CEA Part 2

Estimation and Interpretation

CEA-2 Topics

- Average, marginal and Incremental CE ratios
- ICERs with two and more than two treatment options
- Cost effectiveness threshold
- Net Monetary Benefit
- League Tables
- Presentation of CEA results

Multiple CE Ratios

CE ratios are used to inform decision-makers about the efficiency of a given program and relative to other program alternatives.

ACER and MCER do not involve comparison *between* programs

ACER MCER ICER

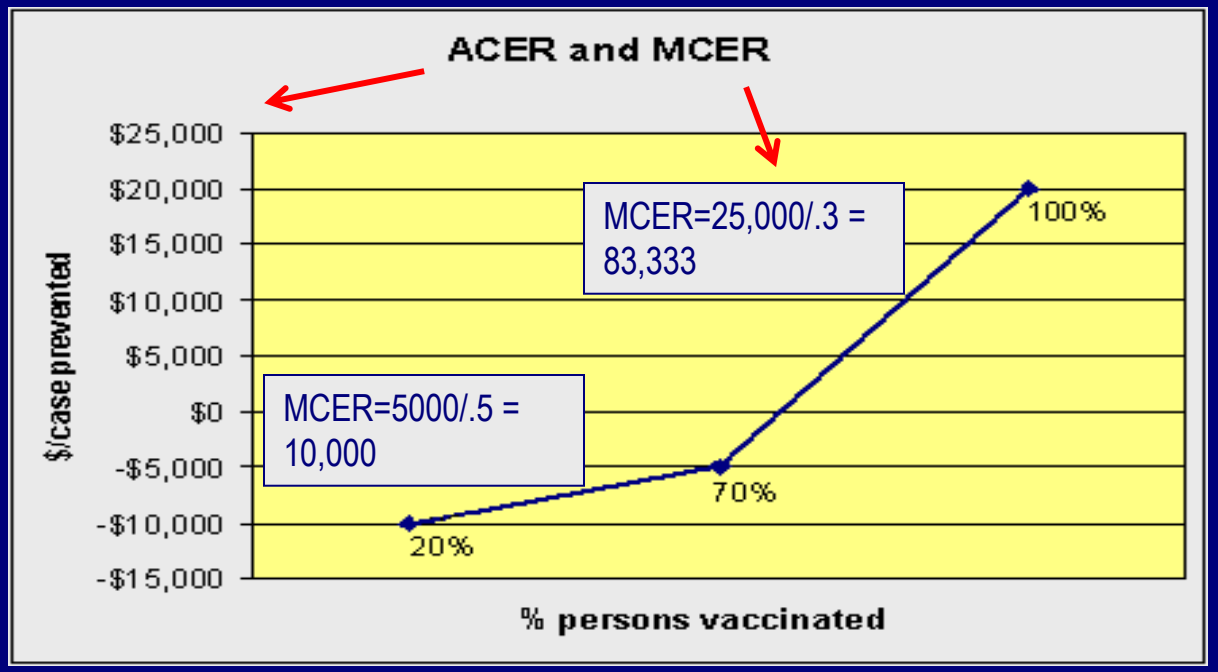
Average Cost-effectiveness Ratio (ACER)

- Deals with a single intervention and evaluates that intervention against its baseline option (e.g., no program or current practice).
- Is calculated by dividing the net cost of the intervention by the total number of health outcomes achieved by the intervention.

Intervention	Net cost	Total outcomes (life-years saved)	ACER cost per life-year saved
Home vaccination program	$50,000	8	$\frac{\$50{,}000}{8} = \$6250$

The marginal cost-effectiveness ratio (**MCER**) assesses the specific changes in cost and effect when a program is expanded or contracted.

ACER and **MCER** for a vaccination program:



At low vaccination coverage rates (70%), the **ACER** is negative, indicating a savings in cost. As that percentage grows, however, so does the **cost per case prevented** because the **marginal cost per each additional person vaccinated** is much higher than the average cost.

