COST-EFFECTIVENESS ANALYSIS


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With slides from Anna Yalouris, J-PAL
Kigali, Rwanda, March 11, 2014
Introduction

• We’ve covered basic theory about how to evaluate impact of a program

• Assume you have done all the work:
  • interesting question/program
  • proper methodology
  • right sample
  • right outcomes

• You have the benefits of the program

• Question: what do you do with this?
Introduction

• Policy recommendations: Should we continue, stop, modify or generalize the policy?

• Different ways to think about this
  • Is it cost effective?
  • will the results hold in another context or generalized to a larger population?

• Need to be able to compare the benefits:
  • with the cost of the project
  • or with the benefits of alternative use of funds
What is Cost-Effectiveness Analysis?

\[
CE \text{ Ratio} = \frac{\text{Total Cost of Implementing Program}}{\text{Total Impact of Program on Specific Outcome}}
\]

- Summarizes a complex program in terms of a simple ratio of costs to impacts
- Allows for comparison between different programs evaluated in different contexts across different timeframes
Comparing multiple programs

Programs to increase student learning outcomes:

- **Remedial education, INDIA**: 0.28 SD
- **Individually-paced computer assisted learning, INDIA**: 0.48 SD
- **Read-a-Thon, PHILIPPINES**: 0.13 SD

Impact on test scores (standard deviations)
Understanding education impacts

![Histogram of normalized test scores](image-url)
Understanding education impacts
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Understanding education impacts
Comparing multiple programs

Programs to increase student learning outcomes:

- Remedial education, INDIA: 0.28 SD
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Impact on test scores (standard deviations)
Incorporating costs

Additional standard deviations (SD) gained per $100

- Remedial education in India: 3.05 SD
- Individually-paced computer-assisted learning in India: 1.54 SD
- Read-a-Thon in the Philippines: 1.18 SD
Central policy challenge

• Policymakers may face multiple options for programs that address a policy goal
  • E.g. Improve student learning outcomes

• There is huge variety in program scope and strategy, and in measured (or anticipated) impact

• How do you choose the best option?
Outline

1. Introduction to CEA
2. Comparative analysis and cost-benefit analysis (CBA)
3. Three steps for calculating CEA
4. Interpreting CEA for policymaking
5. Common uses: Prospective vs. retrospective analysis
6. Key challenges and considerations
7. Exercise: Calculating prospective CE
8. Resources
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Cost-effectiveness analysis (CEA)

- Cost-effectiveness analysis measures the ratio of the costs of a program to the effects it has on one outcome
  - Measure the cost for a given level of effectiveness: e.g. cost to increase school attendance by 1 year
  - Or, measure the level of effectiveness for a given cost: years of additional attendance induced by spending $100
What is cost-effectiveness ratio?

\[
CE \text{ Ratio} = \frac{\text{Total Cost of Implementing Program}}{\text{Total Impact of Program on Specific Outcome}}
\]

- CE is a ratio of program effectiveness to program costs
Comparative cost-effectiveness analysis

- Comparative cost-effectiveness then compares this cost-effectiveness ratio for multiple programs.
Cost-Effectiveness Analysis vs. Cost-Benefit Analysis

- CEA: Ratio of costs to effect on one outcome
  - Summarizes complex program’s impacts as simple ratio of costs/effects, for a specific and objective outcome
  - Easily synthesizes information from multiple evaluations

- CBA: Ratio of costs to monetary value of effects on all outcomes
  - Can deliver absolute judgment on whether a program is worth the investment
  - Makes it easier to assess programs with multiple outcomes
  - But, also requires assumptions about the monetary value of all the different benefits.
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Calculating CEA

• Step 1: Measure program impact

• Step 2: Gather program costs

• Step 3: Divide impacts by costs (or vice versa)
Example: Immunization in Udaipur, India

- **Problem:** Immunization coverage is really low in Rajasthan (less than 5% in Udaipur)

- One possibility is that the supply channel is the problem:
  - Hilly, tribal region with low attendance by city-based health staff to local health clinics (45% absenteeism)

