LIFE CYCLE BENEFIT

AND

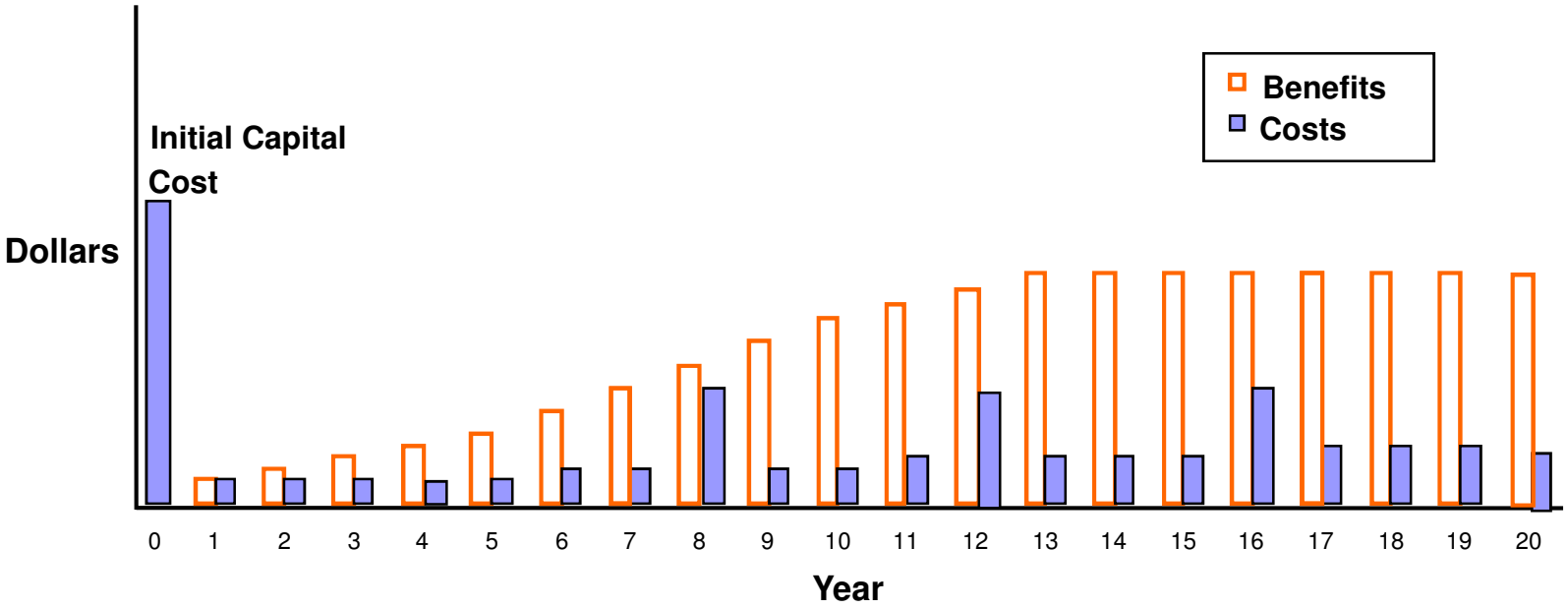
COST ANALYSIS

ECONOMIC ANALYSIS

Issues and Concepts

- Costs and benefits can be valued in currency units.
- Project life cycle is basis for comparison
- To be compared, dollars in different years must be “discounted” to their present value amounts

Typical Life Cycle Profile



Steps for Economic Analysis

- Step 1: Establish design alternatives
- Step 2: Determine activity timing
- Step 3: Estimate costs (Agency and user)
- Step 4: Discount life cycle costs
- Step 5: Analyze the results

Adjusting for Present Value

$$PV = \left(\frac{1}{(1+r)^t} \right) A_t$$

where

PV **= present value at time zero (base year)**

r **= discount rate**

t **= time (number of year)**

A = amount of benefit or cost in year t

Example of Discounting

- What if we want to determine how much a $ 1,000 benefit in 30 years is worth to us today?
  - $1000 is in “real” dollars (i.e., in dollars with today’s purchasing power)
  - Discount rate is 3%

