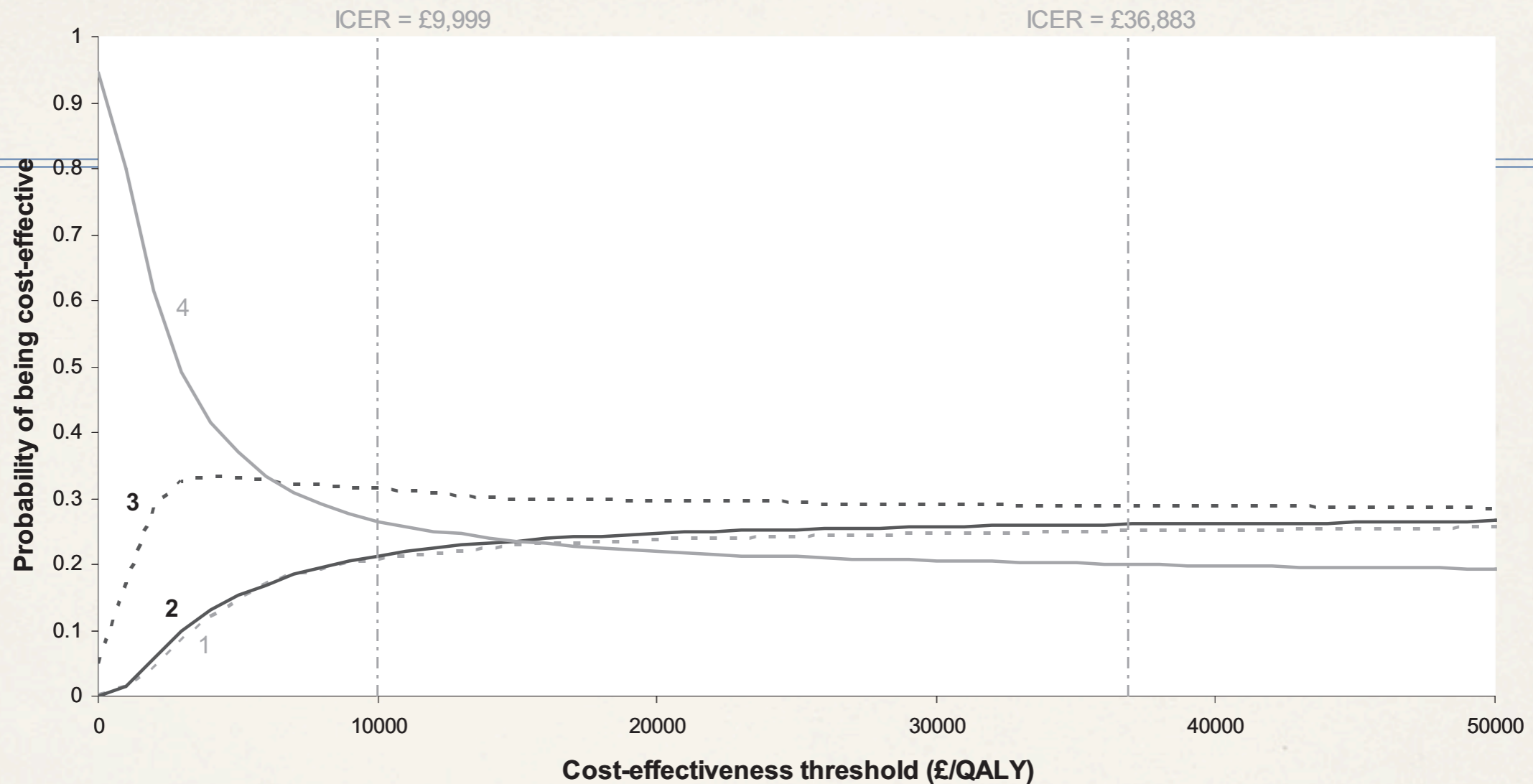


FIGURE 2. Cost-effectiveness acceptability curves (CEACs) for options 1 (light dashed line), 2 (bold continuous line), 3 (bold dashed line), and 4 (light continuous line) constructed using the SF-6D. The incremental cost-effectiveness ratio (ICER) for options 3 and 2, respectively, are denoted by the vertical dashed lines, for λ values below the first ICER option 4 was estimated to be cost-effective, compared with option 3 before the second ICER, and option 2 thereafter.

- ❖ Each instrument different health dimensions / domains and number of health states
- ❖ Results discrepant based on what population is being questioned (EQ-5D: patients with mild health conditions vs. SF-6D: patients with worse health)

Valuing Health - The QALY/DALY debate

Disability Adjusted Life Years

- ❖ DALYs offer a combined index of quality adjusted life expectancy
- ❖ Two basic components are summed
 - ❖ Years of Life Lost (YLL) due to premature mortality
 - ❖ Years Lost due to Disability (YLD) for incident cases of the health condition
- ❖ One DALY = one lost year of “healthy” life
- ❖ Aims to measure the gap between current health status and an ideal situation where the “entire population lives to advanced age, free of disease and disability”
- ❖ Vs. QALY, you want less DALYs, not more
- ❖ DALYs can be used to measure the ‘burden of disease’ and inform resource allocation

Calculating DALYs

- ❖ YLL - calculated from # of deaths at each age x a global standard life expectancy for each age
- ❖ YLD for a particular cause in a particular time period - calculation based on the # of incident case in that period, the average duration of disease and a disability weighting factor
- ❖ Disability weight factor - 0: perfect health | 1: death
- ❖ Discounting - time (usually at 3%)
- ❖ Non uniform age weights (less weight to years lived at young and older ages)

DALY - concerns

- ❖ Equity implications (Anand & Hanson, 1997 and Arnesen & Nord, 1999)
- ❖ Role of burden of disease approaches in decision making - should start with people without disease? (Williams 1999, 2000)
- ❖ Expert driven valuations (Williams 1999, 2000)
- ❖ Its actual application in CEA is highly variable (Fox-Rushby & Hanson, 2001)
- ❖ Important when presenting DALYs to include full calculation and sensitivity analyses around weighting, discount rates, etc.

