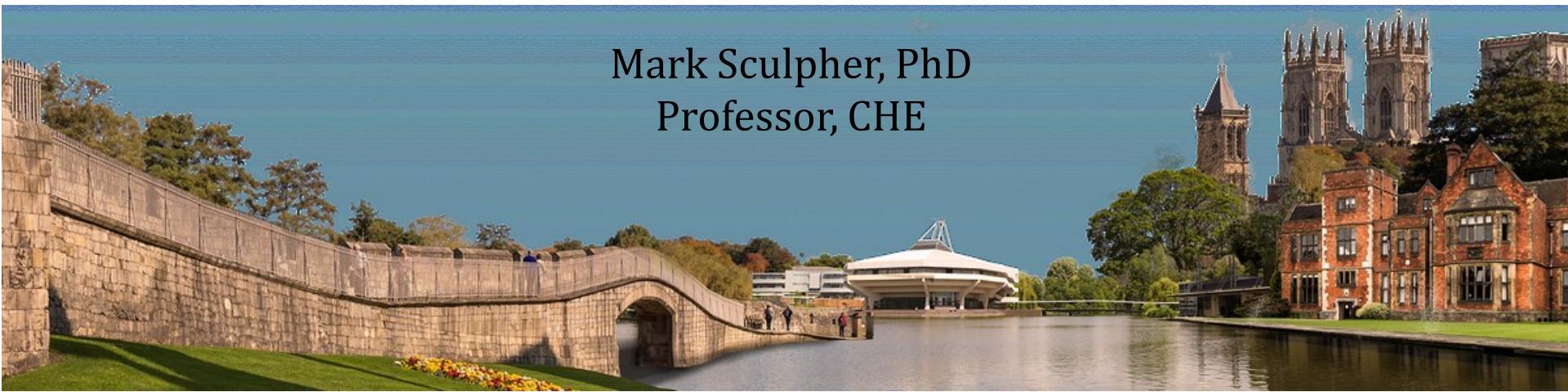


Online Advanced Methods for Cost-Effectiveness Analysis

Welcome Presentation

Mark Sculpher, PhD
Professor, CHE



Outline

- Who are we?
- Who are you?
- The workshop
- Communication

Who am I?

Academic

- 30+ years as researcher in health economics
- Focus on informing policy decisions
- Interest in methods development
- 300+ publications plus two major textbooks

Decision-making

- NICE Appraisal Committee 2003-8
- NICE Public Health Advisory Committee 2005-9
- NICE Diagnostic Advisory Group 2010-20
- Advice on methods for HTA in several countries
- Numerous research funding committees

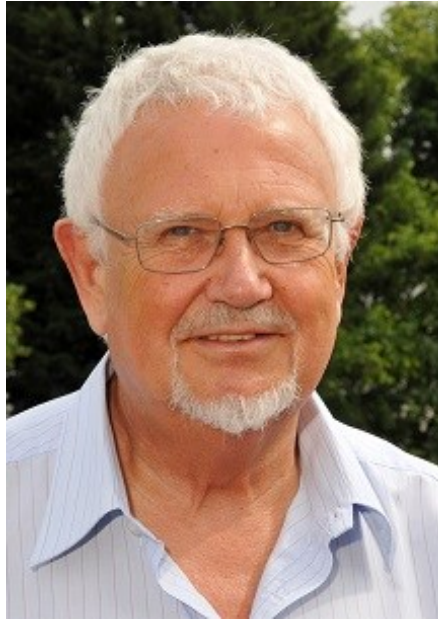
Spare time

- Manchester United FC
- Wine and song
- Vegetables

Who else? Workshop Leaders



Professor Mark Sculpher
Topics 1, 2 and 4



Professor Mike Drummond
Topics 1 and 4

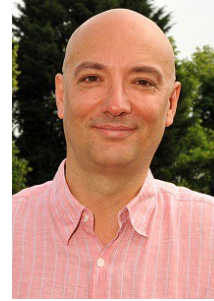


Ms Rita Faria
Topics 2-7

Who else? Presenters



Rita Faria
Senior Research Fellow
Topics 2-7 Exercises



Andrea Manca
Professor
Topic 5



Stephen Palmer
Professor
Topics 3 and 6



Susan Griffin
Professor
Topic 7



Pedro Saramago
Senior Research Fellow
Topic 3



Claire Rothery
Senior Research Fellow
Topic 7

Who else? Tutors






All details on VLE – Your Presenters and Tutors

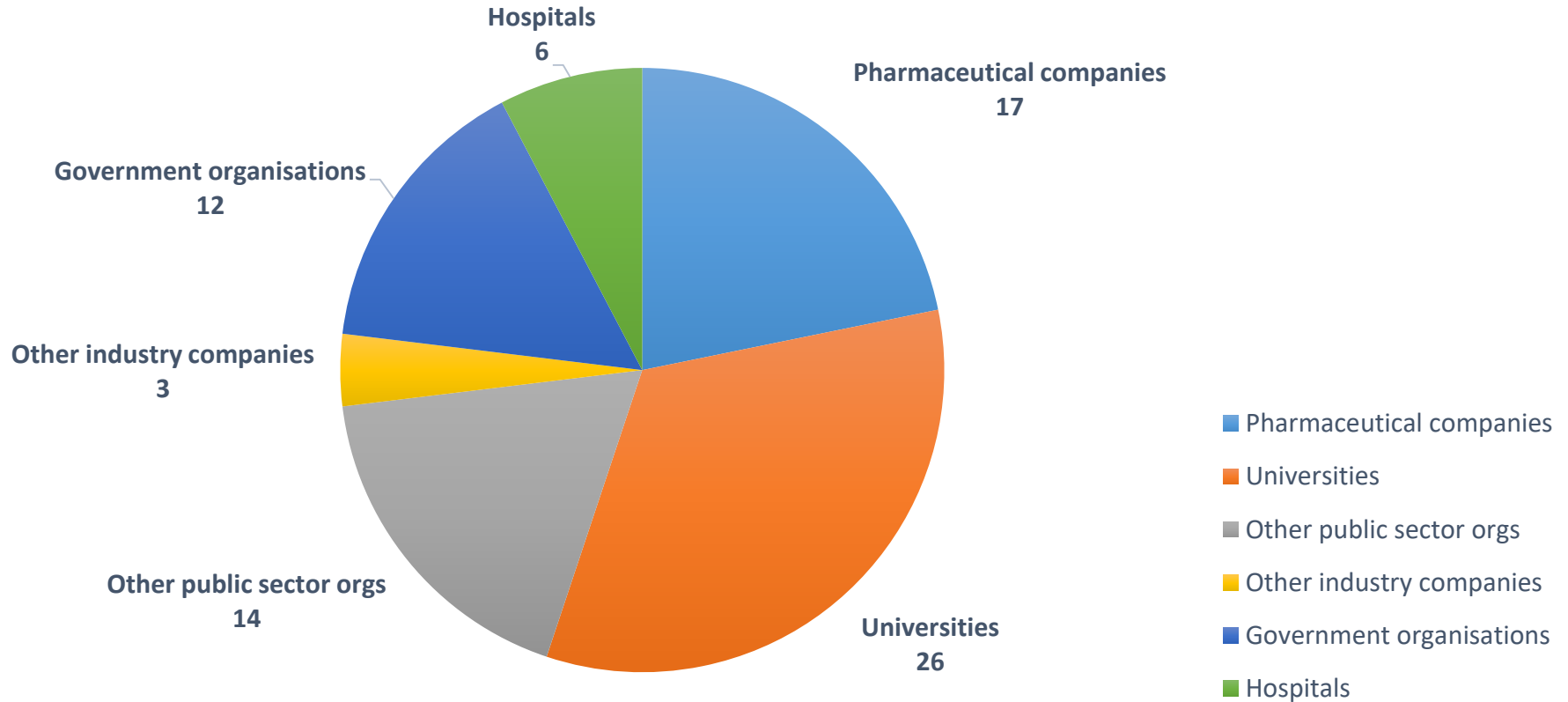
78 participants (at 22.10.21)

Who are you? Countries

Country		Participants
Australia		4
Belgium		3
Canada		1
China		1
Croatia		1
Denmark		2
Ecuador		2
Finland		2
Germany		6
India		1
Italy		2
Japan		1
Kenya		1
Netherlands		1

