COST-EFFECTIVENESS ANALYSIS

Executive Education
Cape Town, South Africa
January 2015

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J-PAL Africa
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Where we’re going

1. Three simple steps for calculating CEA
2. Common uses: Prospective vs. retrospective analysis
3. Methodological challenges and considerations
4. Resources
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?

• Still need to consider
  • Will the results hold in another context or generalized to a larger population?
  • Is the program a good investment? Is it cost-effective?

• 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
Incorporating costs

Program Impact on Specific Outcome
\[
\frac{\text{Cost of Implementing the Program}}{x \text{ $100} = \text{Effect per $100 Investment}}
\]
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?
Cost-Effectiveness vs. Cost-Benefit Analysis

- **Cost-effectiveness analysis** – ratio of costs to program effects for a single outcome measure
  - Easily synthesizes information from multiple evaluations
  - Objective – no judgments about monetary value of outcomes

- **Cost-benefit analysis** – ratio of costs to monetary value of effects on all outcomes
  - Makes it easier to assess programs that have multiple outcomes
  - But requires making assumptions about the monetary value of benefits
    - E.g. need to assign monetary value to saving a life or giving girls access to education
Outline

1. Three simple steps for calculating CEA
2. Common uses: Prospective vs. retrospective analysis
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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: Increasing Immunization in rural India

- Immunizations: free for all, life-saving, in theory widely available at health centers

- Needs Assessment: Immunization coverage is really low - less than 5% in rural Udaipur

- One possibility is that the supply channel is the problem:
  - Low attendance by health staff meant that health centers were frequently closed (45% absenteeism)

- Second possibility, there is a problem of demand:
  - High opportunity cost of going for 5 rounds of vaccination
  - Cultural resistance to vaccination?
Addressing immunization supply & demand

• **T1 - Supply-side intervention:**
  - Conducted well-publicized immunization camps at fixed date each month
  - Camera monitoring for nurse attendance

• **T2 - Incentivizing demand:**
  - Same reliable immunization camps
  - Mothers provided 1 Kg lentils for each immunization (value: Rs. 40 - one day’s wage) plus set of metal plates for full course

• **Control group:** Nothing changes

**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%

Demand = 21 pp

Supply = 12 pp

---

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 GNMs and 4 GNM Assistants + 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>Honourarium</td>
<td>USD 0.26 per child under 2 yrs per shot, given to village workers.</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>Incentive</td>
<td>Utensils and lentils (includes storage boxes)</td>
<td>550,164</td>
<td>28%</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1,950,465</strong></td>
<td><strong>100%</strong></td>
<td><strong>1,206,486</strong></td>
<td><strong>100%</strong></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

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

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

- **Immunization Camps**: Rs. 2,202 ≈ US $56
- **Camps + Incentives**: Rs. 372 + Rs. 730 ≈ US $28

Outline

1. Three simple steps for calculating CEA
2. Common uses: Prospective vs. retrospective analysis
3. Methodological challenges and considerations
4. Resources
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?”
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 Per Child Per Year</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</td>
</tr>
</tbody>
</table>

\[
\frac{74,800}{12,000 \text{ children}} = \$6 \text{ per child}
\]
Question: 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 considered a cost-effective investment?
Calculating the necessary impact to meet the benchmark for cost-effectiveness

\[
1.4 \, SD \, per \, \$100 = \frac{$100}{1.4 \, SD} = $71.43 \, per \, additional \, SD
\]

\[
= \frac{\text{Cost per Child per Year}}{\text{Average Impact on an Individual's Test Scores}}
\]

\[
\frac{$6 \, per \, student}{X \, impact} = $71.43
\]

\[
X = 0.09 \, SD
\]

Is it realistic to expect an impact of this size?
Alternative: Choosing an impact estimate

• Potential sources:
  
  • Best: Evaluation of pilot version of program in exact context
  
  • Next Best: Look in growing body of impact evaluations for an evaluation of the program model from a similar context
  
• 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

**Question:** 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>Estimated impact per child per year</td>
</tr>
<tr>
<td>Estimated cost-effectiveness</td>
</tr>
</tbody>
</table>
## Interpreting Your *Prospective* Cost-Effectiveness Estimate

- **Question:** How would you explain what this estimated range of cost-effectiveness means to your colleagues?

<table>
<thead>
<tr>
<th>The estimate can be interpreted as…</th>
<th>The estimate should NOT be interpreted as…</th>
</tr>
</thead>
<tbody>
<tr>
<td>The average cost-effectiveness that might be expected if all of the assumptions made in the calculations were correct</td>
<td>A precise prediction of the cost-effectiveness of the program</td>
</tr>
<tr>
<td>An indication of the order of magnitude of the program's cost-effectiveness</td>
<td>The general cost-effectiveness of this kind of program</td>
</tr>
</tbody>
</table>
Outline

1. Three simple steps for calculating CEA
2. Common uses: Prospective vs. retrospective analysis
3. **Methodological challenges and considerations**
4. Resources
Comparative Cost-Effectiveness Analysis to Inform Policy in Developing Countries: A General Framework with Applications for Education

Iqbal Dhaliwal, Esther Dufo, 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 Ani Baro, Cristobal Marshall, Leah Horgan, Dina Grossman, Arna Yalouris, and Shayan Powers.
Using common units