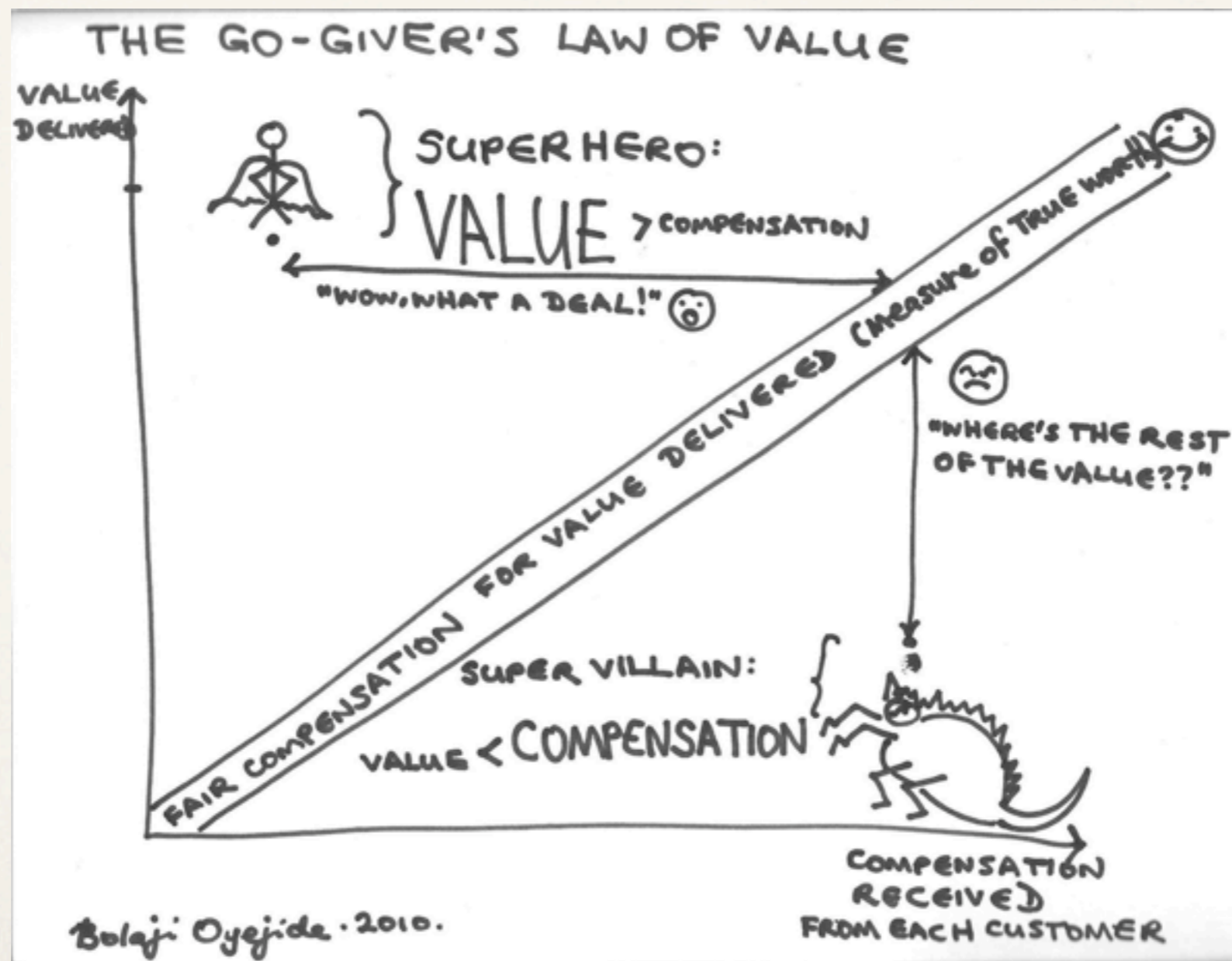
QALYs vs. DALYs



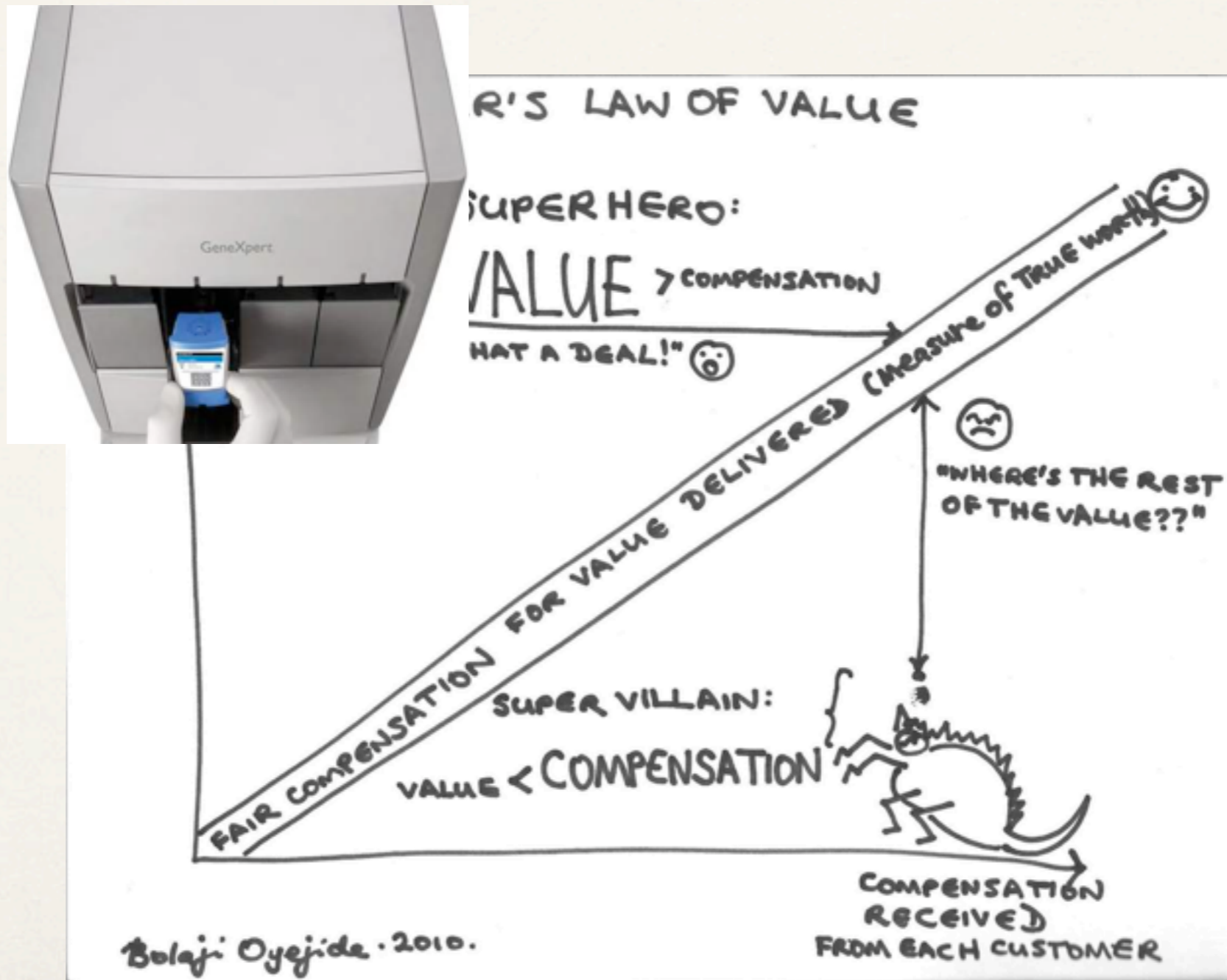
QALY vs DALY - continued

- ❖ Though both seem complementary to one another, the way weights are calculated for same disease is different
 - ❖ Different interpretation
 - ❖ Different values