Incremental Cost-effectiveness Ratio (ICER)

- Compares the differences between the costs and health outcomes of two or more alternative interventions that compete for the same resources, and is described as the additional cost per additional health outcome.

- The **ICER** numerator includes the differences in program costs, averted disease costs, and averted productivity losses if applicable.

- The **ICER** denominator is the difference in health outcomes.

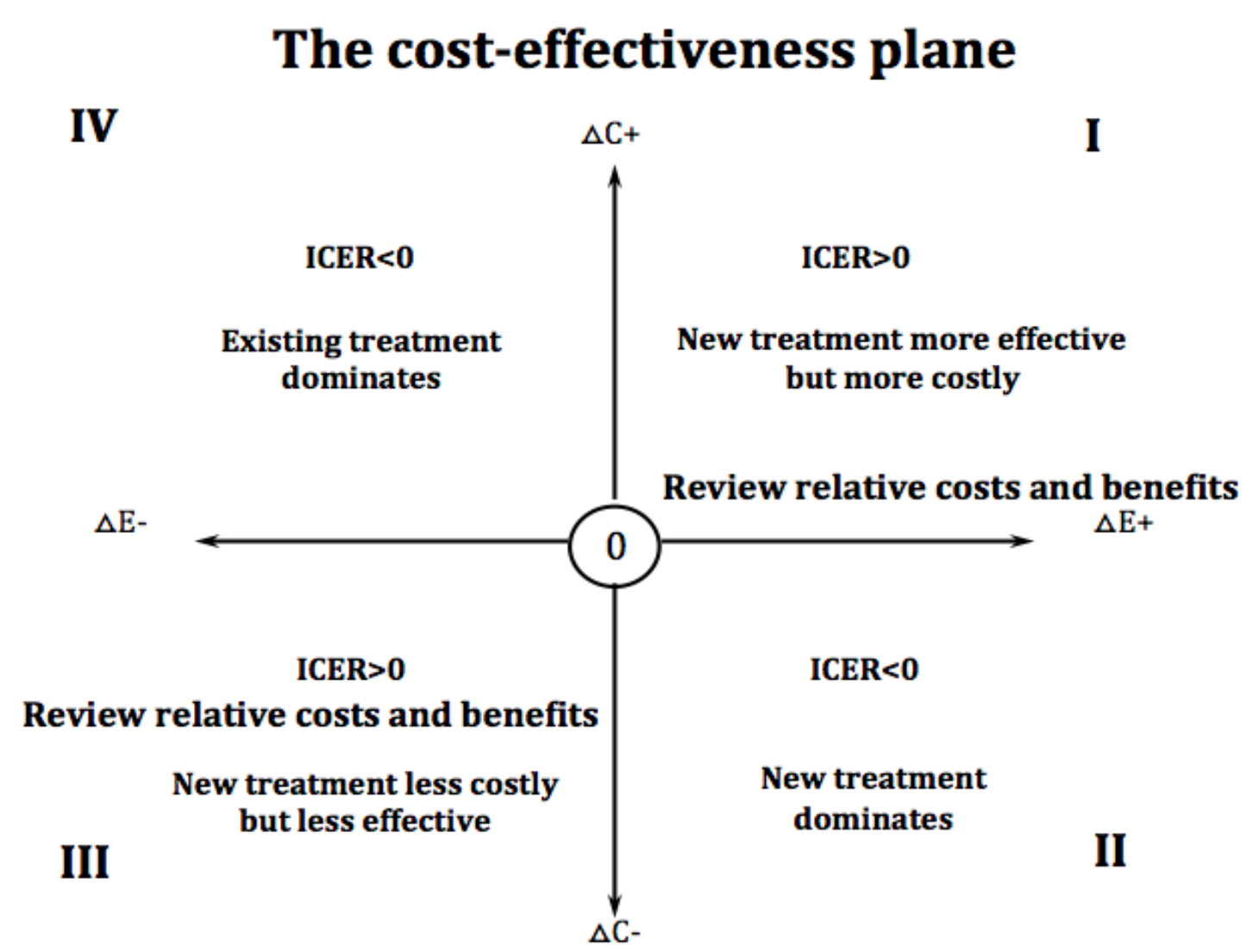
Incremental Cost-effectiveness Ratio (ICER)

