Where are we?

- Cost-benefit analysis
  - a theoretical foundation for resource allocation
  - offers the potential for Pareto improvement.
- Use of cost-benefit analysis for the evaluation of health care interventions remains low.
  - Why?
- Cost-effectiveness analysis offers a more practical approach, but it has lacked a theoretical foundation.
  - What next?

Can the cost-effectiveness analysis approach be improved to address criticisms?

- Is there a link to a theory of social optimization?
- Can we use the theoretical basis to help resolve inconsistencies and problems with CEA?
  - Should unrelated future costs be included
  - What should be included in the measurement of QALYs?
  - To make a decision, there is still a need to value life, at least implicitly
Economic foundations of Cost effectiveness analysis: Garber, Phelps

- When we apply the results of CE analysis to allocate health care, do we make optimal decisions? We have yet to present a way to answer this question.

- Garber/Phelps use conditions for optimization of the lifetime utility model to
  - determine when CE analysis leads to optimal decisions
  - identify a threshold CE ratio to correspond to the allocation selected by direct utility maximization

Garber/Phelps Deriving an individual's maximum acceptable cost-effectiveness ratio

- Optimizing expected utility in period 0 where individual chooses between consumption and two health goods a and b.
  \[ E_0 = U_0 (Y - w_a a - w_b b) + \sum_i U_i (Y_i) F_i \]
  - Consumption of medical care in period 0 affects the probability of being alive in period \( i \), \( F_i \)

- Cumulative prob of being alive \( F_i = \prod_{j=1}^{i} P_j \)
  or could use instead QALY = \( \sum_{i=1}^{N} F_i \delta^i k_i \)
  - \( \delta \) is discount rate and \( k \) is quality of life adjustment
When does CE analysis lead to optimal decisions?

- Choice of health technology is an optimization of individual lifetime utility in terms of the tradeoff between consumption $C$ and health $Q$. The optimal rate of this tradeoff is:
  \[
  \frac{dC}{dQ} = \frac{\nu}{U_0}
  \]
- $\nu$ = future period specific utility $U_i = U_0(Y)$
  - Constant because assumes $Y$ is constant across time periods

The optimal marginal cost-effectiveness ratio

\[
\frac{dC}{dQ} = \frac{\nu}{U_0}
\]

- At optimum, further investment in $a$ is $\nu$ scaled by reciprocal of the marginal utility of consumption in the initial period
- Where $\nu$ is future (period-specific) utility
  ➔ A single optimal CE ratio applies to all interventions (a) for an individual

Implication of Garber-Phelps:

- The optimal CE ratio may vary between individuals
  - marginal utility of consumption is determined by the individual
- What might cause marginal utility in the initial period to differ between individuals?
  - Income!
**EXAMPLE**

<table>
<thead>
<tr>
<th>Population</th>
<th>Program R</th>
<th>Program P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>high income</td>
<td>low income</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>C</td>
</tr>
<tr>
<td>Cost</td>
<td>2 life years</td>
<td>2 life years</td>
</tr>
<tr>
<td>WTP</td>
<td>2YR</td>
<td>2YP</td>
</tr>
<tr>
<td>Net Benefit</td>
<td>2YR-C</td>
<td>2YP-C</td>
</tr>
<tr>
<td>CER</td>
<td>C/2</td>
<td>C/2</td>
</tr>
</tbody>
</table>

- **Traditional CBA:** Because YR > YP there are situations when R will be approved and P will not (i.e., when 2YR - C > 0 and 2YP - C < 0)
- **Traditional CE:** Ratio is C/2 for both programs so with a common threshold both programs will be either rejected or accepted
- **Garber-Phelps CE:**
  - Threshold for R is
  - Threshold for P is

Because of diminishing marginal utility of consumption, \( \frac{C}{R} \) and \( \frac{C}{P} \) are

There are situations where P may fail to meet threshold and R will meet threshold as in CBA. \( \rightarrow \) Turns CEA into CBA
**Phelps-Garber threshold value**

- About $35K per person in 1989 dollars given typical parameter values
  - Assumes utility depends on consumption.
  - Based on willingness to accept money for a life year of $200-$300K (Viscusi)
- But it varies with age, and income
- Threshold goes down (i.e., accept fewer programs)
  - As income goes down
  - As age goes up (U0 goes up because more is spent on health care)

**Can this threshold be used in a universal insurance system?**

- Garber / Phelps: “The optimal CE criterion is equivalent to determining optimal coverage for an actuarially fair insurance policy, under perfect information.”
  - The only people purchasing that policy are those with a willingness to pay for it. It may not be everyone.
- Under a system financed efficiently with raising of subsidies to achieve socially equitable access, this concept gets applied for “a representative individual”
  - Would not accommodate heterogeneity of preferences

**Accounting for Future Costs**

If we save a patient with medical care today who requires care in the future. Should we count that as a cost?
Accounting for Future Costs

- Consider three types of costs:
  - Related illness
    - Angioplasty today, count bypass in future?
  - Unrelated illness
    - Influenza vaccine today, count dialysis in future?
  - Non-medical costs and benefits
    - Suicide prevention today, earnings in future? Consumption in future?

