Estimating the Cost of an Intervention

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Objectives

At the end of the class, you should

- Understand what micro-costing means
- Be familiar with different micro-costing methods
- Understand that the method you use will affect your future analyses
Perspective

- The talk is focused on estimating costs for a CEA using the societal perspective.

- Implementation researchers may need to vary these methods.
POLL

What kinds of economic analysis interest you?

– Cost-effectiveness analysis
– Implementation (e.g., budget impact)
– Both
Outline

1. Introduction
2. Micro-costing methods
   - Direct Measurement
   - Cost Regression
3. Efficient production and economies of scale
4. Example
Focusing Question

What is the cost of a new health care intervention?

Examples:

1. What does it cost to use outreach workers to improve cancer screening?
2. What does it cost to use a robot for stroke rehabilitation?
Outreach workers

- A local hospital routinely performed Pap smears in the ED (when clinically indicated).

- Problem: Low rates of follow-up among abnormal Pap smears (~30% follow-up)

- Potential solution: employ outreach workers to improve follow up

- Question: what is the added cost of using an outreach worker to improve follow-up?
Robots

- Engineers have developed robotic devices to facilitate arm rehabilitation after stroke.
- Robots offer precise, repetitive actions to help the patient with impairment:
  - Direction
  - Speed
  - Control
- What is the cost of robotic-enhanced rehab?
The answer

To answer these questions, we need to use micro-costing methods
Outline

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2. Micro-costing methods
   - Direct Measurement
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Micro-costing

- This term refers to a set of methods that researchers use to estimate costs.

- Methods are needed because costs* are not readily observable.

*cost resulting from a competitive market
Micro-cost Methods

Three commonly-used methods

- Direct measure: measure activities and assign prices to them
- Pseudo-bill: capture services using billing codes. Assign costs to billing codes
- Cost regression: use statistical techniques to identify the cost of the intervention
Selecting a Method

- Data availability
- Method feasibility
- Appropriate assumptions
- Precision and Accuracy
Direct Measurement

- Four steps
  1. Specify the production processes
  2. Enumerate the inputs for each process
  3. Identify price for the inputs
  4. Sum (quantity*price) across all inputs

- Level of precision is critical.
An example outside of health

What is the process of producing a meal?

Get ingredients  Use equipment  Cook the meal  Clean up

A natural sequence of events in the production process
Cost of Cooking

- Buy ingredients
- Buy/rent equipment and space
- Cost of Cooking
- Cost of clean up
The Production Process

- **Efficiency**
  - Use fewer resources to produce more outputs, or
  - Use the same resources to produce more outputs

- **Quality**
  - Services that increase the likelihood of desired health outcomes and are consistent with current professional knowledge
Efficiency and Quality in Cooking

Good equipment (knives, stoves)
Skilled labor
Learning by doing (volume)
Specialization (skills and foods)
Proper preparation
Understanding client flow

These issues transfer to medicine

What is unique to health care is risk and uncertainty.

Returning to Health Care…

- Efficiency and quality are important in health care.

- They are often unobserved in health care production and yet they are correlated with costs!

- We will return to these issue later in the talk.
The Cost of Producing Health Care

Cost types
- Personnel
- Space
- Supplies
- Training
- Contracts

Time horizon
- Fixed
- Variable

Economists and accountants define differently

Cost types:
- Pre-op: Understand patient preferences, risk assessment
- Surgery: The operation itself
- SICU and post-op care: Working with the patient to recognize infection
- Post op: Discharge planning

Diagram:
- Pre-op
- Surgery
- SICU and post-op care
- Post op
- Discharge planning

Economists and accountants define differently.
Precision

- Intervention used 2 FTE for 1000 participants
- Total labor cost is $100,000 for a year

Less Precise Method: Labor cost per participant is $100,000/1,000 or $100

More Precise Method: Track intervention time per participant. Use time estimates to apportion labor costs.
Precision is Expensive

- It is time consuming to track staff activities
- Form was created with input from outreach workers
- Manager reviewed them for accuracy each week
Precision and Accuracy

- The center of the target represents perfect accuracy
- A and B are equally accurate
- A is more precise than B
Accuracy

- SCI-VIP program developed a CPRS app so that time spent providing supportive employment was gathered as part of the documentation in VISTA

- This improved data accuracy
The Precision Payoff

Example at end of lecture
About subgroup analysis
Direct Measurement: Personnel Activities