- **Supply-side intervention:** Conducted monthly immunization camps, held rain or shine from 11a-2p (95% held)
  - Camera monitoring for nurse attendance
The demand side of immunization

- **Second possibility:**
- There is a problem of demand?
  - People not interested in immunization, scared?
  - Opportunity cost of going for 5 rounds of vaccination?
  - Can demand be affected?
Incentivizing demand

- **Extra incentive**: provided one kilogram of lentils for each immunization (Rs. 40 – one day’s wage) plus thali set for full course

- Treatment 1: Reliable camps
  - 30 villages

- Treatment 2: Reliable camps + incentives
  - 30 villages

- Control group: Nothing changes
  - 60 villages

- Collected data on immunization rates
Step 1: Measure impact

**Figure 2:** Percentage of children aged 1-3 years fully immunized by treatment status

- **Comparison Group:** 6%
- **Immunization Camps:** 18%
- **Camps + Incentives:** 39%

Legend:
- Supply
- Demand
Which treatment was more cost-effective?

A. Reliable camps

B. Reliable camps + Incentives

C. Could go either way
### Step 2: Gather cost of the program – ingredients method

<table>
<thead>
<tr>
<th>Cost Components</th>
<th>Details</th>
<th>Camps with Incentives</th>
<th>% of Total</th>
<th>Camps without Incentives</th>
<th>% of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary</td>
<td>Team of 4 GNM's and 4 GNM Assitants + Coordinators Salary</td>
<td>558,500</td>
<td>29%</td>
<td>558,500</td>
<td>46%</td>
</tr>
<tr>
<td>Travel</td>
<td>Staff and Incentive transport to camps</td>
<td>171,460</td>
<td>9%</td>
<td>63,460</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Honourarium</strong></td>
<td><strong>USD 0.26 per child under 2 yrs per shot, given to village workers.</strong></td>
<td>119,580</td>
<td>6%</td>
<td>62,370</td>
<td>5%</td>
</tr>
<tr>
<td>Daily allowance</td>
<td>USD 1.10 for attending bi monthly meetings, given to village workers.</td>
<td>19,500</td>
<td>1%</td>
<td>19,500</td>
<td>2%</td>
</tr>
<tr>
<td>Consultancy fees</td>
<td>Paid for training of nurses and assistants.</td>
<td>2,200</td>
<td>0%</td>
<td>2,200</td>
<td>0%</td>
</tr>
<tr>
<td>Lodging &amp; boarding</td>
<td>Expenses incurred during trainings.</td>
<td>7,333</td>
<td>0%</td>
<td>7,333</td>
<td>1%</td>
</tr>
<tr>
<td>Travel</td>
<td>For village worker's transport to trainings</td>
<td>4,645</td>
<td>0%</td>
<td>4,645</td>
<td>0%</td>
</tr>
<tr>
<td>Training Material</td>
<td>Office supplies disbursed during trainings.</td>
<td>1,500</td>
<td>0%</td>
<td>1,500</td>
<td>0%</td>
</tr>
<tr>
<td>Medicines</td>
<td>Includes paracetemol, syringes and needles, needle cutters, blood pressure instruments, and stethoscopes.</td>
<td>43,925</td>
<td>2%</td>
<td>15,320</td>
<td>1%</td>
</tr>
<tr>
<td>Refrigerators</td>
<td>Four for vaccine storage.</td>
<td>25,178</td>
<td>1%</td>
<td>25,178</td>
<td>2%</td>
</tr>
<tr>
<td>Cost of Monitoring</td>
<td>Includes cameras, film, and manpower required for monitoring camps, entering, and analyzing data.</td>
<td>446,480</td>
<td>23%</td>
<td>446,480</td>
<td>37%</td>
</tr>
<tr>
<td><strong>Incentive</strong></td>
<td><strong>Utensils and lentils (includes storage boxes)</strong></td>
<td>550,164</td>
<td>28%</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>1,950,465</td>
<td>100%</td>
<td>1,206,486</td>
<td>100%</td>
</tr>
</tbody>
</table>
Step 3: Calculate cost-effectiveness

- Divide the costs by the number of fully immunized children to get the cost-effectiveness of camps and incentives

CE Ratio = \[\frac{\text{Total cost of implementing immunization camps}}{\text{Number of fully immunized children}}\]
Giving incentives was twice as cost-effective.