Country		Participants
Norway		2
Pakistan		2
Philippines		1
Portugal		1
Qatar		1
Republic of Korea		1
Saudi Arabia		1
Singapore		3
Sweden		5
Tunisia		4
United Kingdom		25
USA		3
Vietnam		1

Who are you? Organisations



The workshop: sequence of activities

Time



Activity 1

Watch presentations

- Videos on VLE

Activity 2

Attempt exercises

- All materials on VLE
- Tutors available

Activity 3

Live Q&A session

- Discussion on whole topic
- Recorded for later viewing

The schedule

Date		VLE materials for self study	Tutors on Discussion Board	Live Q&As
Topic 1	Presentation 1	Analytical starting points	8-10 November	Wednesday 10 November
8-10 November	Exercise 1	Decision rules	between 9.00am – 5.00pm	12 noon – 1.00pm GMT/UTC
Topic 2	Presentation 2	11-15 November	11, 12 and 15 November	Monday 15 November
11-15 November	Exercise 2	Conceptualisation	between 9.00am – 5.00pm	12 noon – 1.00pm GMT/UTC
Topic 3	Presentation 3	Populating models - effectiveness	16-18 November	Thursday 18 November
16-18 November	Exercise 3	Effectiveness	between 9.00am – 5.00pm	12 noon – 1.00pm GMT/UTC
Topic 4	Presentation 4	Populating models - costs and outcomes	19, 22 and 23 November	Tuesday 23 November
19-23 November	Exercise 4	Assembling costs and outcomes	between 9.00am – 5.00pm	12 noon – 1.00pm GMT/UTC
Topic 5	Presentation 5	Analysing individual patient data	24-26 November	Friday 26 November
24-26 November	Exercise 5	Working with individual patient data	between 9.00am – 5.00pm	12 noon – 1.00pm GMT/UTC
Topic 6	Presentation 6	Model structure	29 Nov – 1 Dec	Wednesday 1 December
29 Nov – 1 Dec	Exercise 6	Building a decision model	between 9.00am – 5.00pm	12 noon – 1.00pm GMT/UTC
Topic 7	Presentation 7	Uncertainty, heterogeneity and the value of information	2-3 December	Friday 3 December
2-3 December	Exercise 7	Uncertainty and value of information	between 9.00am – 5.00pm	12 noon – 1.30pm GMT/UTC

Other resources

- Interviews with key experts
- Learning resources
 - 'Blue Book'
 - Excel functions
 - Glossary
 - University of York Library
- Useful links

Communication

Technical & non-academic issues

Email Kay and Ness: irss82@york.ac.uk

Questions on presentations

Topic-specific Discussion Forums
Live Q&A

Questions on exercises

Topic-specific Discussion Forums
Live Q&A

Other questions and comments

General Chat & Questions Forum
Live Q&A
End of Workshop Live Q&A

Evaluation/Feedback Form



Your feedback on this workshop is vital to us to enable the continued success of CHE's online short courses and workshops



Please take some time to complete our Advanced Online Workshop Evaluation/Feedback Form on the VLE

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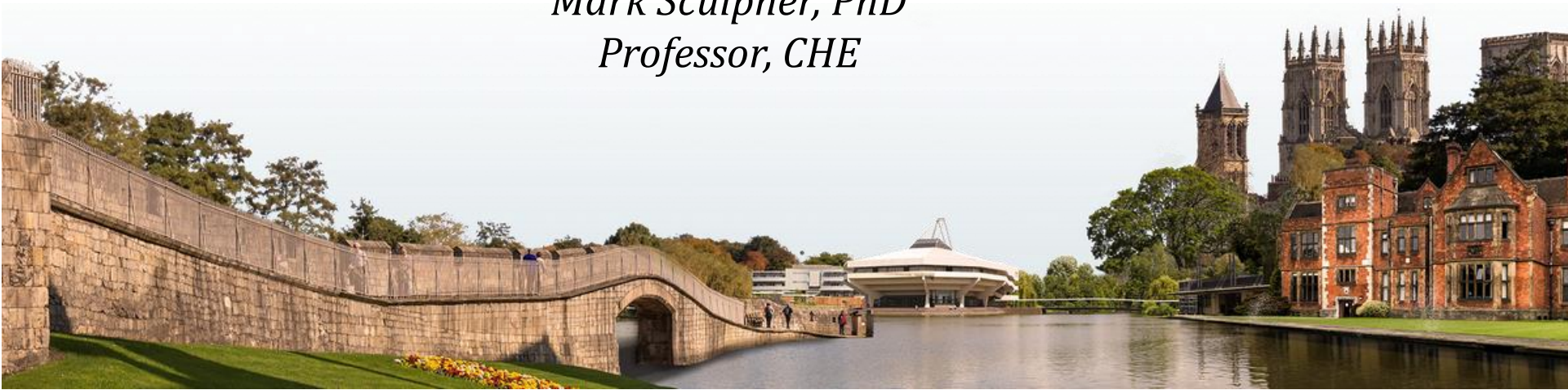


<https://www.linkedin.com/company/79838911>

Online Advanced Methods for Cost-Effectiveness Analysis

Presentation 1: Analytical Starting Points 1.1: Overview and objectives

Mark Sculpher, PhD
Professor, CHE



Overview

- Health systems' resource allocation decisions reflect
 - Potentially infinite claims on resources
 - Finite funding
- Policymakers increasingly use economic evaluation to inform some types of decisions
- Cost-effectiveness analysis is widely used in health
- Need to understand key principles to study complexities, challenges and methods advances

Sections

- Presentation 1.2: Analytical starting points - decisions
- Presentation 1.3: Analytical starting points – ‘decision rules’
- Presentation 1.4: Analytical starting points - net benefits
- Presentation 1.5: Analytical starting points - conclusions

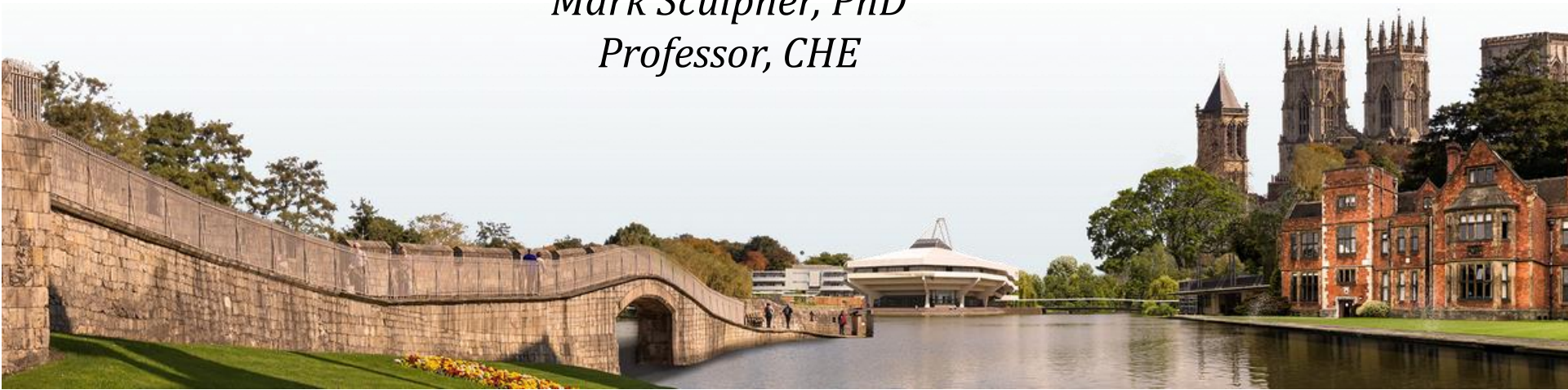
Objectives

- Consider types of decisions that economic evaluation can inform
- Review appropriate analytical methods
- Understand how cost-effective options are established ('decision rules')
- Distinguish incremental cost-effectiveness ratios from net benefits