- ❖ Both methods have validity problems - how can one accurately assess health status over different ages, etc.
 - ❖ Disable person's life worth less than a healthy person?
 - ❖ Future health benefit? - DALY's discounting weights seem to address this, but not perfectly

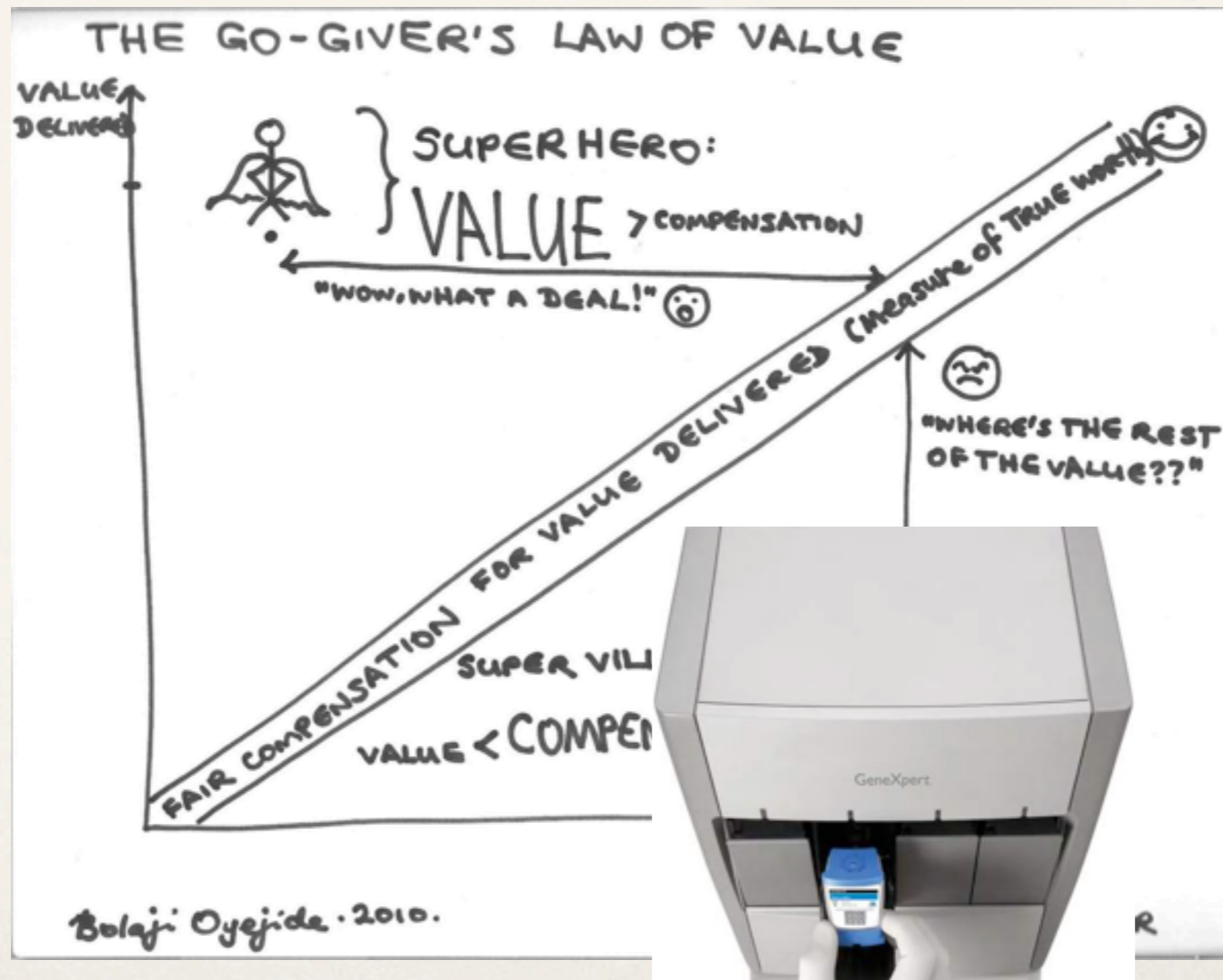
Now, how do we value health interventions?