- We subtract the base case cost and effectiveness from those of the new intervention.
- ICER Numerator $C_1 – C_0$
- ICER Denominator $E_1 – E_0$
- ICER = $(C_1 – C_0) / (E_1 – E_0)$
- Where the sub-script 1 denotes the new intervention and 0 denotes the base case or control group.
- Positive and negative signs should be examined for the numerator and denominator separately

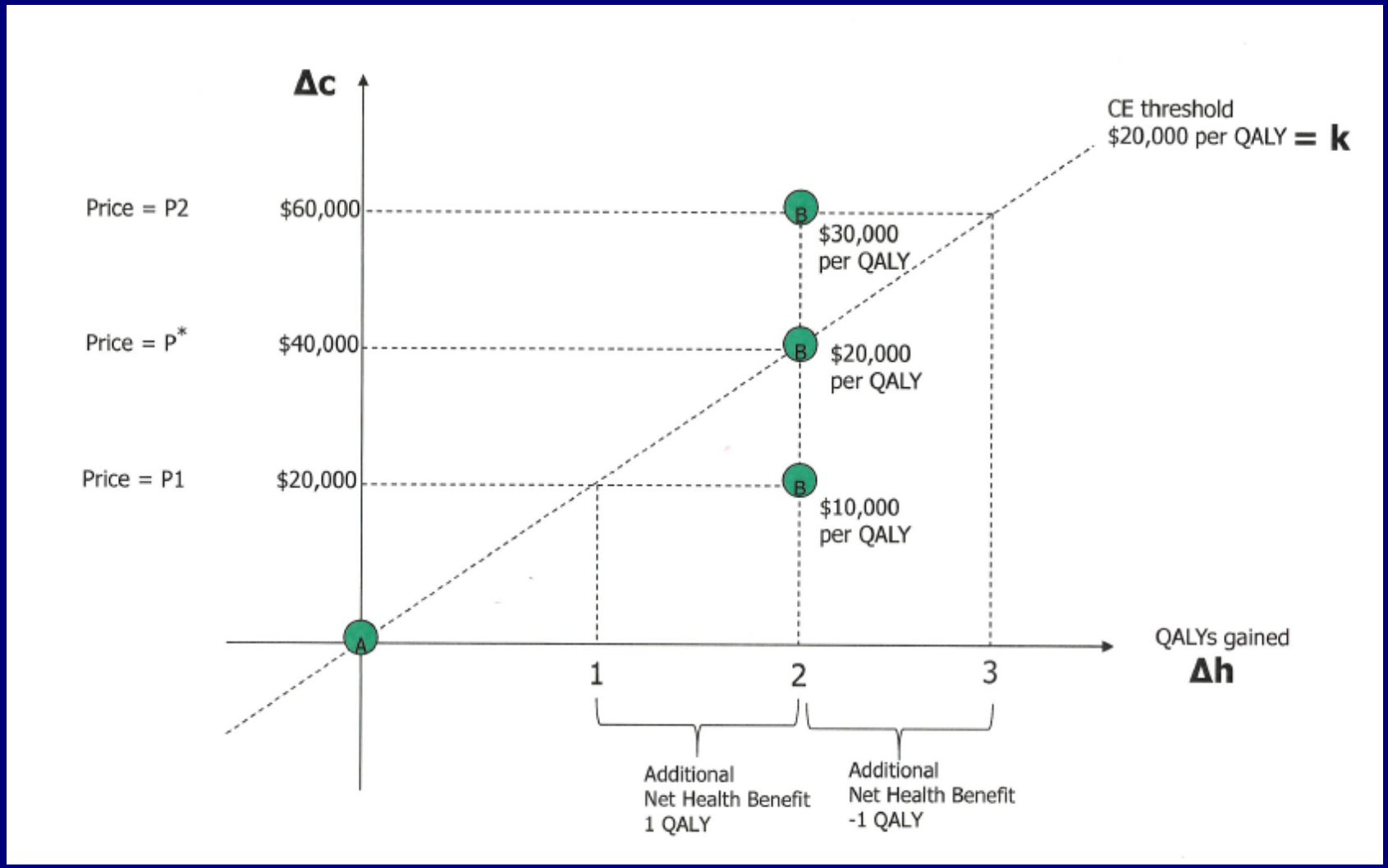
Incremental Cost-effectiveness Ratio (ICER)