Online Advanced Methods for Cost-Effectiveness Analysis

Presentation 1: Analytical Starting Points 1.2: Decisions

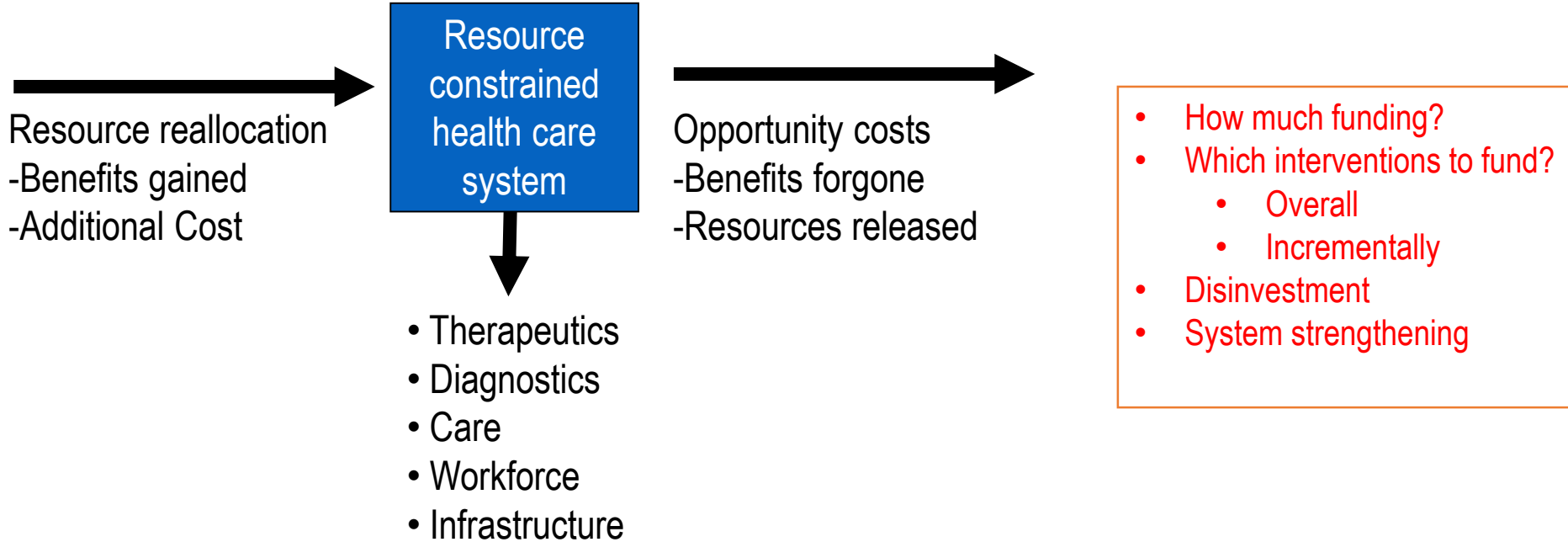
Mark Sculpher, PhD
Professor, CHE



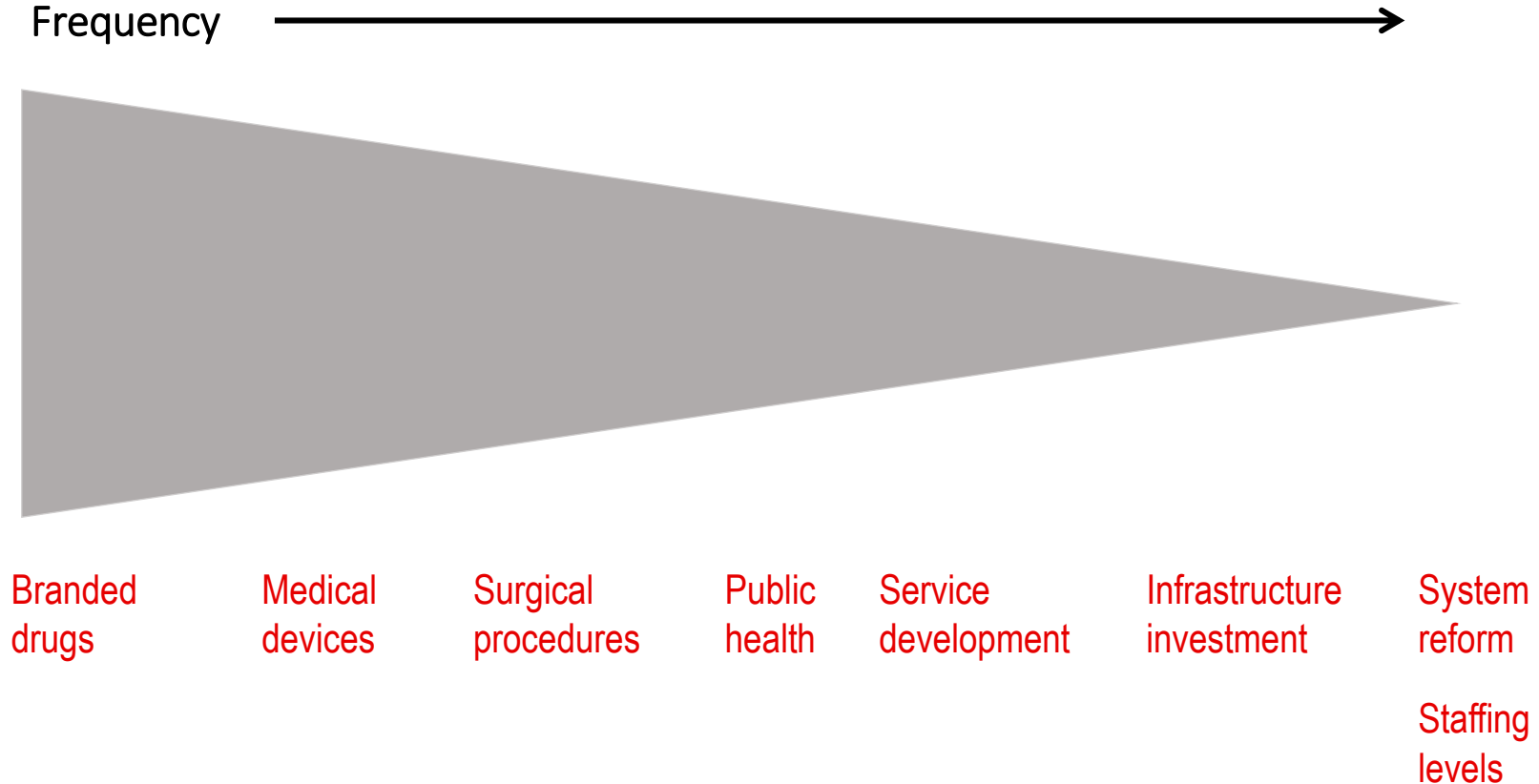
Objectives

- Understand key aspects of economic evaluation for decisions
- Clear about emerging policy trends
- Appreciate different types of decisions
- Understand appropriate analysis for different decisions