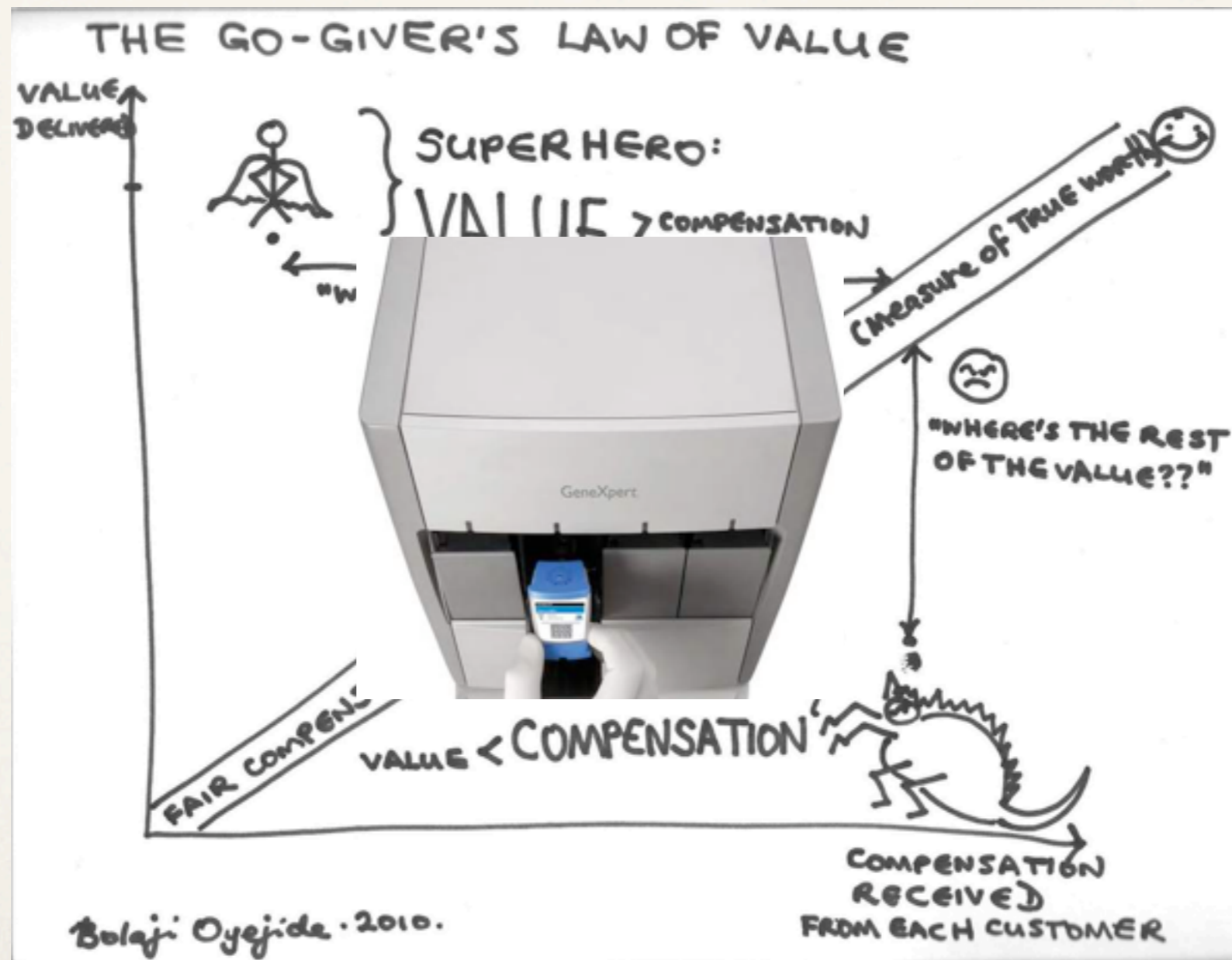
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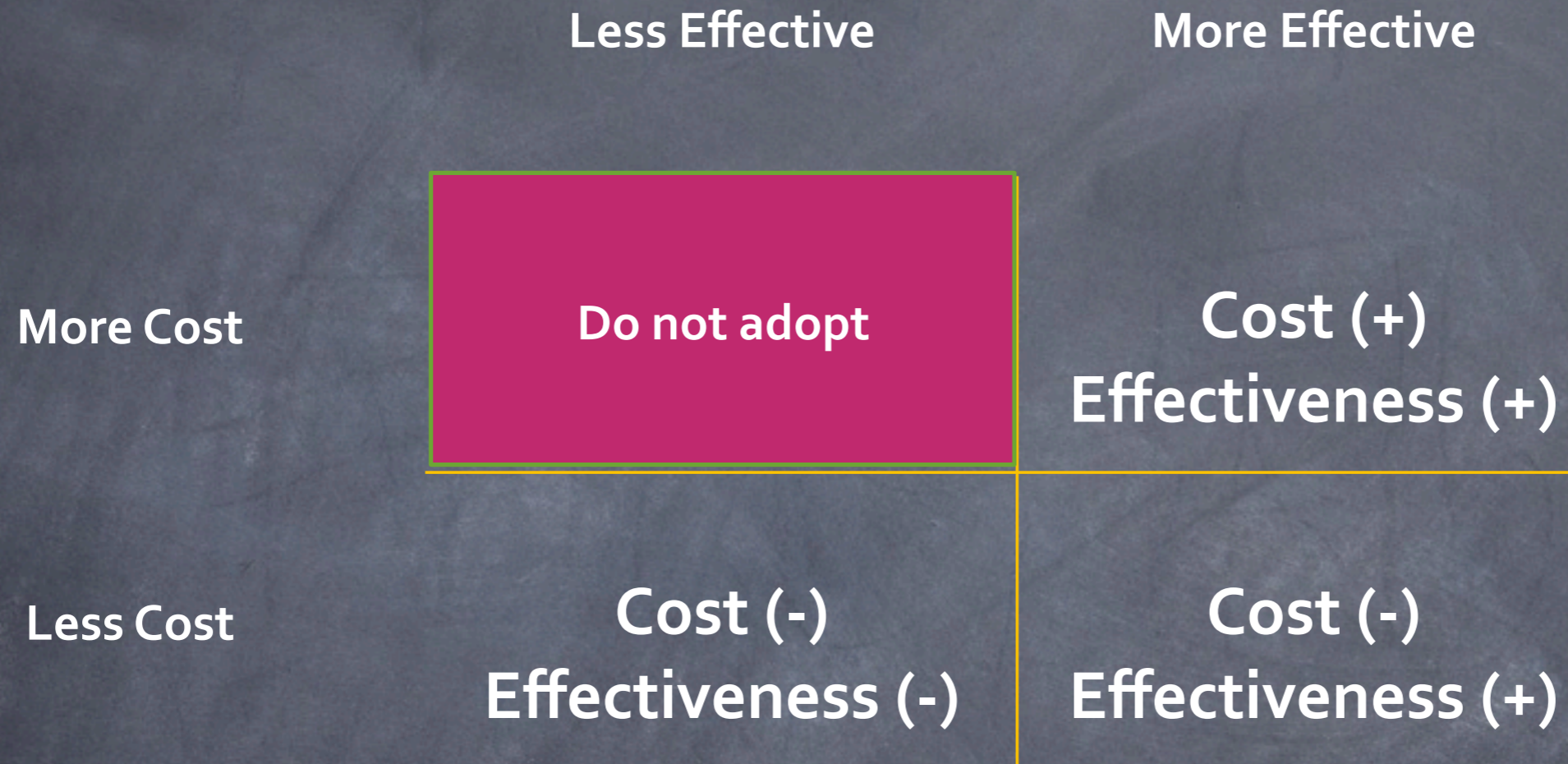


