ECONOMIC TOOLS TO EVALUATE LINEAR INFRASTRUCTURE IN ASIA

22 September, 2021
3:00 – 5:00 a.m. GMT

Module 2 of Building a Foundation for LINEAR INFRASTRUCTURE IN ASIA WEBINAR SERIES
AGENDA

- Why do we need economic analysis of linear infrastructure and safeguards?
  - Some key considerations
- What economic tools can we use?
  - Valuation
  - Cost-benefit analysis and Cost-effectiveness analysis
  - Economic impact analysis and other tools
- Q&A Session
- Case studies of economic analysis of LI safeguards
  - Transmission line in Indonesia
  - Highway in Malaysia
- Regional and national road development planning in Latin America and Africa
- Q&A Session
ECONOMIC ANALYSIS OF LINEAR INFRASTRUCTURE

How do we include the environment in development decisions?
Some key considerations…
Tradeoffs and indirect impacts
Net economic benefits
Avoidance before mitigation
What is environmental valuation?

- Placing a value or price on environmental goods and services that are left out of market transactions
What is environmental valuation?

Placing a value or price on environmental goods and services that are left out of market transactions
Why do we need it?

- Valuation is needed because price does not equal value for most environmental goods and services

Price ≠ Value

No price ≠ no value
Missing information and markets
Public /shared resources (common pool)
Externalities
Lack of property / tenure rights and restrictions
Figure 2: The Cascade Model (Haines-Young & Potschin, 2010)

What are we “valuing”?

Ecosystems and biodiversity

- Biodiversity structures & processes (e.g. forest habitat)
- Biodiversity functions (e.g. interception of water by trees)

Ecosystem services
- (e.g. timber supply, flood moderation)

Benefits (values)
- (e.g. water, materials, health, protection of property)

Human wellbeing

Forestry sector:

- Official statistics: forests contribute <0.5% (US$ 160M) to the economy
- Almost all from commercial timber
Real total value: US$ 7.3 billion

- Direct forest income 15%
- Costs, losses & damages avoided 32%
- Value-added to production in other sectors 53%

- Carbon sequestration 12.2%
- Timber & wood 8.0%
- Local NTFP use 6.9%
- Other 0.4%
- Coastal protection 9.7%
- Watershed protection 9.9%
- Fisheries nursery & breeding 15.5%
- Insect pollination 37.4%

How do we do it?

Market proxies using complementary or substitute goods, activities and preferences

<table>
<thead>
<tr>
<th>Direct Market</th>
<th>Uses data from existing markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Function</td>
<td>Values a change in productivity or production</td>
</tr>
<tr>
<td>Revealed Preferences</td>
<td>Economic values are revealed through individual’s behaviour/choices</td>
</tr>
<tr>
<td>Stated Preferences</td>
<td>Simulated/hypothetical markets elicit individual’s value for a change</td>
</tr>
</tbody>
</table>
Why do a valuation study?

- Shaping minds, growing awareness, establishing common language
- Strategic use, prioritizing actions, assessing tradeoffs
- Balance sheets, cost-benefit assessments
- Setting incentives, targeting actors
- Damage and compensation claims

Litigation
Economic valuation of tiger reserves in India

- More than half of global wild tiger population
- Provide a wide range of economic, social and cultural benefits via various ecosystem services – almost all non-market benefits
- Employment, carbon, water, soils, waste assimilation, pollination, storm protection, habitat/nurseries, recreation, agriculture, fishing, fuelwood, grazing, timber, research
- Benefits = US$130 million - $270 million per year ($800-$3000 per ha/year)
- Benefits 200X - 500X management costs
- But often local costs > local benefits
Elephant conservation in Sri Lanka

• Stated willingness to pay for elephant conservation

• Benefits - elephant-based tourism and recreational activities, ecological role, cultural and religious values

• WTP based on ethical or existence values decreases once population is stable

• Use values increase with population size

• WTP a guide to demand for conservation action to preserve a species, but does not capture other values
COST-BENEFIT ANALYSIS

- *Framework* to assess the merits of a project, policy or investment versus its cost
- A process of identifying, measuring, and comparing the benefits and costs of a project or program
- Determines if a project/investment is worthwhile
- It is a decision *support* tool
What questions can CBA answer?

- Is this project worthwhile?
- Is it feasible for the private entrepreneur?
- Is it beneficial to society at large?
- What is the distribution of costs and benefits among different stakeholders?
- What are the main constraints?
CBA Process

1. Define project and identify alternatives
2. Identify perspectives of analysis and estimate costs and benefits
3. Calculate indicators of project feasibility
4. Sensitivity and risk analysis, scenarios
5. Equity considerations
Define perspectives

1. Government (Fiscal)
2. Private (Financial)
3. Social/Environmental (Economic)
Financial Analysis ("private perspective")
Economic analysis ("social perspective")

Private net benefit + Externalities

Group A

Project owners

Group B

Group C

Country
CBA strategy

• Are there better alternatives?
• Is project technically feasible?
• Is project financially feasible?
• Is project economically feasible?
  – Can external or intangible costs/benefits be quantified?
• Is project equitable?
  – What is the distribution of costs and benefits?