- A positive denominator (increase is effectiveness) is desired and a negative denominator is acceptable within bounds (for some stakeholder negative denominator is unacceptable).
- No change in the denominator is acceptable if the numerator is negative (a purely cost-saving strategy).
- Negative numerator implies the new intervention is cost saving and is a good sign if the denominator is positive or zero.
- Positive numerator implies the new intervention costs more and is acceptable within bounds (based on WTP per unit effect.) if the denominator is positive.
- No change in the numerator is acceptable if the denominator is positive.

The Cost-Effectiveness Plane



Cost-Effectiveness Threshold



Cost-Effectiveness Threshold

- When considering quadrant I establishing explicit and evidence based threshold is imperative.
- Resources are limited and costs have to fall within budgets. Increase in cost in one area will often involve cutting costs in another area.
- NICE uses a threshold of £ 20,000 to £ 30,000. In many studies in the US a threshold of $50,000 has been used.
- There are practical and ethical considerations of the threshold.
- Threshold often requires valuation of the effectiveness. Should QALY of a 5 year old, 30 year old and 70 year old be valued the same?

Considering multiple alternatives/options

Table 4.5 ICERs and net benefit with multiple alternatives

	Cost	QALYs	ICERs compared to			Net benefit	
			Lowest cost (A)	Next lowest cost	Relevant alternative	$20,000 per QALY	$30,000 per QALY
A	$4,147	0.593	-	-	-	$7,713	$13,643
B	$8,363	0.658	$64,862	$64,862	ED	$4,797	$11,377
C	$8,907	0.787	$24,536	$4,217	$24,536	$6,833	$14,703
D	$9,078	0.758	$29,885	SD	SD	$6,082	$13,662

Considering multiple alternatives/options

- Multiple pairwise comparisons multiple ICERs
- Example options: A, B, C and D
- First rule out strongly dominated alternatives before performing ICERs. Rule out D, it is strongly dominated by C
- ICER comparison:
  - Pick a comparison/control option and compare all other options to this control option i.e. compare B, C and D to A. Reason for picking A is often – it is the status quo or it is the least effective and least expensive alternative

Considering multiple alternatives/options

- ICER comparison:
  - Order the alternatives by increasing cost and compare to the previous lowest cost
  - Order the alternatives by increasing QALY or effectiveness and compare to the previous lowest QALY
- Ensure that ICER comparisons are performed with all relevant and acceptable alternatives.

Considering multiple alternatives/options

- Moving from A to B is cost-effective at a threshold of $70,000/QALY
- So is moving from A to C or B to C
- As long as A and C exists B will never be chosen – B is not strongly dominated but dominated due to the existence of the combination A and C – B is extendedly dominated or weakly dominated by the existence of A and C together.
- If threshold is $20,000/QALY only option A is viable because C should be compared with A (once B ruled out as extendedly dominated)