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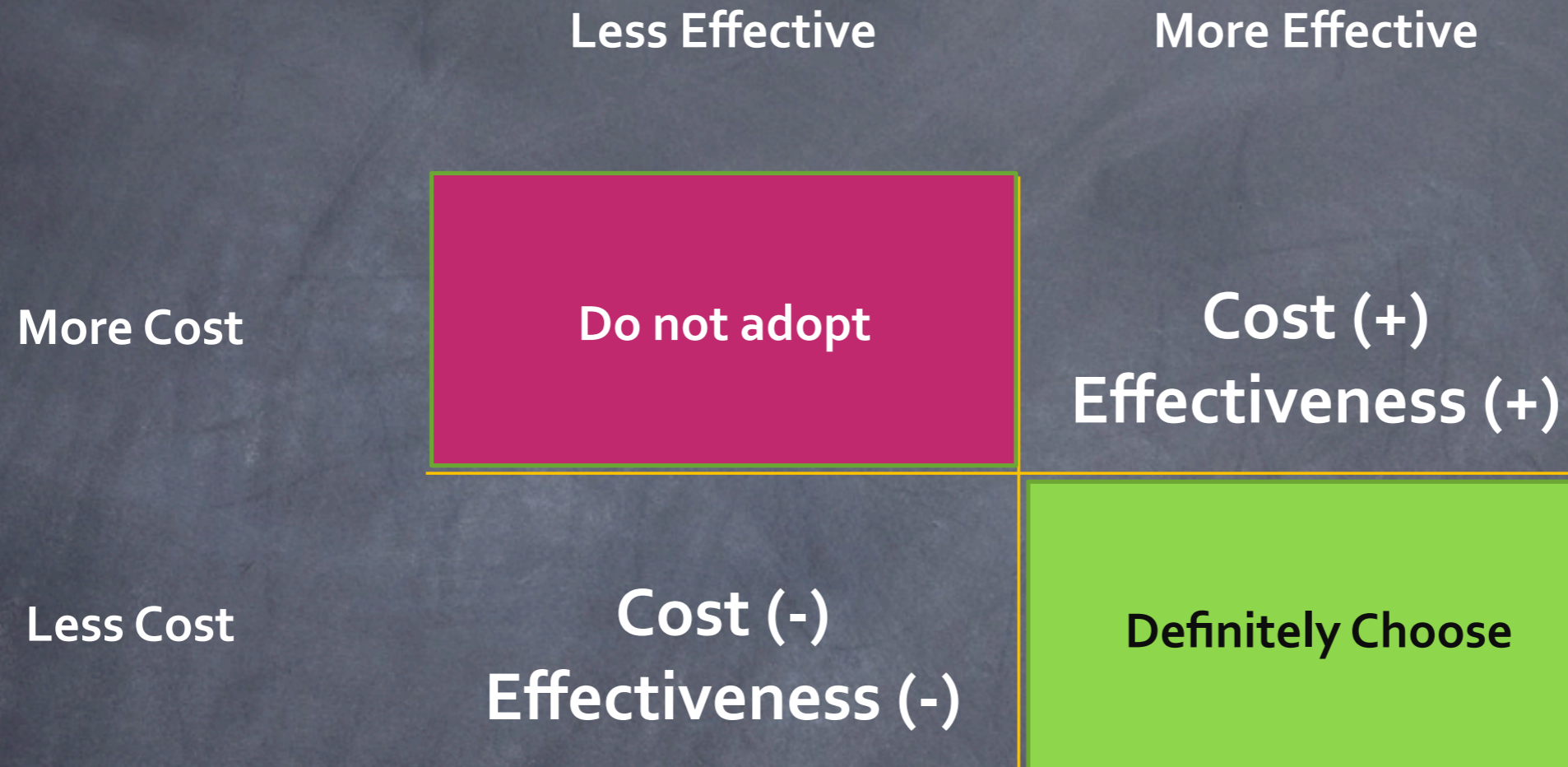
Now, how do we value health interventions?