- Research staff can produce several “products”
  - Exclude development cost
  - Exclude research-related costs
  - Should measure when program fully implemented
Personnel Costs

- Pay can affect quantity and quality; attracts different types of people
- Need to include benefits (when appropriate)
- Need to include direct/productive and indirect/non-productive costs (e.g., meeting times)

Assumption: changing personnel pricing will not affect the quality or effectiveness of the intervention

- VA Labor costs
  http://www.herc.research.va.gov/resources/faq_c02.asp
Outline

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Cost Regression

- Use a regression model to estimate the marginal cost of an intervention

- Caveats
  - Only works when there are existing cost data
  - Not a good method for a new technology (e.g., secure messaging) where cost accounting may be underdeveloped
Ex: Cost of Telephone Care

- We conducted a RCT to examine whether telephone case monitoring improves substance use care relative to usual care.
- Intervention averaged 9.1, control averaged 1.9 calls (difference=7.2, p<.001)
- MCA tracks SUD telephone care costs in clinic stops (543, 544, 545)
- We summarized the cost data per person
Each additional call cost an average of $10.53
Assumptions

- Cost and workload data are accurately captured
- Accuracy could vary by location
- Costs are biased toward 0 if the workload is not being captured
Cost Regression

- Large literature on analyzing cost data
- Cost data are frequently skewed
  - Skewed errors violates assumptions of Ordinary Least Squares
  - Error terms not normally distributed with identical means and variance
  - Transformation
    - Typical method: log of cost
    - Can make OLS assumptions more tenable

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Important Assumptions: Scale Economies

- We created a health guide for a RCT
- We paid $14 per guide for 1000 guides
- If we ordered more, the cost per guide would decrease, eventually reaching $3
- Which cost estimate should you use for the CEA?
Poll

For the CEA, which method should you use?

- $14 per guide
- $3 per guide
- Somewhere in between
Economies of Scale

- If the unit costs ($/Q) of producing a good decrease as the quantity (Q) of goods increase, use the unit cost when there are constant returns to scale.
Quality

- In this example, we make an assumption about efficient production
- Quality is unobserved
- Changing assumptions about costs could affect quality (and outcomes).
Outline

1. Overall approaches
2. Direct Measurement
3. Cost Regression
4. An important assumption: Efficient production and economies of scale
5. Example
Example: Estimating Labor Costs by Direct Measurement


Outreach workers

- A local county hospital routinely performs Pap smears in the ED.

- Problem: Low rates of follow-up among abnormal Pap smears (~30% follow-up)

- Question: what is the cost of using an outreach worker to improve follow-up?
Objective

- We evaluated the cost-effectiveness of usual care (a mailed postal reminder) with a tailored outreach intervention compared to usual care alone.
- Does CEA vary by disease risk?
Study Overview

- Randomized, controlled trial
- Usual care: notified by telephone or mail, depending on the degree of abnormality. Provided intervention after 6 months.
- Intervention: Usual care plus outreach and tailored individual counseling
- Estimated costs using direct measurement
Methods

- Method 1: Sum all the intervention costs and divide by number of participants (easy)

- Method 2: Estimate the cost of the intervention for each patient (hard)

- If you want to ask, “was the intervention more cost-effective for subgroups?”, then you need to use method 2?
# Unit Costs (2002 dollars)

<table>
<thead>
<tr>
<th>Item</th>
<th>Intervention (n=178)</th>
<th>Usual care (n=170)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outreach worker costs</td>
<td>$142</td>
<td>$0</td>
</tr>
<tr>
<td>Travel costs at $.365 per mile</td>
<td>$4</td>
<td>$0</td>
</tr>
<tr>
<td>Office space and supplies</td>
<td>$28</td>
<td>$0</td>
</tr>
<tr>
<td>Outreach worker quality assurance</td>
<td>$19</td>
<td>$0</td>
</tr>
<tr>
<td>Usual care</td>
<td>$1</td>
<td>$1.00</td>
</tr>
<tr>
<td>Subtotal</td>
<td>$47</td>
<td>$0</td>
</tr>
<tr>
<td>Patient Travel Costs for Follow-up</td>
<td>$19</td>
<td>$9.9</td>
</tr>
<tr>
<td><strong>Total unit cost from societal perspective</strong></td>
<td>$214</td>
<td>$10.9</td>
</tr>
<tr>
<td><strong>Cost to add intervention from provider perspective</strong></td>
<td>$194</td>
<td>$0</td>
</tr>
</tbody>
</table>
Effectiveness