• Challenge of CEA = converting all costs and impacts into “common units,” adjusting for:
  • Inflation
  • Exchange rates
  • Year of implementation

• Must define year of analysis and base year
Order of operations

1. First convert all costs into common currency, usually US$, using year specific exchange rates
2. Deflate costs to value in base year prices, using avg. US inflation rate btw base yr and yr costs incurred
3. Compute present value of these prices
4. Inflated costs to value in Year of Analysis using avg. US inflation rate btw base yr and yr of analysis
Imprecision in estimates

- Need to consider not only magnitude of impact, but also precision

- Cost effectiveness estimates can be sensitive to using the high and low bounds of estimated impact
  - One program might appear more cost effective when using point estimate, but may not be significantly different if variance around point estimates is taken into account

- Also imprecision in estimates of costs and how they could vary between contexts
COST-EFFECTIVENESS: IMPRECISION IN IMPACT ESTIMATES
90% CONFIDENCE INTERVALS

ADDITIONAL STANDARD DEVIATIONS (SD) PER $100

- Remedial education, India: 3.07 SD
- Extra contract teacher + tracking, Kenya: 1.97 SD
- Individually-paced computer assisted learning, India: 1.52 SD
- Read-a-Thon, Philippines: 1.18 SD
Other methodological considerations

- Goods and services procured for free
  - E.g. labor donated by community
  - Consider costs to the implementer or costs to society as a whole?

- Including costs incurred by beneficiaries
  - E.g. when parents must attend meetings - opportunity cost of time
  - Included as a cost when beneficiaries time is a requirement of the program

- Transfers
  - E.g. is a cash transfer to a participant a “cost”?
  - Accounting cost but not a cost to society as a whole

- High-level management overhead
  - E.g. operational costs for implementing organization

- Experimental vs scalable models
  - Program costs at pilot phase compared to at scale
Main Take Away

- Define “the program” and do not include evaluation costs
- Many considerations in how account for costs
  Most important is to be consistent with methodological decisions for all programs in analysis

- With disaggregated costs:
  - Sensitivity analyses show how relative CE changes when applying different assumptions or contextual characteristics
    - Considering programs across contexts.
    - Eg. how cost-effective would this remedial education program be if implemented in India versus Ghana?
  - Greater transparency
Sensitivity to exchange rates

**COST-EFFECTIVENESS:** SENSITIVITY TO EXCHANGE RATES

- **Remedial education**
  - Standard exchange rate: 3.07 SD
  - PPP exchange rate: 1.29 SD
- **Extra contract teacher + tracking**
  - Standard exchange rate: 1.97 SD
  - PPP exchange rate: 0.93 SD
- **Individually-paced computer assisted learning**
  - Standard exchange rate: 1.52 SD
  - PPP exchange rate: 0.64 SD
- **Read-a-Thon**
  - Standard exchange rate: 1.18 SD
  - PPP exchange rate: 0.68 SD

**Additional standard deviations (SD) per $100**

- **India**
- **Kenya**
- **Philippines**
Sensitivity to contextual factors
Outline

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3. Methodological challenges and considerations
4. Resources
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

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# 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>Units 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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<tbody>
<tr>
<td>Hourly wages, surveyors for targeting survey?</td>
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<td>Transportation per diem for surveyors?</td>
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<td>Hourly wages, data entry staff?</td>
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<td>[Insert your own cost items]</td>
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<thead>
<tr>
<th>Costs of Marketing &amp; Education</th>
<th>Unit Cost</th>
<th>Currency (Location &amp; Yr)</th>
<th>Units 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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<thead>
<tr>
<th>Cost of Materials &amp; Productive Assets</th>
<th>Unit Cost</th>
<th>Currency (Location &amp; Yr)</th>
<th>Units 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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<tbody>
<tr>
<td>Procuring productive assets?</td>
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<tr>
<td>Productive asset (per client)?</td>
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<td>Transportation fee (per asset)?</td>
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</table>
Running Randomized Evaluations

• Rachel Glennerster & Kudzai Takavarasha

• Chapter 9: Cost-Effectiveness

• Resources available: www.runningres.com
COST-EFFECTIVENESS ANALYSIS

Executive Education
Cape Town, South Africa
January 2015

Anna Yalouris
J-PAL Africa
University of Cape Town
Cost-Effectiveness: Additional Years of Student Participation per $100 Investment

- Information on returns to education, for parents (Madagascar): 20.7 yrs
- Deworming through primary schools (Kenya): 13.9 yrs
- Free primary school uniforms (Kenya): 0.71 yrs
- Merit scholarships for girls (Kenya): 0.27 yrs
- Conditional cash transfer for girls' attendance (Malawi): 0.09 yrs
- Unconditional cash transfer for girls (Malawi): 0.02 yrs

CEA as a starting point for evidence-based policy
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)
   - 20.7 yrs

2. Deworming through primary schools (Kenya)
   - 13.9 yrs

3. Free primary school uniforms (Kenya)
   - 7.0 yrs
   - 0.71 yrs
   - 0.36 yrs

4. Merit scholarships for girls (Kenya)
   - 0.27 yrs
   - 0.14 yrs
## Prospective vs. retrospective analysis

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