

Introduction to Cost-Benefit Analysis

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BGVW Chapter 1

Outline

- ▶ Basic steps of CBA
- ▶ Direct and Indirect Benefits
- ▶ Two ways of estimating benefits:
National income vs. Consumer &
producer surpluses

Basic steps of CBA

- ▶ CBA compares policy alternatives
 - ▶ Simplest is a comparison between two cases, With and Without a project
- ▶ Steps of CBA
 - ▶ Define With and Without Cases
 - ▶ Toll changes: toll reduction, road pricing, peak-load pricing
 - ▶ Capacity investment: construction of new railway lines
 - ▶ Regulation: environment, health, safety
 - ▶ Forecast impacts for both cases
 - ▶ Evaluate the benefits and costs of policy impacts
 - ▶ Measure the values of impacts
 - ▶ Cost-benefit analysis, Cost-effectiveness analysis, Qualitative CBA
 - ▶ Evaluate the reliability of the estimation results

Basic steps of CBA (BGVW Ch.1)

- ▶ Step 1 – Specify the set of alternative projects.
- ▶ Step 2 -- Decide whose benefits and costs count (standing).
- ▶ Step 3 – Identify the Impact Categories, Catalogue them and select the measurement indicators.
- ▶ Step 4 -- Predict the impacts quantitatively over the life of the project.
- ▶ Step 5 -- Monetize (attach dollar values to) all impacts.
- ▶ Step 6 -- Discount benefits and costs to obtain present values
- ▶ Step 7 -- Compute the net present value of each alternative.
- ▶ Step 8 -- Perform sensitivity analysis.
- ▶ Step 9 -- Make a recommendation.

Basic calculation in CBA: Transportation example

- ▶ Basic calculation in transport cost-benefit analysis ([World Bank Transport Note No. TRN-5](#))

$$\begin{array}{rcccl}
 \text{Overall} & & & & \\
 \text{Economic} & = & \text{Change in} & & \text{Change in} & & \text{Change in costs} & & \text{Investment} \\
 \text{Impact} & & \text{transport} & + & \text{system} & + & \text{of externalities} & - & \text{costs} \\
 & & \text{user} & & \text{operating} & & \text{(Environmental} & & \text{(including} \\
 & & \text{benefits} & & \text{costs and} & & \text{costs, accidents,} & & \text{mitigation} \\
 & & \text{(Consumer} & & \text{revenues} & & \text{etc.)} & & \text{measures)} \\
 & & \text{Surplus)} & & \text{(Producer} & & & & \\
 & & & & \text{Surplus and} & & & & \\
 & & & & \text{Government} & & & & \\
 & & & & \text{impacts)} & & & &
 \end{array}$$

- ▶ Necessary to consider:
 - ▶ The scope of the appraisal in terms of mode, study area and range of impacts;
 - ▶ The calculation of transport user benefits (consumer surplus);
 - ▶ The calculation of impacts on transport providers and the government (includes producer surplus and investment costs);
 - ▶ Monetary valuation of time and safety;
 - ▶ The treatment of environmental impacts and other externalities.
 - ▶ The mechanics of the process including inputs, project life, discounting, aggregation of benefits and costs, unit of account.

Examples of “projects” to be evaluated

- ▶ **An improvement in transportation**
 - ▶ The cost of the project vs. Reduction in time and operating costs
 - ▶ Impacts: Increase in users of the improved route, Decrease in users of other routes, Changes in land use and land price, Changes in employment, Changes in production
- ▶ **Better medical care**
 - ▶ Improvement in health vs. Higher medical costs
 - ▶ Impacts: higher labor income, increase in population, change in productivity

Direct and indirect impacts

- ▶ A highway improvement project: reduction in transport costs
- ▶ Direct impacts: Increase in traffic in the improved route
- ▶ Indirect impacts: Changes in all other markets
 - ▶ Reduction in traffic of other routes, which reduces congestion there
 - ▶ Reduction in transport costs leads to reductions in the prices of transported goods, which then induces relocation of producers
 - ▶ Changes in other markets change the traffic in the improved route, e.g., reduced congestion in other routes reduces the traffic there
- ▶ Two (general) equilibria without and with the improvement project:
 - ▶ Prices in all markets adjust so that supply = demand in all markets
 - ▶ Trucking companies whose costs are reduced by the project are not the ultimate beneficiaries of transportation improvements. Benefits shift to producers who transport the goods, and then to consumers of the goods.

Two ways of estimating the benefits

- ▶ Focus on the primary market (the market directly affected by the project): Consumer surplus approach
 - ▶ Changes in consumer and producer surpluses in a market directly affected by a policy
 - ▶ OK in the first best with no price distortion (price = marginal social cost)
- ▶ Comparison of welfare levels between two general equilibria with and without the project: National income (index number) approach
 - ▶ A change in real national income with fixed prices measures the benefits (approximately)
- ▶ Two ways of estimating the same benefits

National Income Approach (Can be skipped)

- ▶ A change in **real** national income measures a welfare change:

Utility Maximization

$$\frac{\partial u(x) / \partial x_i}{\partial u(x) / \partial x_1} = \frac{p_i}{p_1}$$

$$\Delta u = u(x_1 + \Delta x_1, \dots, x_n + \Delta x_n) - u(x_1, \dots, x_n) = \sum_i \frac{\partial u(x)}{\partial x_i} \Delta x_i = \underbrace{\frac{\partial u(x)}{\partial x_1} \frac{1}{p_1}}_{\text{Marginal Utility of Income}} \sum_i p_i \Delta x_i$$

- ▶ Incidence based: Increase in utility after the induced changes in all markets. Looking at ultimate beneficiaries.
- ▶ Evaluated at **fixed consumer** prices
- ▶ Changes in all consumption goods
- ▶ Laspeyres and Paasche indices as upper and lower limits
- ▶ Need a general equilibrium simulation model to apply this method.

Consumer Surplus Approach (Can be skipped)

- ▶ Changes in consumer and producer surpluses in a market **directly affected** by a policy
 - ▶ The surpluses often transferred to others. Trucking companies are not the ultimate beneficiaries of transportation improvements.
- ▶ OK in the first best with no price distortion (price = marginal social cost)
- ▶ With price distortion, impacts on secondary markets (deadweight losses) must be evaluated

Consumer surplus and producer surplus: Review

- ▶ **Consumer surplus:** The area to the left of a demand curve
 - ▶ Height of a demand curve = Willingness to pay (WTP)
 - ▶ WTP: Maximum amount an individual is willing to pay to obtain something good
 - ▶ Net benefit for a consumer = WTP - Price
- ▶ **Producer (supplier) surplus:** The area to the left of a supply curve
 - ▶ Height of a supply curve: Opportunity cost = Marginal cost
 - ▶ Opportunity Cost: Value of an input in its best alternative use
- ▶ **Social Surplus:** Consumer surplus + Producer surplus

