Valuation of CO$_2$ Emissions in Cost-benefit Analysis of Transportation Projects: Report from Japan

Prof. Hironori Kato
Department of Civil Engineering
The University of Tokyo

Presented at JTRC Meeting at OECD
December 2013
Contents of This Presentation

• Government’s Manuals of Cost-benefit Analysis for Transportation Projects in Japan
• Discussions about Valuation of CO$_2$ Emissions in Japan
• Conclusions
Government’s Manuals of CBA for Transportation Projects in Japan

- Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan has published CBA manuals of transportation projects including road, rail, air, and water transportation.

- All manuals are available online at the website of Ministry of Internal Affairs and Communications.

CBA manuals of transportation projects in Japan

<table>
<thead>
<tr>
<th>Type of project</th>
<th>Title</th>
<th>Latest updated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rail</td>
<td>Project Evaluation Manual of Rail Projects</td>
<td>July 2012</td>
</tr>
<tr>
<td>Road</td>
<td>Cost-benefit Analysis Manual</td>
<td>November 2010</td>
</tr>
</tbody>
</table>
CBA Manuals vs. Technical Guidance

• CBA manuals of transportation projects are independently made by different bureaus under the MLIT.
  – They reflect the different characteristics of transportation facilities/services.

• “Technical Guidance of Cost-benefit Analysis for Public Project Evaluation” (TG) presents general recommendations to all CBA manuals of transportation projects.
  – The latest TG was published in June 2009 by MLIT.
  – Note each CBA manual is not obliged to follow the TG.
Basic Method shown in TG

• Evaluation indexes:
  – Three indexes: Net Present Value (NPV), Cost-benefit Ratio (CBR), and Economic Internal Rate of Return (EIRR)

• Social discount rate: 4 percent

• Evaluation period:
  – Appropriate period should be used by type of projects.
    • Air: 50 years
    • Rail: 30 years or 50 years
    • Road: 50 years
    • Sea Port: 20 to 50 years
Notes on Social Discount Rate: Comments in TG

• Although there are two approaches to setting the social discount rate (SDR): capital cost approach and social time preference approach, it is difficult to determine the SDR with social time preference approach in practice.
• TG recommends the SDR estimated from market interest rate based on the capital cost approach.
• It estimated SDR to be approximately 4% using the past data of Japanese Government Bond Yield.

Japanese Government Bond Yield from 1980s to 2000s

<table>
<thead>
<tr>
<th>Period</th>
<th>JGB 10 year Yield (Nominal, average)</th>
<th>JGB 10 year Yield (Real, average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 to 1995</td>
<td>4.09%</td>
<td>3.91%</td>
</tr>
<tr>
<td>1986 to 1995</td>
<td>4.78%</td>
<td>3.85%</td>
</tr>
<tr>
<td>1993 to 2002</td>
<td>2.23%</td>
<td>3.10%</td>
</tr>
<tr>
<td>1983 to 2002</td>
<td>3.95%</td>
<td>3.52%</td>
</tr>
</tbody>
</table>

Source: MLIT (2009)
Evaluation of Environmental Impacts
Recommended by TG

• TG raises negative impacts of transportation projects on environment such as air quality, water quality, noise, vibration, soil quality, biodiversity, etc.

• It recommends alternative cost method, hedonic method, contingency valuation method (CVM), and travel cost method (TCM) for valuing the environmental impacts.

• It also recommends the valuation of CO$_2$ emissions.
  – 10,600 JPY per t-C (2006 year value)
  – This is estimated with damage cost approach
### Benefit Estimation in Each Manual

<table>
<thead>
<tr>
<th></th>
<th>Components of benefit</th>
<th>Estimation methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airport</td>
<td>Saving of travel time, saving of travel cost, improvement of travel time reliability, increase of service frequency, noise</td>
<td>Consumer surplus approach, abatement cost approach (noise)</td>
</tr>
<tr>
<td>Rail</td>
<td>Saving of travel time, saving of travel cost, improvement of transfer at stations, reduction of in-vehicle congestion, increase of service frequency, NOx, noise, CO₂</td>
<td>Consumer surplus approach, CVM, abatement cost approach (NOx, noise), TG method (CO₂)</td>
</tr>
<tr>
<td>Road</td>
<td>Saving of travel time, saving of travel cost, improvement of traffic safety</td>
<td>Consumer surplus approach</td>
</tr>
<tr>
<td>Seaport</td>
<td>Saving of travel time, saving of travel cost</td>
<td>Consumer surplus approach</td>
</tr>
</tbody>
</table>