What is an unrelated medical cost?

- When the level of a particular health expenditure is unchanged with a change in the quantity of the intervention consumed
  - Successful trauma surgery should not affect expenditures for future illnesses
  - What about cancer treatment in early adulthood and health expenditures later in life?
- What if the intervention prolongs life?
  - Which medical costs are unrelated?

The Phelps & Garber (1997) view on unrelated future costs

- How does result change if unrelated future costs of health care are included?
  \[ \frac{\partial C}{\partial U} = \frac{\nu + K}{U^\sigma} \]
- Same as before except the term K is added. K is a constant if future costs are unrelated to the intervention
- A single optimal CE ratio still applies to all interventions
- The key is to be consistent. We either use unrelated future costs or we don’t. As long as we are consistent, decisions will be the same.
The Meltzer (1997) view on unrelated future costs

- Include
  - related Medical costs
  - All future unrelated medical costs
  - Unrelated non-medical costs net of earnings ("net resource use")

- What are "unrelated" costs?
  - Costs that are independent of current spending, apart from the effects of that spending on survival.

- "Net resource use"
  - Consumption + medical expenditures - earnings
  - From -$10,000/ year @ age 25 to +$20,000/year @ age 85

- Relative rankings of interventions change when future net non-medical costs are included
  - Analyses that omit future costs generally favor interventions that extend life over those that improve quality of life

Why are Meltzer’s conclusions different from Phelps/Garber?

- Phelps/Garber assume net annual resource use is zero. (i.e., in every period you spend what you make)
  - Meltzer allows for variable income and intertemporal reallocation of income and consumption

![Graph showing consumption, medical expenditure, earnings, and net resource use by age.](image)
Intuition

- Consider two interventions with equal current cost that both produce one QALY for a 65 year old
  - \( A \) increases life expectancy by one year at QOL=1
  - \( B \) increases life expectancy by two years at QOL=0.5
- Which is preferred?
  - QOL the same: 1.0 = 0.5+0.5
  - Costs of \( A \) are lower: avoids the cost of supporting an extra year of life
  - Hence, \( A \) preferred overall
- Omitting future costs favors interventions that extend life (\( B \)) versus those that increase QOL (\( A \)) when extending life has net costs
  - And what if Age<50?

Basic model in Meltzer

- Person maximizes \( EU = \sum_{t=1}^{T} S(U_t) \),
- If medical care to date affects health, and health and consumption affect utility, this becomes:
  \[ EU = \sum_{t=1}^{T} S(m_0, \ldots, m_{t-1}, X_t, m_t + \sum_{t=1}^{T} \frac{1}{r(1+r)^{t-1}} X(m_0, \ldots, m_{t-1}) \),
  \]  
- Where \( m \) and \( c \) are medical and non-medical costs.
- Lifetime budget constraint where \( I \) is income
  \[ \sum_{t=1}^{T} \frac{1}{r(1+r)^{t-1}} X(m_0, \ldots, m_{t-1}) \leq I \]
First order condition (in the form of a cost-effectiveness ratio)

$$\sum_{i=1}^{T} \left[ \frac{1}{1+r} \sum_{t=1}^{T} \left( \frac{\sum K_{m,t} - \sum C_{m,t} - I_{j,t}}{\sum K_{m,t}} \right) \right] \frac{1}{t}$$

- Numerator is total discounted increase in costs.
- Denominator is additional discounted utility.
- Note that total costs are in the numerator, both medical \((m)\) and non-medical \((c)\).

Simplified FOC:

$$\frac{\Delta \text{cost}}{\Delta \text{QALY}} = \frac{\Delta \text{related cost}}{\Delta \text{QALY}} + C \frac{\Delta \text{LY}}{\Delta \text{QALY}}$$

- When an intervention prolongs life, marginal value of other consumption \((C)\) does not cancel out.
- Therefore, this term \(C\) (total consumption-total production in added years) cannot be ignored in CE analysis of interventions that change the duration of life.