**Figure 3: Costs per Fully Immunized Child**

<table>
<thead>
<tr>
<th>Immunization Camps</th>
<th>Camps + Incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rs. 2,202</td>
<td>Rs. 372 + Rs. 730</td>
</tr>
<tr>
<td>≈ US $56</td>
<td>≈ US $28</td>
</tr>
</tbody>
</table>
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When is cost-effectiveness analysis useful?

- You have a specific outcome measure you want to affect
  - There are many possible interventions to address this goal, and you are unsure which will get the most impact at the least cost

- You want to demonstrate that a non-obvious program is a good idea
  - Shows comparative effectiveness that would be difficult to predict from theory

- You want to understand how the CE of a program could vary with contextual and implementation factors
Cost-Effectiveness: Additional Years of Student Participation per $100 Spent

- Information on returns to education, for parents (Madagascar): 20.7 yrs
- Deworming through primary schools (Kenya): 13.9 yrs
- Free primary school uniforms (Kenya): .71 yrs
- Merit scholarships for girls (Kenya): .27 yrs
- Conditional cash transfer for girls' attendance (Malawi): .09 yrs
- Unconditional cash transfer for girls (Malawi): .02 yrs

CEA as a starting point for evidence-based policy
Sensitivity to contextual factors

**Cost-Effectiveness: Diarrheal Incidents Avoided per $1000**

Sensitivity to Population Density

- Source improvements
- Changing behavior
- Chlorine treatment

- **Kenya**
  - Free Chlorine Dispensers at Water Sources: 494 (632 upper bound, 303 lower bound)
  - Free Home Delivery of Chlorine: 333 (339 upper bound, 319 lower bound)
  - Encasing Water Sources in Concrete: 305 (453 upper bound, 158 lower bound)

- **Pakistan**
  - Handwashing Promotion with Free Soap: 71 (73 upper bound, 66 lower bound)

- **Note:** Numbers represent cost-effectiveness ratios, with higher values indicating greater cost-effectiveness.
Sensitivity to assumptions

COST-EFFECTIVENESS: SENSITIVITY TO EXCHANGE RATES
(additional years of education per $100 spent)

AFRICA

- standard exchange rate
- ppp exchange rate
- program achieves multiple outcomes

1. INFORMATION ON RETURNS TO EDUCATION FOR PARENTS (MADAGASCAR)
2. DEWORMING THROUGH PRIMARY SCHOOLS (KENYA)
3. FREE PRIMARY SCHOOL UNIFORMS (KENYA)
4. MERIT SCHOLARSHIPS FOR GIRLS (KENYA)
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CEA can be undertaken at two distinct stages of program implementation

- **Prospective analysis** takes place prior to the start of a pilot or at-scale program
  - “Roughly how cost-effective could this proposed program be?”
  - “How big an impact must this achieve to meet our threshold?”

- **Retrospective analysis** takes place after an evaluation of the program is completed
  - “Exactly how cost-effective was that pilot program?”
  - “Roughly how cost-effective might this program be if rolled out at national scale?”
## Prospective vs. retrospective analysis

<table>
<thead>
<tr>
<th></th>
<th>Necessary Data</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
</table>
| **Prospective analysis** | • Projected costs  
• Impact estimates from a similar program                                      | Even rough calculations can help rule out programs that can’t be cost-effective | Cost projections and impact estimates from similar programs may not be accurate                     |
| **Retrospective analysis** | • Cost data from exact program that was evaluated  
• Rigorous impact estimates                                                                 | Gives precise estimates of how cost-effective a program was in that context | Still suffers from external validity problem for cost and impact estimates                            |
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Three Key Challenges in Doing CEAs

I. Absence of incentives to do CEA
   - What if the program was effective but not really cost-effective?
   - No editorial requirement to show CEA in most social-science journals

II. Assumptions are required
   - Number of assumptions are needed to complete the analysis (e.g. multiple outcomes, spillover effects, exchange rates, discounting, inflation, etc.)
   - No one “right” way, but consistency is important!