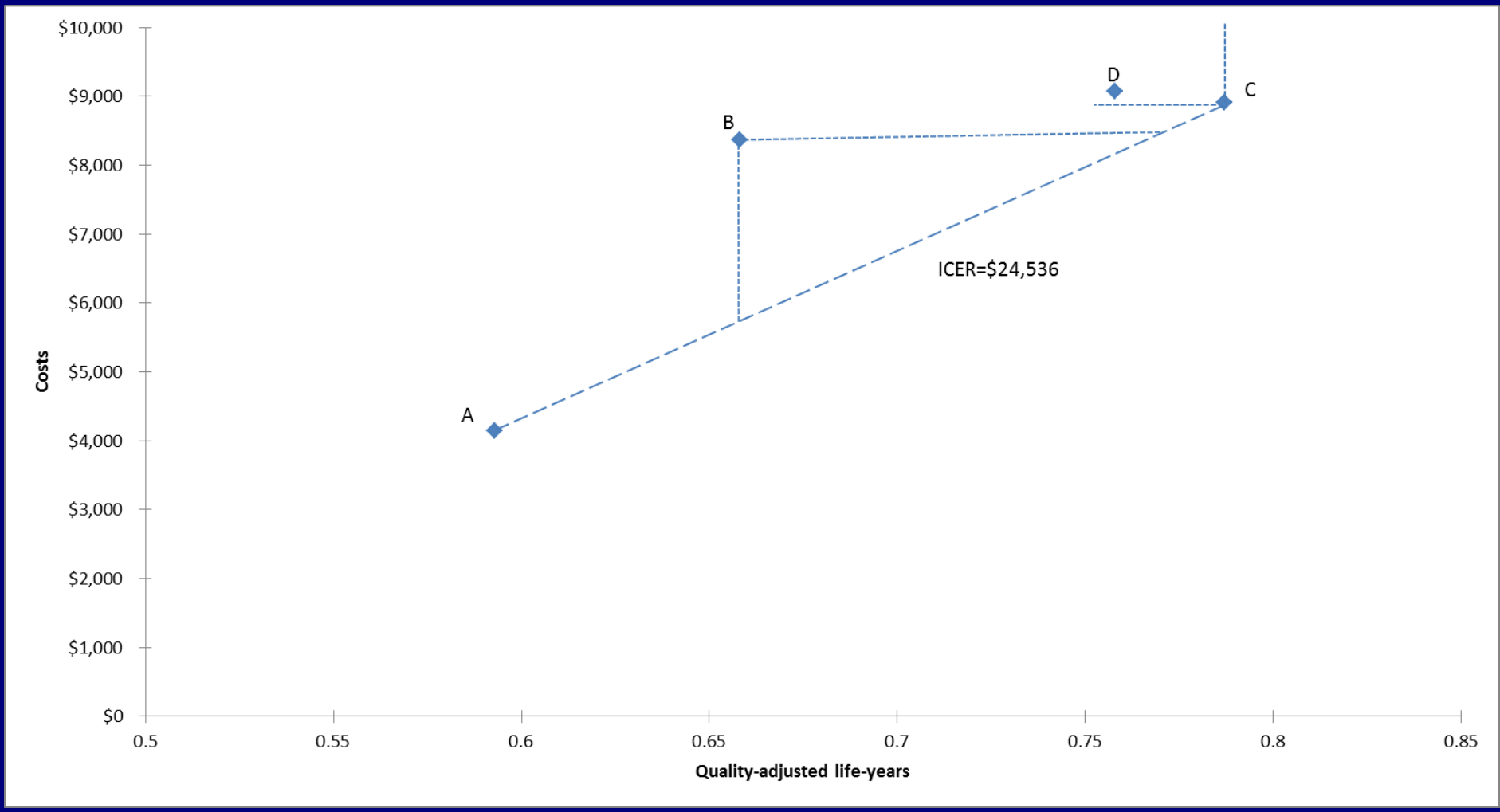
Dominance

- Occurs when one treatment alternative is both more effective and less costly (or equally as costly) than another treatment alternative.
  - Also referred to as strong dominance
  - Quadrant II in slide 11 the new treatment “dominates” the existing
  - The existing treatment “dominates” the new treatment in quadrant IV of slide 11
  - Option D in slide 12 is strongly dominated by C

Extended Dominance

- When an option is not strongly dominated but will never be picked when compared with the options before and after it (when the options are arranged in the order of increasing cost or QALY). Often the linear combination of the options before and after will strongly dominate the extendedly dominated option
- Also called weak dominance
- Example: Option B in slide 12. If A is provided to 50% of the population and C to the remaining 50% the cost of this combination is $6,527 and effectiveness is 0.69 which strongly dominates B. Any linear combination of A and C dominates B.