Generalization of economic evaluations

2 x 2 table or the concept of the quadrant



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	Cost (-) Effectiveness (-)	Definitely Choose

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

Generalization of economic evaluations

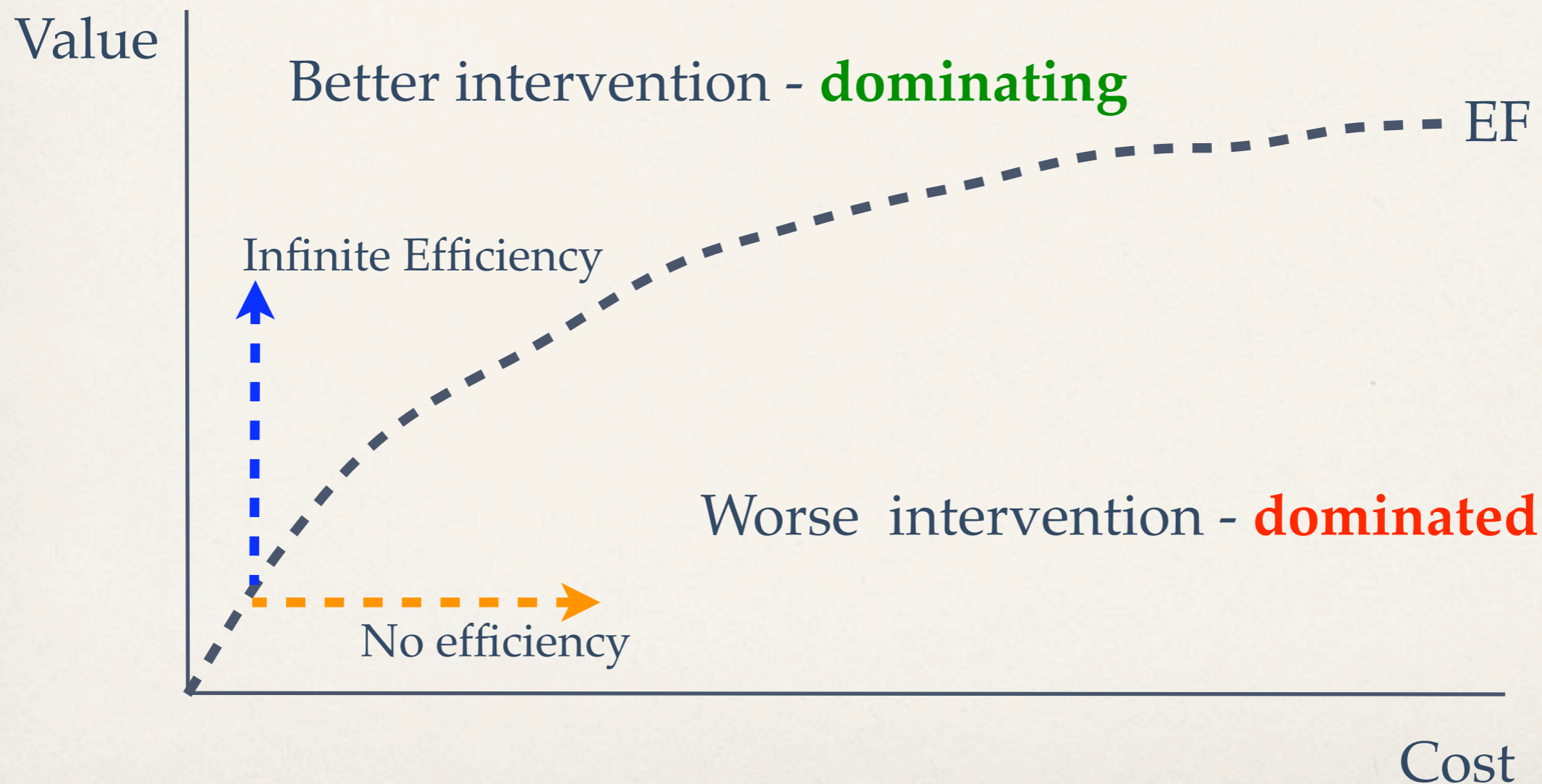
2 x 2 table or the concept of the quadrant