CBA limitations

• Environmental benefits and costs are difficult to measure
• Forecasting might be inaccurate
• Future values preclude sustainability
  – Discounting
Is it socially efficient?

Yes

Define additional criteria for prioritizing projects (equity etc.), if necessary.

No

If providing basic needs (health, education, security, basic access), are there more cost-effective alternatives?

If it is not efficient nor provides basic needs – implementation probably unjustified.
Cost-effectiveness analysis

CEA = cost per unit of outcome
Economic Impact Analysis

- Flow of gross benefits of an economic investment/project through an economy
- Job creation, labor income, and tax benefits
- Multiplier impacts, leakage
- Does not consider costs or feasibility – i.e. important to ask if benefits (e.g. jobs) could be gained at lower cost
- It is not the same as impact evaluation – i.e. whether a policy or intervention achieved its intended effect

DIRECT IMPACT
- Initial investment
- Tourism spending

INDIRECT IMPACT
- Inter-industry spending

INDUCED IMPACT
- Spending of employee’s wages

https://www.boyette-sa.com/services/impact-analysis/
Other analysis tools

- Multi-criteria analysis
- Least-cost path analysis
References


Thank you

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Questions?
Economics Module 2 Presentation 2
CASE STUDIES

Transmission Line (Indonesia)
Java-Bali 500 Kilovolt Project
Road (Malaysia)
FR 4 East-West Highway
CASE STUDY

• Transmission line (Indonesia)
  – Java-Bali 500 Kilovolt Project
TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

• Proponents
  – National government and ADB
• Project description
TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

• TL crosses to national parks
  – Baluran National Park
  – Bali Barat National Park
• ADB (lending institution) requires safeguards
INDONESIA
JAVA-BALI 500-KILOVOLT POWER TRANSMISSION CROSSING
Transmission Lines Along Periphery of Baluran National Park in East Java and Bali Barat National Park in Bali
(as completed)

National Park Zonation:
- Core Zone
- Wilderness Zone
- Utilization Zone
- Special Utilization Zone

Existing 150 kV Transmission Line
Planned Transmission Line with Tower
Road
National Park Boundary
Regency Boundary

kV = kilovolt
Boundaries are not necessarily authoritative.
TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

- Cost-benefit analysis of the Java-Bali 500 kV Project

<table>
<thead>
<tr>
<th>Step</th>
<th>Value (US$ million, over 10 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 - Financial analysis</td>
<td></td>
</tr>
<tr>
<td>Costs (including mitigation measures)</td>
<td>2,282</td>
</tr>
<tr>
<td>Benefits</td>
<td>2,470</td>
</tr>
<tr>
<td>Net Present Value</td>
<td>188</td>
</tr>
<tr>
<td>Step 2 – Other externalities</td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>26</td>
</tr>
<tr>
<td>Step 3 - Environmental mitigation measures</td>
<td></td>
</tr>
<tr>
<td>Benefits</td>
<td>3.9</td>
</tr>
<tr>
<td>Step 4 - Adjusted Net Present Value</td>
<td></td>
</tr>
<tr>
<td>Adjusted Net Present Value</td>
<td>166</td>
</tr>
</tbody>
</table>
TRANSMISSION LINE: Java-Bali 500 Kilovolt Project (INDONESIA)

- Lessons learned
  - Safeguard costs were included in the project, but
  - Not the benefits
- Protect the environment and wildlife
- Add to the project’s overall net value
CASE STUDY

- Road (Malaysia)
  - FR 4 East-West Highway

Wadey et al. (2018). Why did the elephant cross the road? The complex response of wild elephants to a major road in Peninsular Malaysia. Biological Conservation 218, 91-98.
ROAD: FR 4 East-West Highway (MALAYSIA)

• Proponent
  – National government

• Project description
ROAD: FR 4 East-West Highway (MALAYSIA)

ROAD: FR 4 East-West Highway (MALAYSIA)

• Obstruction to wildlife movement
  – Between the Temenggor Forest Reserve and the Royal Belum State Park
ROAD: FR 4 East-West Highway (MALAYSIA)

• **Environmental safeguards** to mitigate the negative impacts
  
  – Acquisition of lands surrounding both parks to expand connectivity between them and reduce the number of people living close to these parks to reduce human-wildlife conflicts.
  