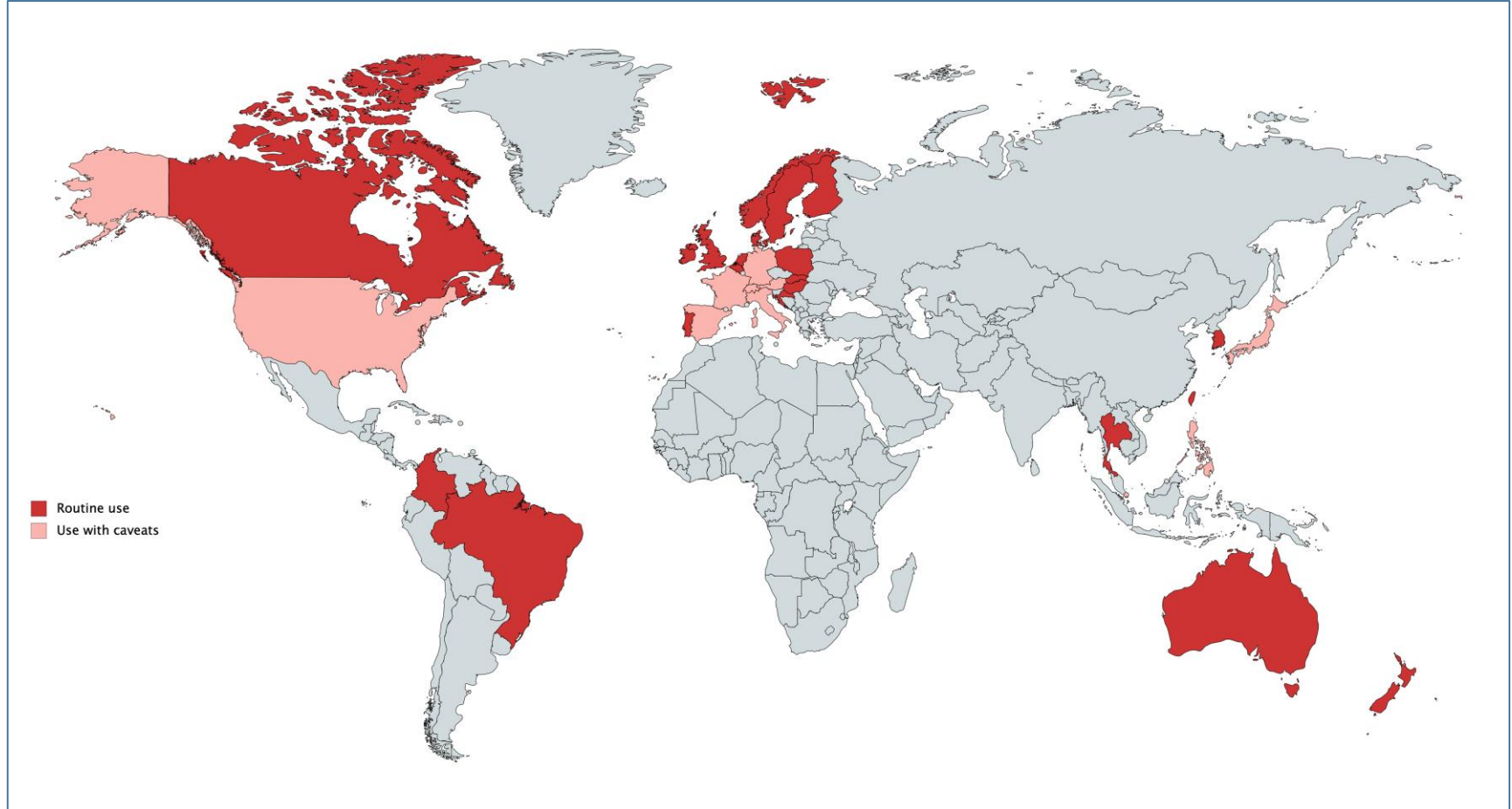
Economic evaluation to inform decisions



What types of intervention?



Economic evaluation in drug funding decisions



Positive versus normative

- Positive
 - How do decision makers reach decisions?
 - What factors do they take into account?
- Normative
 - How should decisions be made?
- What position should analysts take?
 - Reflect decision makers' stated requirements
 - Present all relevant information
 - Seek to make decisions transparent
 - Contribute to making decision makers accountable?

Two decisions for health care interventions

Is the intervention cost-effective based on existing evidence?

		Yes	No
Is additional research valuable?	Yes	Adopt Demand additional evidence Revisit decision	Do not adopt Demand additional evidence Revisit decision
	No	Adopt Do not demand extra evidence Review decision if other evidence emerges	Do not adopt Do not demand extra evidence Review decision if other evidence emerges

Analytical requirements for decision making

Adoption decision – decision problem

Relevant population



- As specific as possible
- Often defined by line of treatment (e.g. 1st line treatment of metastatic breast cancer)

Relevant sub-population(s)



- One or more sub-groups
- Possibility of heterogeneity

Options being compared



- Full range of options
- May be intervention of interest plus comparators
- Includes strategies (e.g. sequences, stopping rules)

Analytical requirements for decision making

Adoption decision – design

Clear objective function



- No consensus on fully specified function
- Centrality of health
- Can include other factors (e.g. severity, inequality)

Defining constraints



- Usual focus on financial (budget) constraints
- Increasing interest in real resource constraints

Usual all relevant evidence



- Importance of systematic evidence identification
- Different type of evidence
- Quality assessment, synthesis

Analytical requirements for decision making

Research decision

Quantification of uncertainty



- Consider all evidence simultaneously
- Ideally parametric and structural
- Decision uncertainty – probability of a wrong decision

'Costs' of a wrong decision



- In terms of health or financial costs
- Aggregate to population level
- Equivalent to value of perfect information

Implications for decisions



- Adds to decision options with research
- Will research be undertaken if adopted?
- How long will research take?
- Will other information emerge to reduce uncertainty?

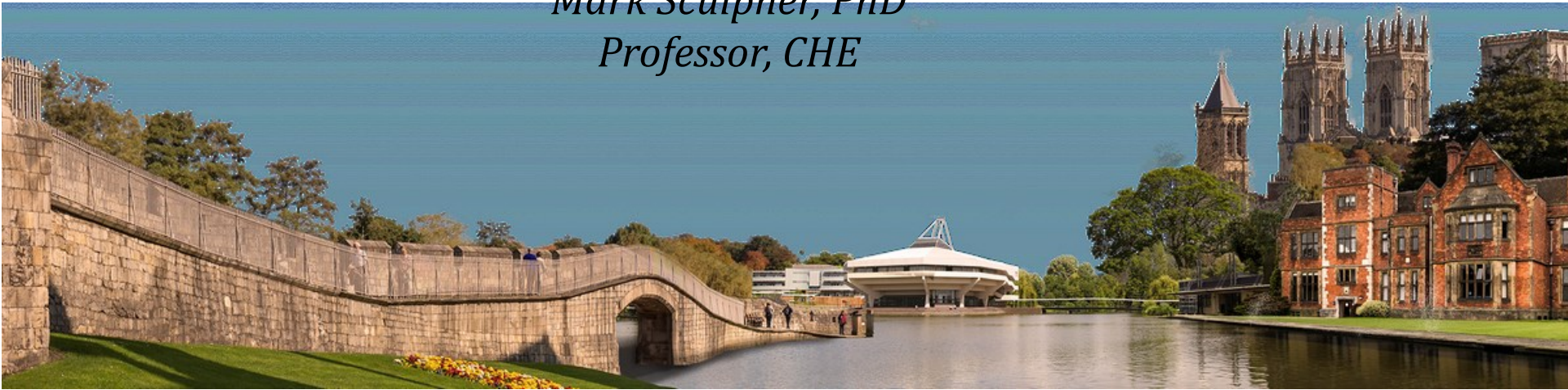
Summary

- Increasing use of economic evaluation in policy
- Focus on pharmaceuticals but principles apply more widely
- Important distinction between adoption and research decisions
- Important principles of analysis to address each question

Online Advanced Methods for Cost-Effectiveness Analysis

Presentation 1: Analytical Starting Points 1.3: 'Decision rules'

Mark Sculpher, PhD
Professor, CHE



Objectives

- Distinguish between independent programmes and mutually exclusive options
- Appreciate details of cost-effectiveness plane
- Understand dominance and ICERs
- Consider role of cost-effectiveness threshold
- Beware its multiple meanings
- Understand importance of an empirical measure of opportunity cost