Example (continued)

- Plug values into discounting formula:

$$PV = \left(\frac{1}{(1+.03)^{30}} \right) \$1{,}000_{year\ 30}$$

- Do calculations:

$$PV = \$1{,}000 \text{ x } 0.41199 = \$412$$

Discount Rate Is Important

- Higher the discount rate, the lower the present value of a future dollar
  - At 3%, $1,000 30 years from now is worth only $412 today
  - Worth $231 at 5% and $57 at 10%
- Discount rate can influence project selection or design

Life-Cycle Cost Analysis (LCCA)

- Subset of BCA
  - The “blue bars” on the life cycle profile
- LCCA reveals lowest life-cycle cost alternative for a project
- Used only when all design alternatives yield same benefits

LCCA Formula

- LCCA is done using the basic multi-year discounting formula:

$$PV = \sum_{t=0}^{N} \left(\frac{1}{(1+r)^t} \right) Cost_t$$

- where “Cost” equals the cost for design alternative in year t

How to Get Best LCCA Results

- Evaluate all reasonable design alternatives for the project
- Analyze alternatives over identical analysis periods
- Evaluate all relevant costs that vary among the alternatives

Cost Items Used in LCCA

Agency Costs

- **Design and engineering**
- **Land acquisition**
- **Construction**
- **Reconstruction/Rehabilitation**
- **Preservation/Routine Maintenance**

User Costs At Work Zones

- **Delay**
- **Crashes**
- **Vehicle Operating**

Benefits of LCCA

1. Better information for decisions
2. Improved rehabilitation strategies
3. Consideration of user costs
4. Support for overcoming the "first cost" limitations.
5. Expose areas of uncertainty and quantify the risk

….LCCA done in ALL infrastructure cases.

Limitations of LCCA

- Cannot compare design alternatives that have different benefits (e.g., reconstruct road vs. reconstruct road with widening)
- Cannot, of itself, answer question of whether an improvement is worth pursuing (i.e. the project has a positive net present value)

Benefit Cost Analysis (BCA)

- BCA compares discounted value of project's benefits to discounted value of its costs
  - The blue and red bars on the life cycle profile
- BCA is the superset of LCCA and focuses on finding out the benefits from different alternatives of the project.

BCA Formula

- BCA is done using the basic multi-year discounting formula:

$$PV = \sum_{t=0}^{N} \left(\frac{1}{(1+r)^t} \right) (Benefit_t - Cost_t)$$

Applications of BCA

- BCA is used to address the following resource allocation decisions:
  - Whether or not to pursue an improvement
  - Select among design alternatives with different benefits
  - Select among competing projects in same mode
  - Select among competing projects in different modes

Challenges of BCA

- Calculation of benefits and costs over life cycle is often difficult
  - Agency costs associated with projects can be hard to ascertain
  - User costs and benefits are critical
    - User benefits are purpose for building the road but may be hard to measure and value
    - Uncertain forecasts of traffic, delays, and crash rates
    - Valuation of time and safety is often controversial
  - Externalities and social impacts resist quantification

Discounting

- Discounting is the backbone of Economic analysis
- Use of a discount rate facilitates comparison of the costs and benefits of alternative transportation projects over time
- Dollars can be:
  - Relocated in time
  - Any combination of flows can be summed into a single value at a single point in time
  - Lump sums can be converted to annual flows
- Discount rate is distinct from inflation rate

Key Role of Discount Rate in BCA

- Discount rate reflects the productivity of capital, people's preferences for current over future consumption, and the scarcity of investable resources
- If an investment doesn't yield discounted benefits that exceed discounted costs, this means resource allocation is not economically efficient

Conclusions

- EA has an important role in Transportation Asset Management
- EA tools are versatile and can accommodate a large number of variables as well as uncertainty
- EA informs Decision Makers, about which alternative to choose out of a given alternatives