Back to Intuition

- Is \(C\) relevant if \(\Delta \text{LY}=0\)?
- When does extending life \((\Delta \text{LY}>0)\) increase the cost-effectiveness ratio?
  - When \(C>0\) (mostly at younger ages)
- \(C\) matters more of \(\Delta \text{Q}\) is small relative to \(\Delta \text{LY}\)
Implication of including non-medical cost
– Does not really differ from WTP in that by including future consumption, income and ability to pay enter more fully into the estimate
– Generally alters how resources are allocated in favor of interventions that improve quality of life
– Change in production in the market due to morbidity gets included in costs because it affects net earnings

But future costs are rarely included in CEA
• Don't believe they belong; think future costs implicit in people's answers to quality of life questions
  – Costs due to increased life expectancy largely not borne by individuals
  – Empirical evidence that people do not consider these costs when answering QALY questions
• Some convinced by theory, think it’s “mean spirited”
• C is net earnings and not net income

What is the perspective of C?
• C is total consumption in added years minus earnings in those years
• Why use earnings and not income?
  – Doesn't this bias results away from elderly where income is much greater than earnings because of pension and asset income? (Lee)
• What is the effect of Medicare (subsidized health insurance) on the cost-effectiveness of life saving programs?
  – Individuals want life saving programs more than society
Approximate Effects of Future Costs

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Cost/QALY without future costs</th>
<th>ΔLE/ΔQALY</th>
<th>Co (ΔLE/ΔQALY)</th>
<th>Cost/QALY with future costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Severe Hypertension Men Age 40</td>
<td>$18,000</td>
<td>-$5,000</td>
<td>1.03</td>
<td>-$5,200</td>
</tr>
<tr>
<td>Treatment Severe Hypertension Men Age 60</td>
<td>$60,000</td>
<td>$8,000</td>
<td>1.07</td>
<td>$8,500</td>
</tr>
<tr>
<td>Adjuvant Chemo Duke’s C Colon CA Men Age 60</td>
<td>$67,000</td>
<td>$8,000</td>
<td>18</td>
<td>$144,000</td>
</tr>
<tr>
<td>Hemodialysis for ESRD Men Age 60</td>
<td>$117,000</td>
<td>$8,000</td>
<td>1.5</td>
<td>$12,000</td>
</tr>
</tbody>
</table>

Are Financial Factors in QALYs?

- Report of the Panel on Cost-effectiveness in Health and Medicine argues that lost income should not be counted as a cost in cost-effectiveness analysis
  - Based on assumption that individuals consider income changes when answering quality of life questions
  - This has been used as an argument for excluding lost income in accounting for future costs
- Even if personal costs are fully reflected in QOL, there are discrepancies between personal and social costs
  - Public and private insurance
  - Payroll and income taxes
- Ambiguities about whether respondents consider personal economic costs in answering QOL questions
  - Health Utilities Index explicitly excludes lost income
  - All other utility elicitation techniques silent on lost income
Do respondents consider economic costs in answering QOL questions?

- Meltzer performed an experiment and asked people responding the TTO questions whether they considered financial factors in answering quality of life questions
  - Financial considerations may alter answers to TTO questions
    - Average TTO values change with guidance about financial factors
    - Standard TTO questions without guidance generate heterogeneous assumptions across respondents
    - Even with guidance about financial factors, most respondents say they were not a factor or that they were not thinking about effects of illness on work
  - Probably best to instruct people to ignore economic consequences of illness and count those costs separately
    - Besides, individually optimal economic consequences differ from socially optimal because of taxes and subsidies such as Medicare and social security

Traditional Treatment of Future Costs and Benefits in CEA

- Issue commonly arises in decision models
  - Judgments tend to be arbitrary
- Analyses generally include:
  - Future benefits
    - Length of life x Quality of life = QALYs
    - Future medical costs for related illnesses
- Analyses generally exclude:
  - Future medical costs for unrelated illnesses
    - Few exceptions: Weinstein, OTA
  - Future non-medical costs

Whether future costs should be excluded has been debated

- Old economists:
  - Don’t include future unrelated costs
    - already captured in the survival outcome (and its value), since the survivors are part of future consumption
    - Question: Would you attach less money value to an extra life year if future medical costs (or hamburger costs) were higher?
- Decision Scientists:
  - Include unrelated medical costs because there is a fixed medical budget (Weinstein)
New economists:

- (Garber-Phelps): it matters for the definition of the target C-E ratio. The key is to be consistent.
- (Meltzer): include all future costs, medical and non-medical. Seemingly unrelated costs become related when the length of life changes.