Programmes and options

Independent programme

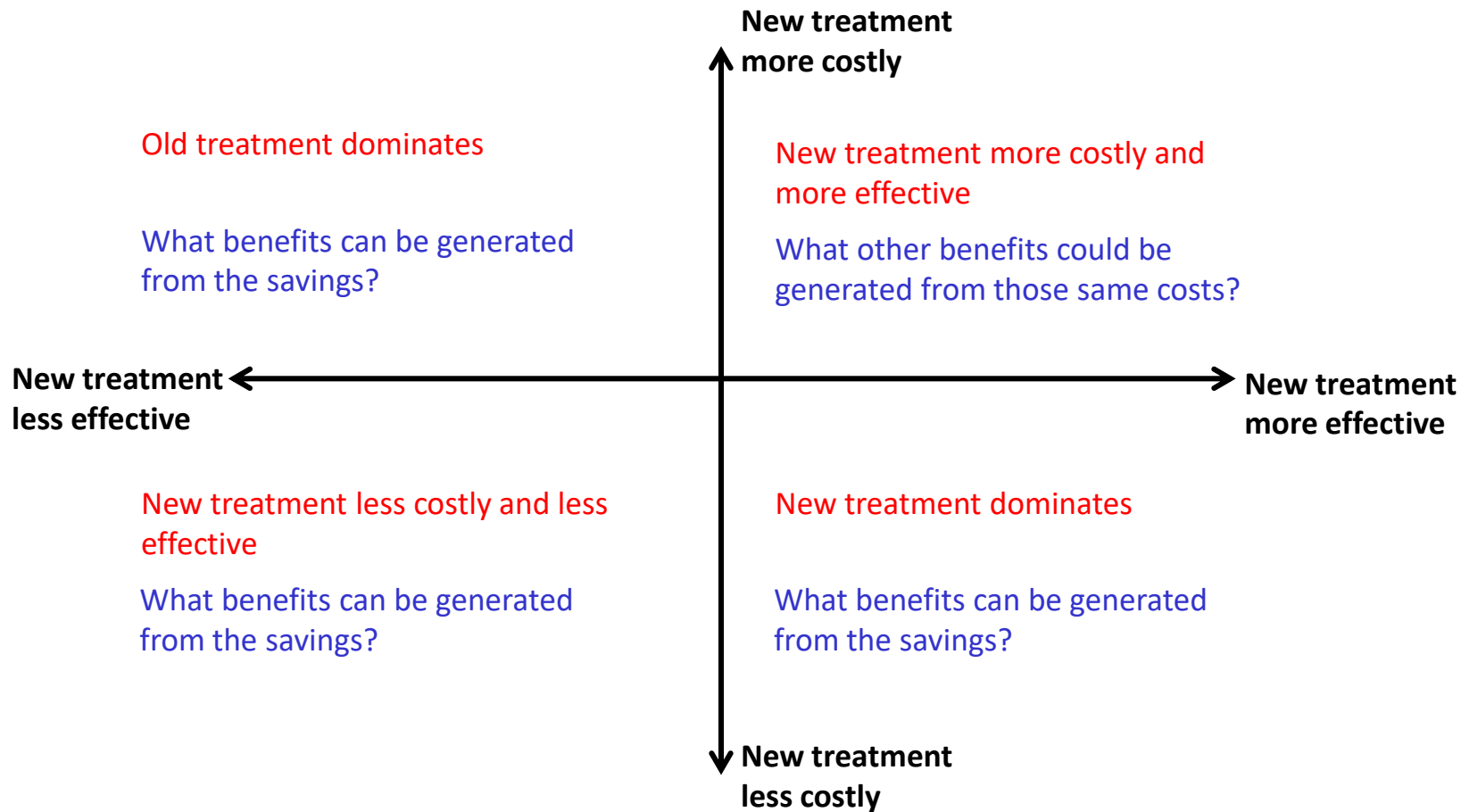
- Essentially the population
- e.g. severe migraine



Mutually exclusion options

- Comparison of all options
- One must be selected

Cost-effectiveness plane



Examples of mutually exclusive options within independent programmes

<u>Management of angina</u>			<u>Breast screening</u>			<u>Treatment of HIV</u>		
Option	Costs	Effects	Option	Costs	Effects	Option	Costs	Effects
A	20,000	8	A	110,000	20	A	30,000	25
B	30,000	4	B	120,000	29	B	56,000	40
C	50,000	19	C	150,000	50	C	78,000	42
D	60,000	23	D	190,000	60	D	115,000	62
E	110,000	20	E	240,000	70	E	150,000	74

Dominance

Management of angina

Option	Costs	Effects
--------	-------	---------

A	20,000	8
---	--------	---

B	30,000	4
---	--------	---

C	50,000	19
---	--------	----

D	60,000	23
---	--------	----

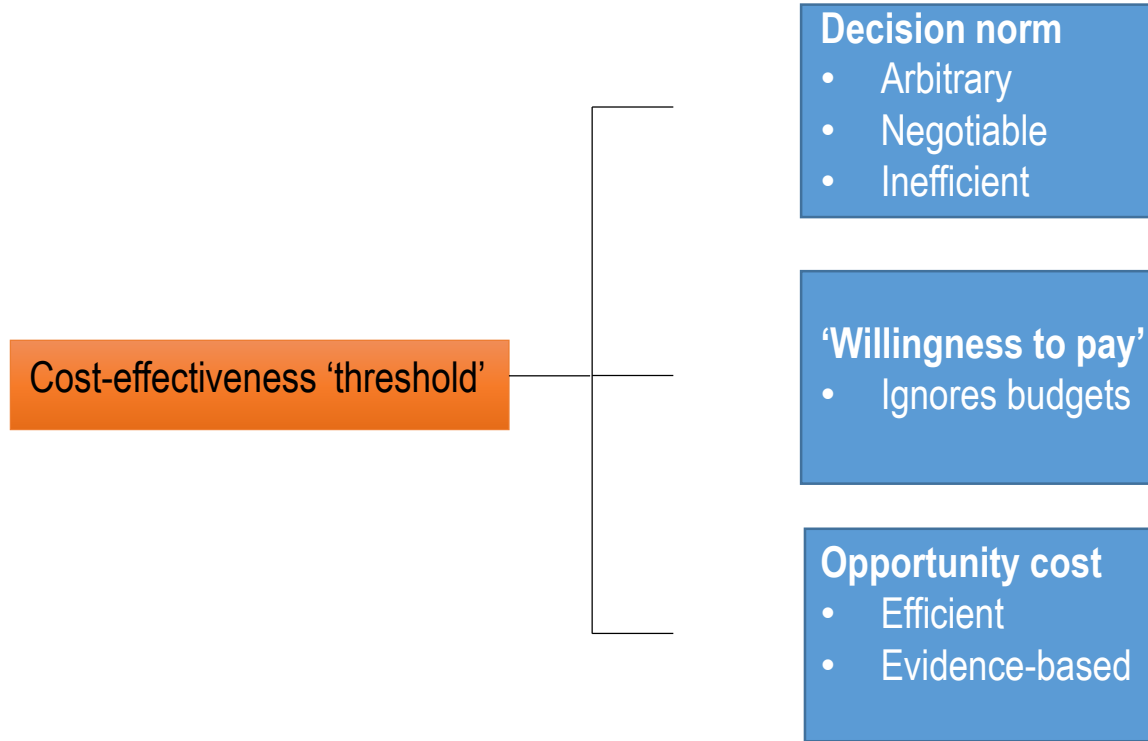
E	110,000	20
---	---------	----

→ Dominated: B and E have lower effects and higher cost than other options. B and E are removed from consideration.

Incremental cost-effectiveness ratios (ICERs)

Option	<u>Breast screening</u>		$\Delta C / \Delta E$
	Costs	Effects	
A	110,000	20	-
B	120,000	29	1,111
C	150,000	50	1,429
D	190,000	60	4,000
E	240,000	70	5,000