Efficiency Frontier

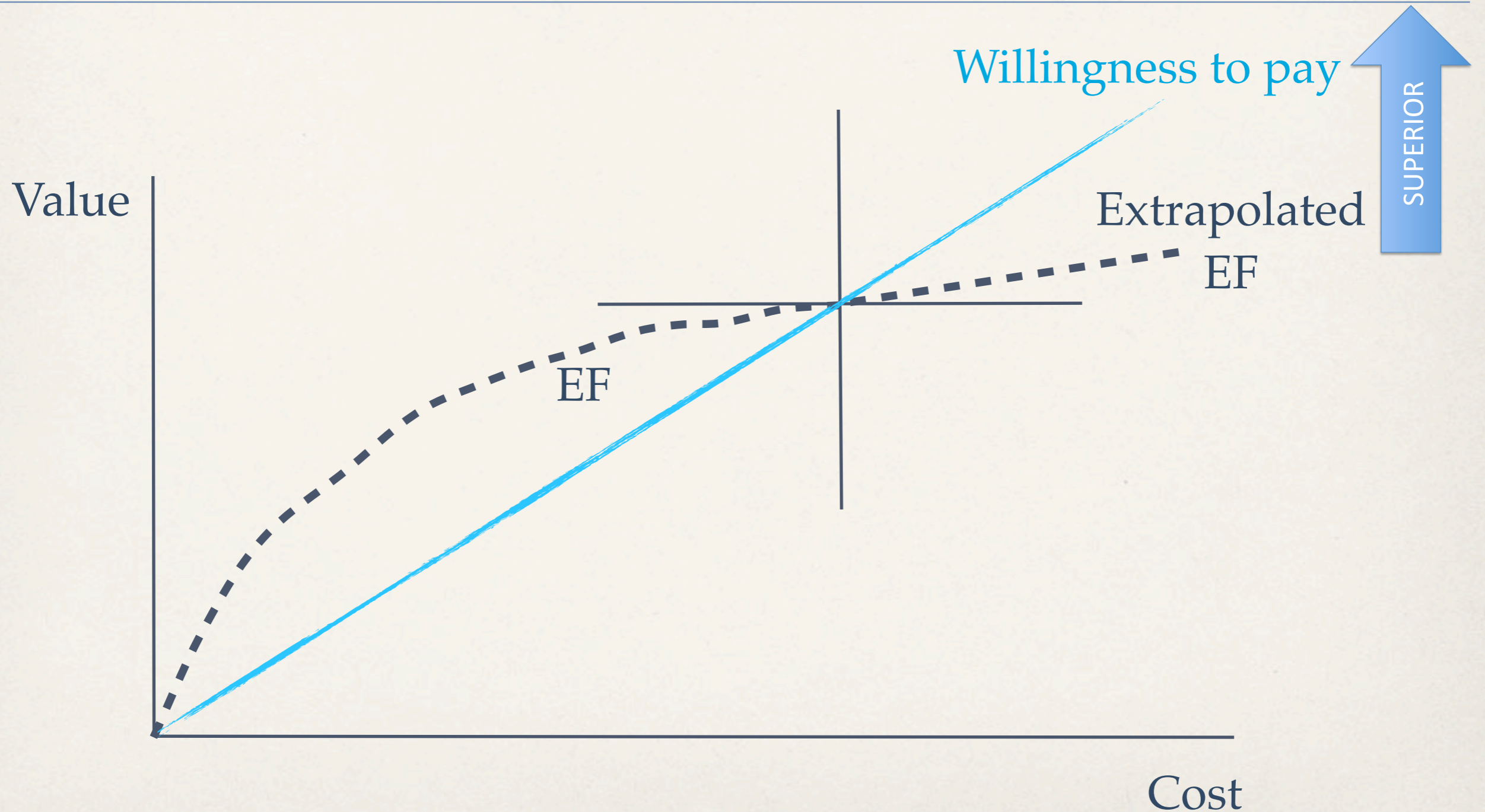
- ❖ Used to 'prioritize' interventions
- ❖ Underlies incremental economic evaluation (cost utility analysis)
- ❖ Long history of use in economics - first in finance (~1950's)
- ❖ Constructed so that it reflects the relevant health technologies in a given therapeutic area with 1) full, detailed specification of the therapeutic area at issue (specific disease, conditions of treatment, the intended patient population, therapeutic sequence, etc)
- ❖ Establishing the costs of existing interventions and the value of the health improvement ("benefit")
- ❖ Locating interventions on a coordinate system with the value of the benefits on the vertical axis and costs on the horizontal

Efficiency Frontier

Reflects the “going rate” for benefits in a specific therapeutic area



Efficiency Frontier - decision making



5 types of economic evaluations

In healthcare

- ❖ Cost Minimization Analysis
- ❖ Cost-Effectiveness Analysis
- ❖ Cost-Utility Analysis
- ❖ Cost-Benefit Analysis
- ❖ 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 Analyses