III. Costs are hard to gather
   - Collecting cost data not seen as key part of evaluation unlike impact measures, so it is not routinely provided in a standardized way
   - Cost data is surprisingly hard to collect from implementers (budgets different from implementation costs; hard to divvy up overhead and existing costs to project)
External validity and prospective CEA

“Will those estimates from there apply here?”

Three key factors (and see discussion this afternoon):
1. Context
2. Scale
3. Implementing institution and design

Choosing a benchmark for (prospective) CEA may require tradeoffs between external relevance and internal validity/rigor of available evidence
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**Exercise: Calculating prospective CEA**

- Imagine you are a program manager and you want to know whether a new after-school remedial education intervention (Teacher Community Assistants Initiative, or TCAI) will be a **good investment**

- Program has not yet been implemented so data on actual costs and impacts does not exist

- What can you do?
Estimated costs for after-school remedial intervention (TCAI)

Table 1: Estimated Prospective Cost per Child for TCAI-ASR

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total estimated, monetary cost per year to implement TCAI-ASR</td>
<td>$74,800</td>
</tr>
<tr>
<td>Total number of schools/children in TCAI-ASR treatment group</td>
<td></td>
</tr>
<tr>
<td>Projected cost per child per year to implement</td>
<td>$6 per child</td>
</tr>
</tbody>
</table>

\[
\frac{74,800}{12,000 \text{ children}} = $6 \text{ per child}
\]
DISCUSS: Based on the 1.4 SD benchmark and the total cost of the program, how large must the impact of TCAI be for the program to be a cost-effective investment?
Choosing an impact estimate

- Potential sources:
  - Ideal: Evaluation of pilot version of program in *exact* context
  - Alternatives:
    - Look in growing body of impact evaluations for an evaluation of the program model from a similar context
    - Non-experimental studies from close contexts

- Key considerations to assess the quality or applicability of an impact estimate:
  1. The methodology used to generate the estimate
  2. The similarity of the evaluated program to the proposed program
  3. The context in which the program was evaluated
  4. The scale and sample composition of the evaluated program
Estimating program impact

There have been several evaluations of programs similar to TCAI from which you can draw impact estimates.

<table>
<thead>
<tr>
<th>Evaluated Program</th>
<th>Duration</th>
<th>Avg. Impact on an Individual’s Test Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial tutoring by volunteers, India</td>
<td>2 years</td>
<td>0.28 SD</td>
</tr>
<tr>
<td>Tracking students by ability, Kenya</td>
<td>18 months</td>
<td>0.18 SD</td>
</tr>
</tbody>
</table>

DISCUSS:

• Why do you think the impact estimate from *India* may or may not be a good approximation of the impact of the TCAI intervention?

• Why do you think the impact estimate from *Kenya* may or may not be a good approximation of the impact of the TCAI intervention?
Calculating cost-effectiveness

**DISCUSS:** Based on the impact estimates from comparable programs, calculate a range of potential cost-effectiveness

<table>
<thead>
<tr>
<th>Table II: Estimated Cost-Effectiveness of TCAI-ASR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated cost per child per year of TCAI-ASR</td>
</tr>
<tr>
<td> Remedial tutoring by volunteers, India</td>
</tr>
<tr>
<td> Tracking students by ability, Kenya</td>
</tr>
<tr>
<td>Estimated impact per child per year</td>
</tr>
<tr>
<td>Estimated cost-effectiveness</td>
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J-PAL existing CEAs available online

www.povertyactionlab.org/policy-lessons

- Reducing child diarrheal diseases
- Increasing service provider attendance (teacher/health worker)
- Increasing student attendance
- Improving student learning outcomes
Comparative Cost-Effectiveness Analysis to Inform Policy in Developing Countries: 
A General Framework with Applications for Education