Making decisions from ICERs



Evidence of opportunity costs

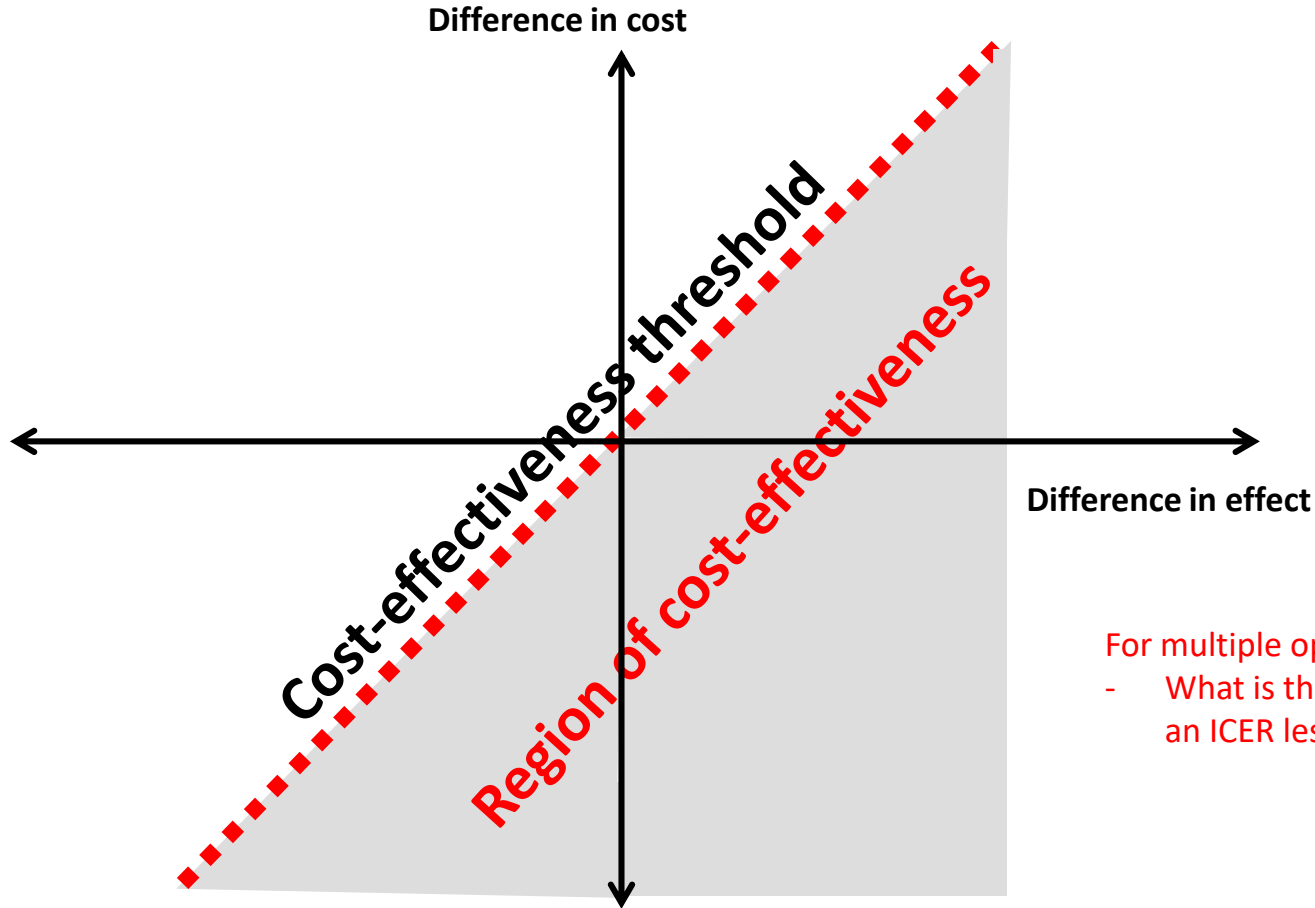
HEALTH TECHNOLOGY ASSESSMENT

VOLUME 19 ISSUE 14 FEBRUARY 2015
ISSN 1366-5278

**Methods for the estimation of the National
Institute for Health and Care Excellence
cost-effectiveness threshold**

*Karl Claxton, Steve Martin, Marta Soares, Nigel Rice, Eldon Spackman,
Sebastian Hinde, Nancy Devlin, Peter C Smith and Mark Sculpher*

Cost-effective region of cost-effectiveness plane



For multiple options:

- What is the most effective with an ICER less than the threshold?

Extended dominance

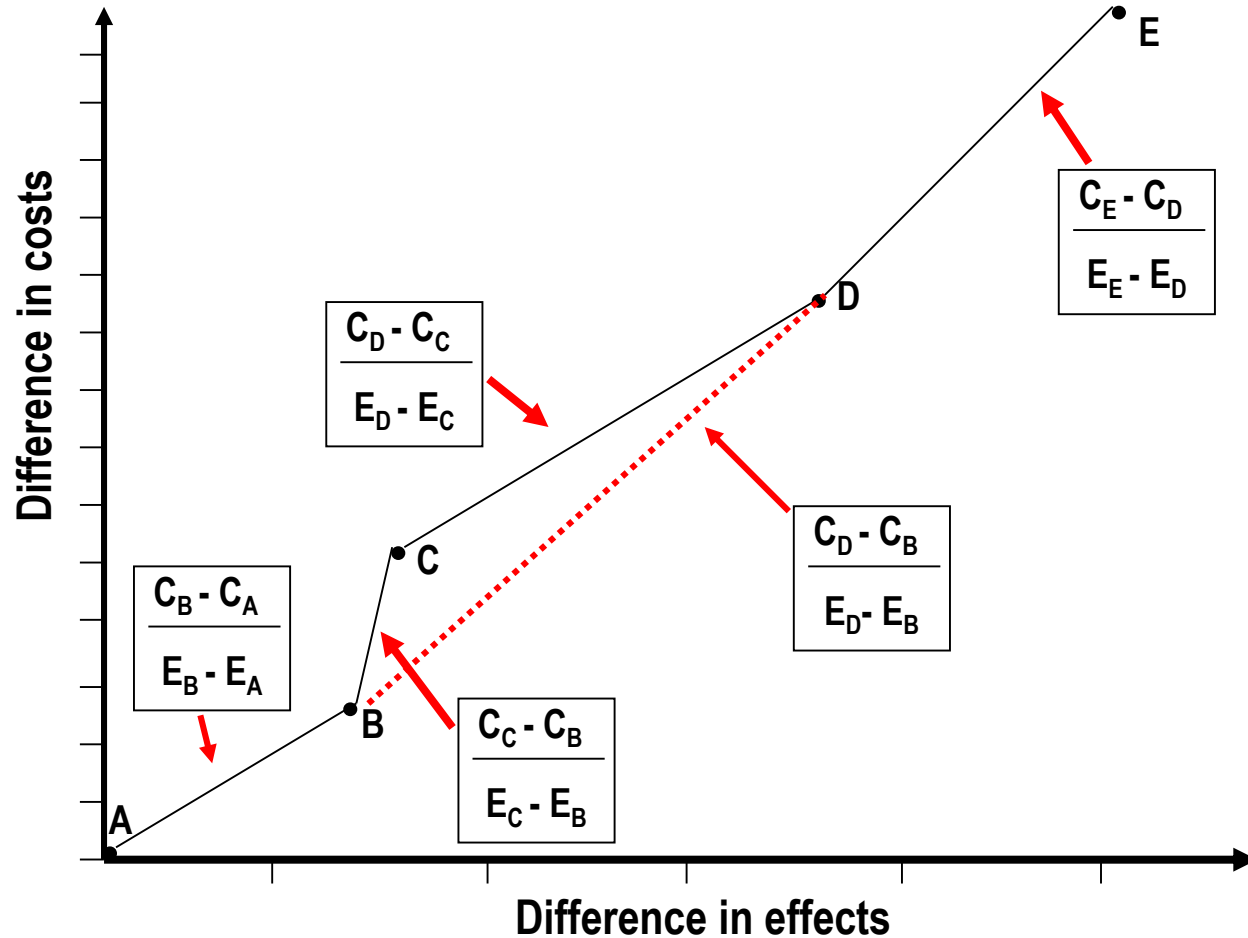
Option	<u>Treatment of HIV</u>			
	Costs	Effects	$\Delta C/\Delta E$ (1)	$\Delta C/\Delta E$ (2)
A	30,000	25	-	-
B	56,000	40	1,733	1,733
C	78,000	42	11,000	ED
D	115,000	62	1,850	2,682
E	150,000	74	2,917	2,917

Option C is subject to extended dominance as it has a higher ICER than a more effective programme