Extended Dominance



Extended Dominance

- For the extended dominance by a linear combination to be realistic certain assumptions have to be met
  - Treatments are perfectly divisible
  - When C and A are delivered to a smaller proportion of the population the fixed and variable costs, and effectiveness are such that the cost-effectiveness stays the same
  - These assumptions are often not true hence B is extendedly dominated (due to the existence of A and C) not strongly dominated

Disadvantages of ICERs

- Issues when using ICERs
  - CE ratios give no indication of size or scale of treatments or programs being assessed
  - The numerator and denominator needs to be examined separately because the positive or negative sign of the ICER can mean opposite things if the denominator changes sign
  - Testing for statistical differences between ratios give rise to complications
    - ICERS can be negative
    - If the denominator of ICER is zero (no effect) the ratio is infinite
    - As a ratio statistic, the ICER is not easy to use in a regression analysis and regression analysis can be utilized to control for covariates and for conducting subgroup analysis.

Computing Net Monetary Benefit

- The threshold for the ICER or the willingness to pay per unit effectiveness (R_T) is used to place a monetary value on the effectiveness
- A positive NMB is good and a negative NMB is unacceptable

A program is cost-effective if it has a positive net monetary benefit (NMB):

- $\Delta C / \Delta E < R_T$, rearranging gives:
- $R_T \Delta E - \Delta C > 0$
  - $R_T \Delta E - \Delta C$ is the NMB of the program. The change in effectiveness (ΔE), multiplied by the decision-maker willingness to pay per unit of increased effectiveness (R_T), less the increase in cost (ΔC).
- Example: if R_T = \$50,000; ΔE = 10; ΔC = \$200,000.
  - NMB = (\$50,000 x 10) - \$200,000 = \$300,000

When ICER = Threshold

- NMB is 0 when the ICER for the health program is equal to the CE threshold.
- Example:

$$If\ RT = \$20{,}000;\ \Delta E = 10; and\ \Delta C = \$200{,}000$$

$$NMB = RTx\Delta E - \Delta C$$
$$= \$20{,}000\ x\ 10 - \$200{,}000$$
$$= \$0$$

Results of NMB as function of R_T

- When R_T is 0, the intercept on the y axis represents the negative value of the incremental cost of the program compared with existing care.