Iqbal Dhaliwal, Esther Duflo, Rachel Glennerster, Caitlin Tulloch
Abdul Latif Jameel Poverty Action Lab (J-PAL), MIT
December 3, 2012

Abstract

In this paper we discuss how comparative cost-effectiveness analyses can help inform policy in developing countries and the underlying methodological assumptions necessary for performing this kind of analysis. This paper does not suggest a single set of “correct” assumptions, because the assumptions adopted in a cost-effectiveness analysis should reflect the perspective of the intended users. Rather, we discuss the issues surrounding many of these assumptions, such as what discount rate to use or whether to include cash transfers as program costs, and make recommendations on which assumptions might be reasonable given the perspective of a policymaker allocating resources between different projects. Examples are drawn from the education field to illustrate key issues and focus on specific applications to education. We hope this paper will contribute to the development of a more standard methodology for cost-effectiveness analyses and a better understanding of how these analyses can be created and used.

---

1 We are grateful to Abhijit Banerjee, Paul Glewwe, Jere Behrman, Miguel Urquiola, and Patrick McEwan for valuable discussion and feedback. We also thank participants at the Minnesota conference on "Education Policy in Developing Countries" for their comments and many colleagues at J-PAL including Mary Ann Bates, Cristobal Marshall, Leah Horgan, Dina Grossman, Arna Yalouris, and Shawn Powers.
Worksheet for gathering project costs

<table>
<thead>
<tr>
<th>Costs of Administration &amp; Targeting</th>
<th>Unit Cost</th>
<th>Currency (Location &amp; Yr)</th>
<th>Unis Req'd (per year)</th>
<th>Years Required</th>
<th>Total Cost/Yr, Local Currency</th>
<th>Total Cost/Yr, Base Year USD</th>
<th>PV of Cost Stream, Base Yr USD</th>
<th>Total Cost, Yr of Analysis USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hourly wages, surveyors for targeting survey?</td>
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<tr>
<td>Transportation per diem for surveyors?</td>
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<td>Hourly wages, data entry staff?</td>
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**Insert your own cost items**

**Insert your own cost items**

<table>
<thead>
<tr>
<th>Costs of Marketing &amp; Education</th>
<th>Unit Cost</th>
<th>Currency (Location &amp; Yr)</th>
<th>Unis Req'd (per year)</th>
<th>Years Required</th>
<th>Total Cost/Yr, Local Currency</th>
<th>Total Cost/Yr, Base Year USD</th>
<th>PV of Cost Stream, Base Yr USD</th>
<th>Total Cost, Yr of Analysis USD</th>
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<tr>
<td>Development of outreach leaflets?</td>
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<td>Printing of outreach leaflets?</td>
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<td>Hourly wages of trainers, for marketing training?</td>
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<td>Per diems of trainers, for marketing training?</td>
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<td>Transportation per diem, for marketers?</td>
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<td>Hourly wages of marketers?</td>
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</table>

**Insert your own cost items**

**Insert your own cost items**

<table>
<thead>
<tr>
<th>Cost of Materials &amp; Productive Assets</th>
<th>Unit Cost</th>
<th>Currency (Location &amp; Yr)</th>
<th>Unis Req'd (per year)</th>
<th>Years Required</th>
<th>Total Cost/Yr, Local Currency</th>
<th>Total Cost/Yr, Base Year USD</th>
<th>PV of Cost Stream, Base Yr USD</th>
<th>Total Cost, Yr of Analysis USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procuring productive assets?</td>
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<tr>
<td>Productive asset (per client)?</td>
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<tr>
<td>Transportation fee (per asset)?</td>
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</tbody>
</table>
Running Randomized Evaluations

- Rachel Glennerster & Kudzai Takavarasha
- Chapter 9: Cost-Effectiveness
- Resources available: www.runningres.com
Key points

- Important to measure the causal impact of a program
  - Rigorous evaluations, including randomized evaluations are very useful.

- Costs matter too
  - Cost-effectiveness analysis provides clear comparisons

- A host of evidence is available
  - See related resources