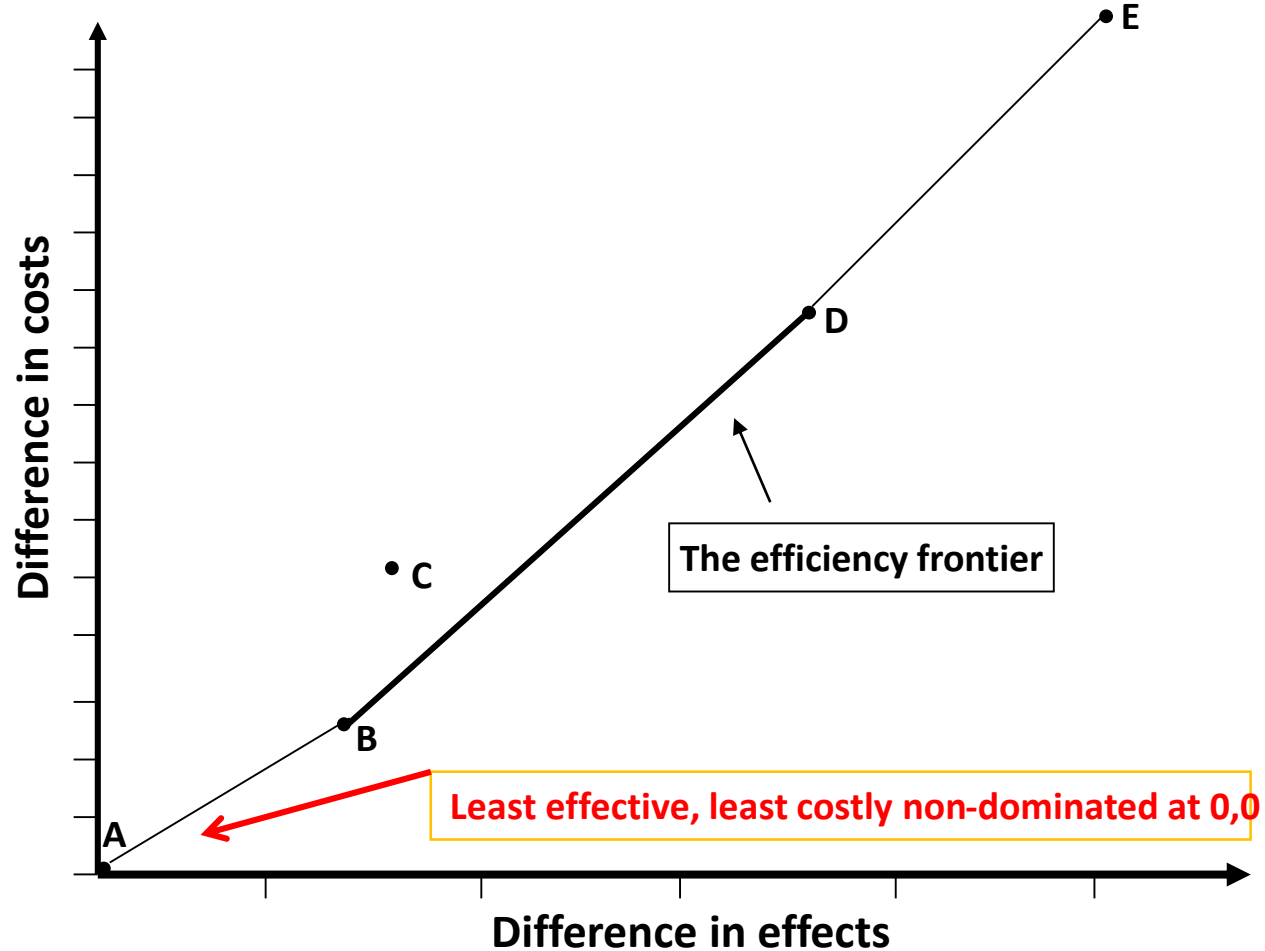
More on extended dominance

- Best way to understand this is that, for a given threshold, an option subject to extended dominance can never be cost-effective
- Practical way to identify extended dominance:
 - i. Rank options by costs or effects
 - ii. Exclude dominated options
 - iii. Calculate ICERs for the remaining ones
 - iv. If an option exists that has a higher ICER than a more effective one, it is subject to extended dominance and can be removed
 - v. Recalculate ICERs
- Note that, for Step (iv) above, beware that the ICERs you are comparing with are not subject to change when extendedly dominated options are removed

Cost-effectiveness plane: management of HIV



Efficiency frontier: management of HIV



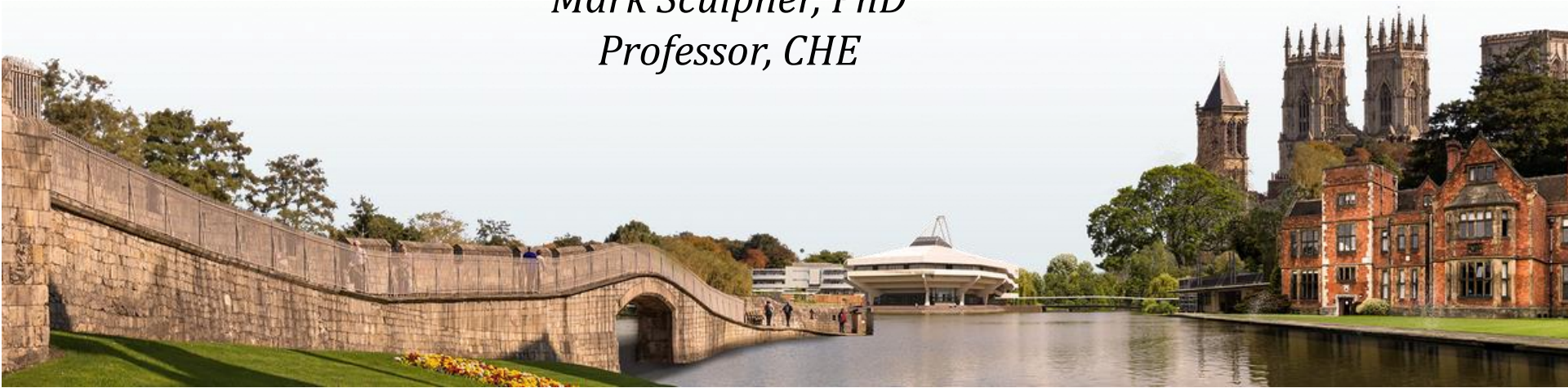
Summary

- Population/sub-population defines independent programme
- ICERs only relevant where no dominance
- ICERs apply in top right and bottom left quadrants
- Beware the concept cost-effectiveness 'threshold'
- Opportunity costs central in cost-effectiveness analysis

Online Advanced Methods for Cost-Effectiveness Analysis

Presentation 1: Analytical Starting Points 1.4: Net benefits

Mark Sculpher, PhD
Professor, CHE



Objectives

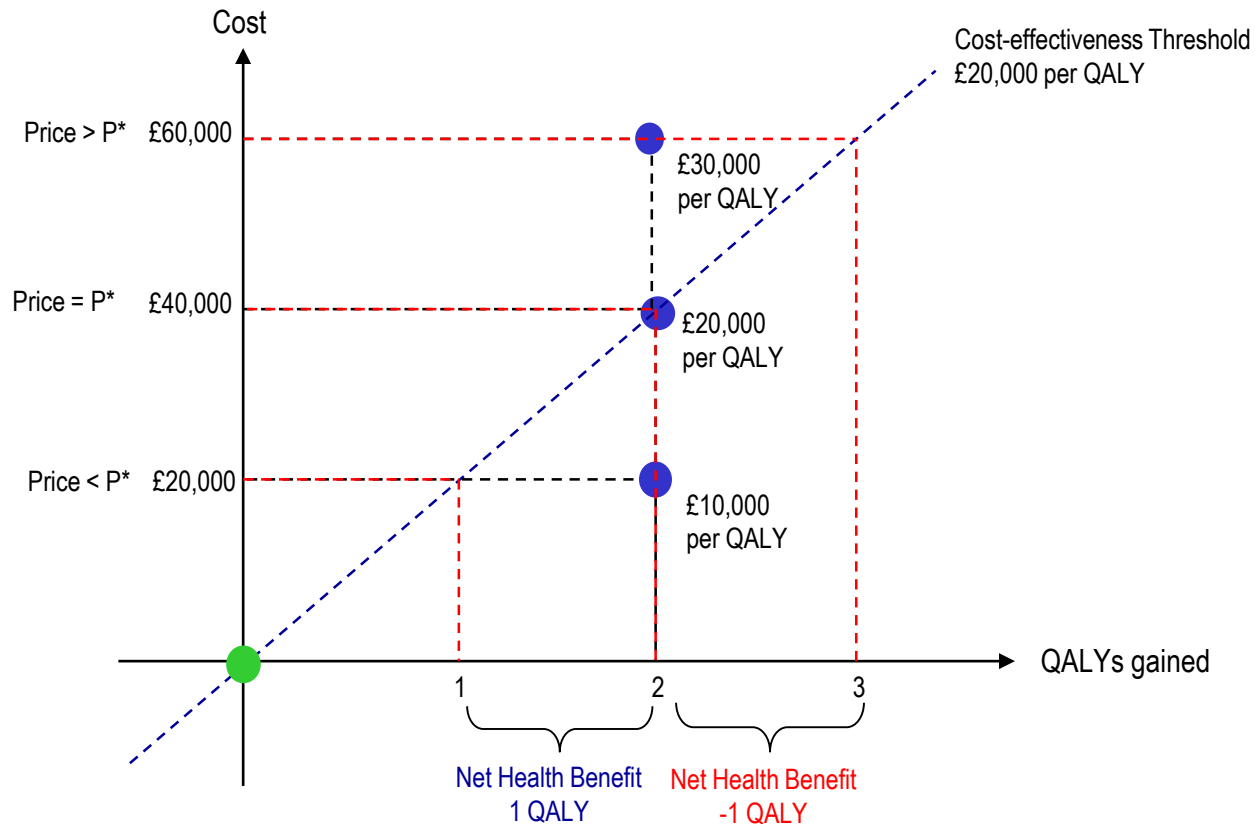
- Distinguish key features of ICERs and net benefits
- Understand net health benefits versus net monetary benefits
- Clarity about the calculation of net benefits
- Appreciate the advantages of ICERs and net benefits