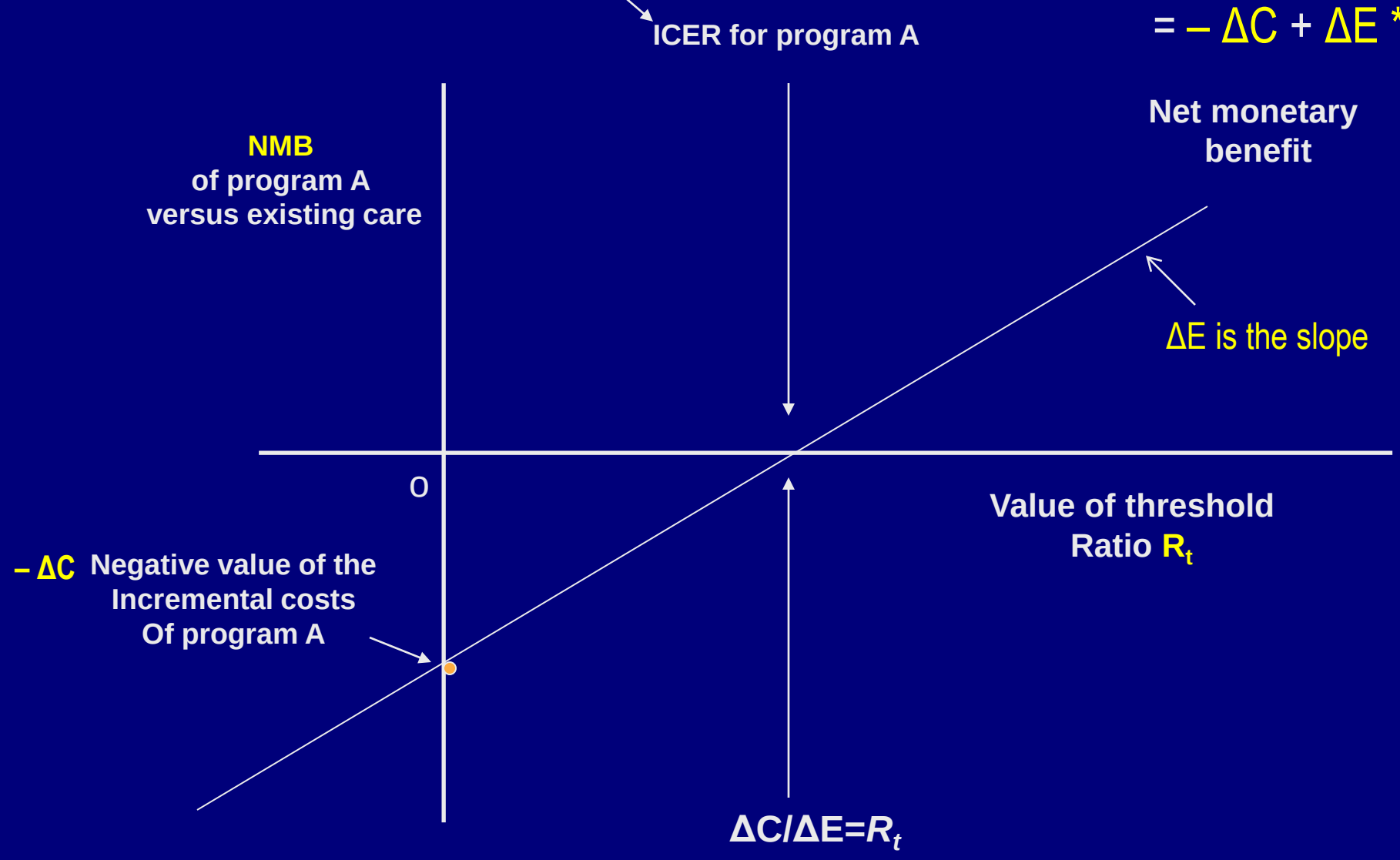
- $If\ RT = \$0;\ \Delta E = 10; and\ \Delta C = \$200{,}000$

$$NMB = RT\ x\ \Delta E - \Delta C$$
$$= \$0\ x\ 10 - \$200{,}000$$
$$= -\$200{,}000$$

ICER = ΔC / ΔE

NMB= RT * ΔE – ΔC

= – ΔC + ΔE * RT



Net Monetary Benefit as a function of the threshold cost-effectiveness ratio.

League Tables

- Rankings of cost-effectiveness of various health and medical interventions
- Listing the cost per QALY of the current study with other interventions
- Tufts New England Medical Center Web Site (comprehensive list of cost-utility ratios in health and medicine)

http://healtheconomics.tuftsmedicalcenter.org/cear4/Home.aspx

Presentation of CEA Results

- The study question.
- A description of the interventions.
- **Study perspective, time frame, and analytic horizon**.
- The assumptions used to build the model.
- Evidence of the effectiveness of the interventions.
- Identification, enumeration, and valuation of all relevant costs.
  - Inclusion or exclusion of productivity costs.
  - Discount rate.

Presentation of CEA Results

- Results of incremental analysis.
- Results of uncertainty analysis (mock-up tables).
  - Sensitivity analysis
  - Statistical analysis
- Discussion of results that addresses all issues of concern and the implications of assumptions used.

Summary

- CEA usually involves the computation of ICER. ACER and MCER are less commonly used.
- Before computing the ICER all strongly dominated strategies should be excluded
- Examine the numerator and denominator of the ICER to understand what the sign of the ICER implies
- NMB analysis can be performed along with the ICER to make the results of the CEA more intuitive and to also use advanced regression methods if need be