- Valuation of changes in CO₂ emissions is incorporated into benefit estimation only in the CBA manual of rail projects.
Discussions about Valuation of CO$_2$ Emissions in Japan
Revision of General Guideline of CBA

• Working Group (WG) of Government Committee on Project Evaluation Method was set up in October 2008 for revision of TG.
• To prepare this discussion, Study Team started discussions about the revisions of TG from January 2007 to June 2008.
• WG finally recommended the results to Government Committee in March 2009.
• The revised TG was published in June 2009.
Discussions among Experts

- Study Team and WG invited eight experts from economists, civil engineers, and transportation researchers in Japan for discussing the necessary revision of TG.
  - One of the issues in WG is valuation of environmental impacts.
  - Earlier version of TG did not include the guidance of CO₂ value although it suggested the emissions trading price approach.
Discussions about Valuation of CO$_2$ Emissions in Japan

• The Study Team and WG examined three potential methods for valuing CO$_2$:
  – Damage cost approach
  – Abatement cost approach
  – Emissions trading price approach

• They reviewed the existing literature as well as current practices in other countries through literature review, interviews, and questionnaire surveys.
  – Austria, Denmark, Finland, France, Germany, Netherland, Sweden, Switzerland, UK, US, New Zealand
  – IPCC Report, HEATCO Report, academic studies/papers
Major Comments from ST/WG Members

• “The assumptions of abatement technologies and expected damages significantly influence the values.”
• “Emissions trading price highly depends on the market design and regulations. The emissions trading market has not been well matured. The market price could be seriously biased.”
• “Abatement cost approach should be excluded because abatement technologies cannot be clearly identified. The willingness-to-pay for reducing CO$_2$ should be reflected into the value.”
• “National value of CO$_2$ emissions may have some strong message to the public and international/domestic market.”
• “Simple reviews of past studies in other countries may be biased by currency exchange rate.”
• “The accuracy of estimating future damage cost may be quite low, thus the sensitivity analysis should be carried out in its application.”
• “Results including state-of-the-art studies should be used. The regular updating process is strongly recommended.”
## Comparisons of Three Approaches

<table>
<thead>
<tr>
<th>Approach</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage cost approach</td>
<td>• Easy to integrate findings of past research due to recent increase of meta-analysis on damage cost.</td>
<td>• Estimated values vary among studies depending on models used and assumptions of future damage</td>
</tr>
<tr>
<td>Abatement cost approach</td>
<td>• Possible to estimate the value being consistent with government’s target of CO₂ reduction in the future</td>
<td>• Estimated values highly depend on the government’s target of CO₂ reduction and the technology development in the future.</td>
</tr>
<tr>
<td>Emissions trading price approach</td>
<td>• Theoretically reasonable as the market price</td>
<td>• Emissions trading market has not been well developed, thus the trading price may not reflect the marginal cost.</td>
</tr>
</tbody>
</table>
Recommendations from WG

• Damage cost approach

• 10,600 JPY/t-C (2006 year value)
  – This value was estimated by referring to Tol (1999).
  – 1990 year value (60 US$/t-C) is first converted into 2006 year value using GDP deflator of US and then converted into JPY (2006 year value) using Purchasing Power Parities (PPPs) as of 2006.

• Sensitivity analysis
  – Minimum: 50 percent; Maximum: 200 percent
Conclusions
Summaries of Report from Japan

• Japanese Government has introduced the value of CO$_2$ emissions into Technical Guidance of CBA since 2009.

• It recommends the use of value of CO$_2$ based on damage cost approach estimated with the empirical evidences from past literature.
Discussions

• However, few manuals of CBA in transportation projects have introduced the value of CO$_2$ emissions into benefit estimation.

• Benefit stemming from reduction of CO$_2$ emissions in transportation project seems to account for very small percent out of total benefit.

• The low influence of CO$_2$-reduction benefit may lead to lower incentive of introducing it into CBA manual.
References