Moving from the ICER to net benefit

- 'Threshold' based on opportunity cost can and should define value of health outcome
- Standard ICER decision rule:
$$\Delta C / \Delta E < k$$

Where k is the threshold
- Net health benefit:
$$\Delta E - (\Delta C / k) > 0$$
- Net monetary benefit:
$$(\Delta E \times k) - \Delta C > 0$$

Cost-effectiveness and net health benefit



Net health and net monetary benefit

Incremental cost-effectiveness ratio (ICER):

$$\frac{\bar{C}_1 - \bar{C}_0}{\bar{E}_1 - \bar{E}_0} = \frac{\Delta C}{\Delta E}$$

Net health benefits

Individual patient level

$$NHB_i = E_i - \frac{C_i}{k}$$

Net monetary benefits

$$NMB_i = (E_i \times k) - C_i$$

Expected net benefit

$$\Delta NHB = \Delta E - \frac{\Delta C}{k}$$

$$\Delta NMB = (\Delta E \times k) - \Delta C$$

k is the cost-effectiveness ratio based on an estimate of opportunity cost

From individual to expected net health

Average ratios have no meaning

$$\frac{\bar{C}_1}{\bar{E}_1} - \frac{\bar{C}_0}{\bar{E}_0} \neq \frac{\bar{C}_1 - \bar{C}_0}{\bar{E}_1 - \bar{E}_0}$$

Average net benefits have a useful property:

$$\begin{aligned} NHB_1 - NHB_0 &= (\bar{E}_1 - \frac{\bar{C}_1}{k}) - (\bar{E}_0 - \frac{\bar{C}_0}{k}) \\ &= (\bar{E}_1 - \bar{E}_0) - \frac{(\bar{C}_1 - \bar{C}_0)}{k} \\ &= \Delta \bar{E} - \frac{\Delta \bar{C}}{k} \\ &= \Delta \overline{NHB} \end{aligned}$$

Net health benefits

Option	<u>Treatment of HIV</u>			
	Costs	Effects	$\Delta C/\Delta E$	NHB*
A	30,000	25	-	13.9
B	56,000	40	1,733	19.3
C	78,000	42	ID	13.1
D	115,000	62	2,682	19.4
E	150,000	74	2,917	18.4

* Expected net health benefit for each option using a threshold = 2700

ICERs versus net benefits

Advantages of ICERs

- Can provide analysis when threshold unknown
- Avoids unrealistic thresholds being hidden in net benefits
- Rapid reassessment of cost-effective option with new threshold
- May be more intuitive

Advantages of net benefits

- Single most cost-effective option clear
- No problems with dominance and extended dominance
- Strategies can be ranked by cost-effectiveness
- Magnitude by which one option is more cost-effective than another can be shown
- Change in cost-effectiveness following sensitivity analysis clear
- Statistical advantages

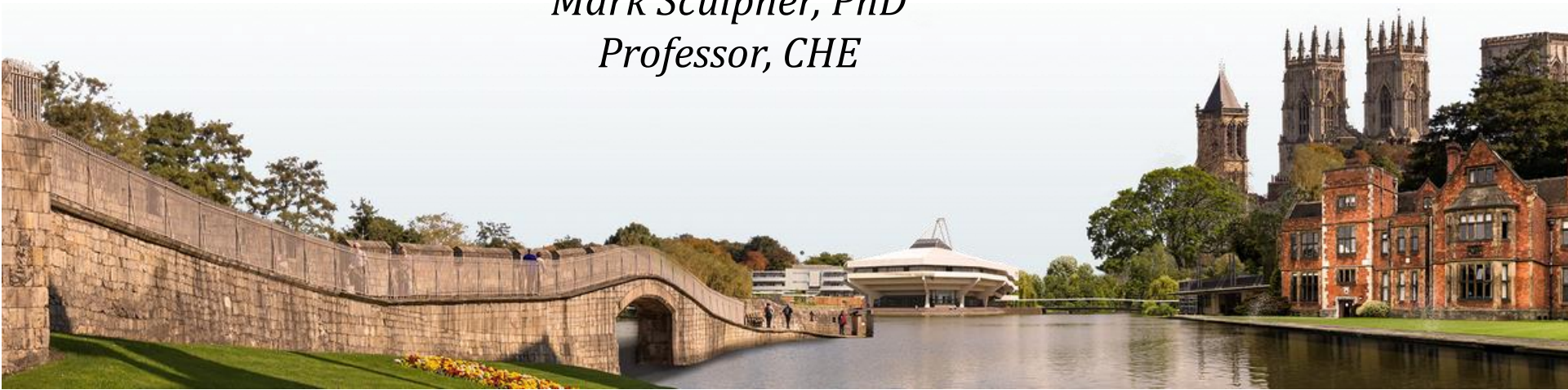
Summary

- ICERs widely used by decision making bodies to report cost-effectiveness
- They can be challenging to use
- Net health and net monetary benefits have some potential advantages
- Need to be able to understand these different metrics

Online Advanced Methods for Cost-Effectiveness Analysis

Presentation 1: Analytical Starting Points 1.5: Conclusions

Mark Sculpher, PhD
Professor, CHE



Conclusions

- Consider types of decisions that economic evaluation can inform
 - Policy focus on proprietary technologies
 - Principles can and should apply to all uses of resources
 - Key distinction between adoption and research decisions
- Review appropriate analytical methods
 - Adoption decision needs appropriately specified decision problem
 - Adoption decision rests on key design methods
 - Research decision focuses on reflecting and using uncertainty
- Understand how cost-effective options are established
 - 'Decision rules' key to understanding cost-effectiveness
 - More complexity when comparing many options
- Distinguish incremental cost-effectiveness ratios from net benefits
 - ICERs widely used but can be cumbersome
 - Net benefits need an appropriate threshold but have advantages

Further reading

Scope of use of economic evaluation

- Sutton M, Garfield-Birkbeck S, Martin G, Meacock R, Morris S, Sculpher M, Street A, Watson SI, Lilford RJ. Economic analysis of service and interventions in health care. *Health Serv Deliv Res* 2018; vol. 6.

Decision rules and net benefits

- Drummond MF, Sculpher MJ, Claxton K, Torrance GW, Stoddart GL. *Methods for the Economic Evaluation of Health Care Programmes*. 4th ed. Oxford: Oxford University Press; 2015 (Chapter 5).
- Paulden M. Calculating and interpreting ICERs and net benefit. *PharmacoEconomics*. 2020;38:785-807.

Cost-effectiveness thresholds

- Claxton K, Martin S, Soares M, Rice N, Spackman E, Hinde S, *et al*. Methods for the estimation of the NICE cost effectiveness threshold. *Health Technology Assessment*. 2015;19(14):503.
- Woods B, Revill P, Sculpher M, K. C. Country-level cost-effectiveness thresholds: initial estimates and the need for further research. *Value in Health*. 2016;19:929-35.