Abnormal Pap Follow-up at Highland Hospital
non-OB Patients
## Cost per follow-up

<table>
<thead>
<tr>
<th>Overall</th>
<th>Cost</th>
<th>Incremental cost</th>
<th>Probability of follow-up</th>
<th>Incremental follow-up</th>
<th>Incremental cost per follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>$77</td>
<td></td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>$355</td>
<td>$278</td>
<td>0.61</td>
<td>0.29</td>
<td>$959</td>
</tr>
<tr>
<td>Bootstrapped 95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(787-1367)</td>
</tr>
</tbody>
</table>

### By severity

<table>
<thead>
<tr>
<th>By severity</th>
<th>Cost</th>
<th>Incremental cost</th>
<th>Probability of follow-up</th>
<th>Incremental follow-up</th>
<th>Incremental cost per follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCUS/AGUS</td>
<td>$75</td>
<td></td>
<td>0.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$347</td>
<td>$272</td>
<td>0.57</td>
<td>0.25</td>
<td>$1,090</td>
</tr>
<tr>
<td></td>
<td>(813-1658)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LGSIL</td>
<td>$74</td>
<td></td>
<td>0.30</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>$374</td>
<td>$300</td>
<td>0.64</td>
<td>0.34</td>
<td>$882</td>
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<tr>
<td></td>
<td>(579-4584)</td>
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<tr>
<td>HGSIL</td>
<td>$105</td>
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<td>0.43</td>
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<td></td>
<td>$405</td>
<td>$300</td>
<td>0.87</td>
<td>0.44</td>
<td>$681</td>
</tr>
<tr>
<td></td>
<td>(486-1989)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example 2: Estimating cost of using robots for stroke rehab

- The MIT robot can assist the patient to initiate movement towards the target.
- The robot can “guide” the movement, making certain that the patient is practicing the movement the correct way.
- As the patient gains movement control, the robot provides less assistance and continually challenges the patient.
- The robot provides quantifiable feedback on progress and performance.

Robot Costs

- **Robot**
  - $230,750 purchase price
  - Need to include financing (6.015%)
  - Robot needs overhead— a room, separate circuit
  - Annual maintenance contract ($15,000 in yrs 2-5)
  - Depreciates over a 5 year-life span
- **Net present cost for 5 years of robot therapy**
  $422,532
Costs per Rehab Unit

- A site could offer 7 sessions per robot
  - Each session lasts 75 minutes
  - 2 patients per session (using different components)
- Number of slots over five years: 21,500
- Robot cost per session: $19.65
- Therapists run the robot: $120 per session
- Total cost per robot session: ~$140
# Results

<table>
<thead>
<tr>
<th>Intervention costs</th>
<th>Robot (n=49)</th>
<th>ICT (n=50)</th>
<th>UC (n=28)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per session</td>
<td>$140</td>
<td>$218</td>
<td>(\text{--})</td>
</tr>
<tr>
<td>Robot cost per session</td>
<td>$20</td>
<td>(\text{--})</td>
<td>(\text{--})</td>
</tr>
<tr>
<td>Therapist cost per session</td>
<td>$120</td>
<td>$218</td>
<td>(\text{--})</td>
</tr>
<tr>
<td>Average number of completed sessions</td>
<td>32.8</td>
<td>32.1</td>
<td>0</td>
</tr>
<tr>
<td>Travel costs</td>
<td>$561</td>
<td>$389</td>
<td>(\text{--})</td>
</tr>
<tr>
<td>Average intervention cost</td>
<td>$5,152</td>
<td>$7,382</td>
<td>(\text{--})</td>
</tr>
</tbody>
</table>

Note: Robot therapy is significantly less expensive than ICT (p<0.001)

ICT is intensive comparison therapy
Resources

- **Converting time into money**

- **Converting travel distance into money.**
  - PSSG has VAST dataset on travel times (VA intranet site) [http://vaww.pssg.med.va.gov/](http://vaww.pssg.med.va.gov/)

- **Caregiver costs (if needed)**
When we estimate the cost of labor, we need to add employee benefits (30%) and overhead (the “back office” components of an organization that keep it running such as HR and IT)

Calculating overhead costs
- 33%-- Arthur Andersen. The costs of research: examining patterns of expenditures across research sectors.
- Estimating overhead costs empirically
Questions