  – Establishment of wildlife crossings and wildlife warning signs and speed limits in the forested corridors used by wildlife.
  
  – Establishment of guidelines for adopting sustainable agriculture management in the areas close to both parks.
Sign posting and speed control
Traffic Control and Monitoring
Ecotourism development and interpretation
Perhilitan Island Tourist Centre for Wildlife Awareness programme
No expansion of human Settlement within corridor
Traffic Control and Monitoring

Buffer area: orang asli settlement
Homestay Programmes – Lookout Tower and Related Facilities
Lookout tower
Gazette State Land as Forest Reserve
Gazette core area as Protected Forest under section 10 NFA (Wildlife Sanctuary)
Agriculture area to apply Sustainable Plantation Guidelines

Human settlement: No Further expansion within corridor
Sign posting and speed control
Traffic control and monitoring

Long Term Strategy: Extend Royal Belum Park to include the core area
ROAD: FR 4 East-West Highway (MALAYSIA)

- Safeguards cost: RM 465,127,865 (USD 131,280,797) in 2009
  - About 71% was the estimated cost related to land acquisition (25,227 hectares)
ROAD: FR 4 East-West Highway (MALAYSIA)

• Safeguards benefits:
  – Land acquisition: Market Price.

  • Assuming a market price of USD 30 per ton of carbon, the area (once reforested) could generate a revenue stream of RM 308 (or USD 87) million annually.
  • If this were the case, the payback for the proposed measures would be two years.
ROAD: FR 4 East-West Highway (MALAYSIA)

• Safeguards benefits:

• Hypothetical scenario: safeguards were not implemented
  – What would be the costs?
    » Focus on human-elephant conflicts
ROAD: FR 4 East-West Highway (MALAYSIA)

• The benefit is RM 450,000 per year.
  – Which is the same as saying that the cost of not having environmental safeguards equals RM 450,000 per year (or about USD 127,000 per year)
ROAD: FR 4 East-West Highway (MALAYSIA)
Safeguards Costs and Benefits: Expiration from the case study

Years

$ 127,000  $127,000  $ 127,000  $ 87,127,000  $ 87,127,000  $ 87,127,000

USD 131,280,797
ROAD: FR 4 East-West Highway (MALAYSIA)
Safeguards Costs and Benefits: Extrapolation from the case study

Benefit = USD 149,280,797

Cost = USD 131,280,797

NPV = $18 million (>0)

Assumption: discount rate = 12% per year
ROAD: FR 4 East-West Highway (MALAYSIA)

• Lessons learned
  – Safeguards benefits > safeguards costs, however
  • The road was built initially without a safeguard plan
  • The safeguards were only partially implemented by the government
    – Upfront financial costs of safeguards too high (despite the positive net benefits)
LESSONS LEARNED FROM THE CASE STUDIES

• The financial feasibility should be an economic feasibility. It should include:
  – Safeguards benefits and costs
  – (If possible) other positive and negative externalities
• Important to consider alternatives and avoid environmental impacts:
  – Investing in avoidance might be cheaper than investing in safeguards
A Better Amazon Road Network for People and the Environment (2019)
A Better Amazon Road Network for People and the Environment

- Analytical framework

Economic return

NPV < 0
- Economic loss
- Socioenvironmental damage

NPV > 0
- Economic gain
- Socioenvironmental damage

Lose-lose situation

Tradeoff
A Better Amazon Road Network for People and the Environment

- Set of road investments:
  - 75 projects
  - 12,263 km
  - US$ 27 billion

- Multicriteria approach:
  - Environmental
  - Social
  - Economic
A Better Amazon Road Network for People and the Environment

**Environmental**
- Deforestation
  - Ecological importance

**Social**
- Positive effects (e.g., access to schools)
- Negative effects (e.g., violation of legal norms)

**Economic**
- Benefits (e.g., reduction in travel time)
- Costs (e.g., investment costs)
A Better Amazon Road Network for People and the Environment

[Scatter plot showing the relationship between less socioenvironmental damage and more economic gain.]
A Better Amazon Road Network for People and the Environment

Percentage of the total socioenvironmental damage score

Cumulative NPV (million US$)

77% at 10%
A Better Amazon Road Network for People and the Environment

• Recommendations

1. Don’t build roads that don’t make economic sense, i.e., NPV < 0.
2. For projects with NPV > 0, use this tool to consider the social and environmental costs too.
3. Be fully aware of the tradeoffs BEFORE making investment decisions.
CONCLUSIONS

• Ideal: AVOID
  – If avoidance not possible, mitigate impacts
    • Important to consider costs and benefits of mitigation measures/safeguards
References

• Wadey et al (2018). Why did the elephant cross the road? The complex response of wild elephants to a major road in Peninsular Malaysia, Biological Conservation, 218, 91-98


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