- * Examples in TB diagnostics (mostly limited to laboratory settings)
 - * Various iLED microscopes - which instrument is the most cost minimizing one for large scale up for 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
 - ❖ To save 1 additional day in Time to Treatment Initiation

CEA - continued

- ❖ Most common type of analysis
- ❖ Incremental Cost Effectiveness Ratio (ICER) - most informative for competing intervention
 - ❖ E.g.
 - ❖ Drug-eluting stents - prevention of revascularization interventions (angioplasty & CABG) = +/- \$ 20K
 - ❖ Screening for breast cancer in 50-69 - \$57000/life year gained
 - ❖ Screening for prostate cancer or down syndrome
 - ❖ Prevention of vaccine-preventable diseases, STDs, HIV and AIDS
- ❖ Limitation - one indicator at a time in analysis

3. Cost Utility Analysis

- ❖ Really a sub-set of CEA
- ❖ Measures cost per health utility (e.g. QALY or DALY)

4. Cost Benefit Analysis

- ❖ 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 study part of CBA
 - ❖ Inputs are measured in terms of opportunity costs
 - ❖ Initial ongoing expense vs. expected return

CBA - limitations

- ❖ Focus on gaining productivity (human capital method)
- ❖ Ethical problems with value of a human life
- ❖ Requirements for data that may be difficult to obtain
- ❖ Conflict - economic vs. public health perspective (e.g. smoking & death at retirement)

5. Cost Consequence Analysis

- ❖ Given the numerous limitations of CUA / CEA / 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

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 %

CCA - Pros and Cons

❖ Pros

- ❖ global perspective
- ❖ Decision-maker evaluates what is important
- ❖ Avoids inadequate hypotheses

❖ Cons

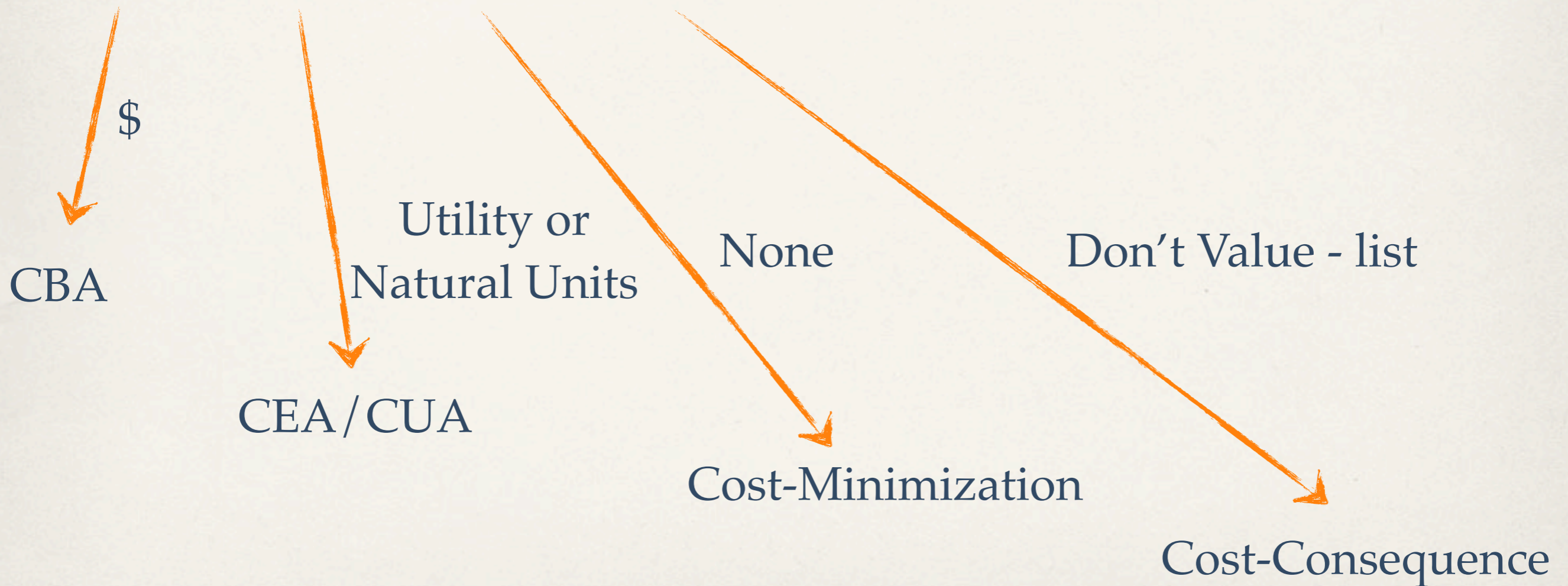
- ❖ burden of analysis for hurried decision-makers

Types of Studies - a summary

Adapted from J. Caro

Value Change in Resource Use

Value Change in Health



Limitations of economic evaluations

- ❖ Efficacy vs. effectiveness
- ❖ Cost-effectiveness directly influential o types of parameters included in the analysis (subjective vs. objective & transparency is an issue)
- ❖ How do we value health effects?
- ❖ Which is worth more? (routine interventions vs heroic intervention)

A checklist for evaluating economic evaluation studies in healthcare

- ❖ Was the question properly asked?
- ❖ Were alternative programs adequately described?
- ❖ Has the program's effectiveness been validated?
- ❖ Were all important & relevant costs & effects identified?
- ❖ Was an appropriate analytical perspective and analysis carried out?
- ❖ Were comparisons between programs properly adjusted for time?
- ❖ 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 settings

- ❖ 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