Chapter 14

Economic Analysis in the Public and Regulated Sectors

Think of Chapter 14 as Two Separate Topics

1. Benefit-cost analysis – used widely in the public sector (e.g., government agencies) (14.1-14.8)
2. Revenue requirements analysis – used widely by regulated public utilities (e.g., phone, electric, gas) (14.9-14.12)

Benefit-cost analyses (public sector) and the *revenue requirements method* (regulated organizations) both (1) differ from traditional ATCF industrial analyses, and yet (2) are consistent with and equivalent to traditional ATCF analyses

Benefit-Cost Analysis (14.1-14.8)

- Introduction - The Nature of Public Projects
- Build-Operate-Transfer
- Objectives in Public Project Evaluation
- Guidelines in Public Sector Evaluation
- U.S. Federal Government Guidelines
- Using SEAT in Public Sector Evaluations
- Benefit-Cost and Cost-Effectiveness Calculations
- Important Considerations in Evaluating Public Projects

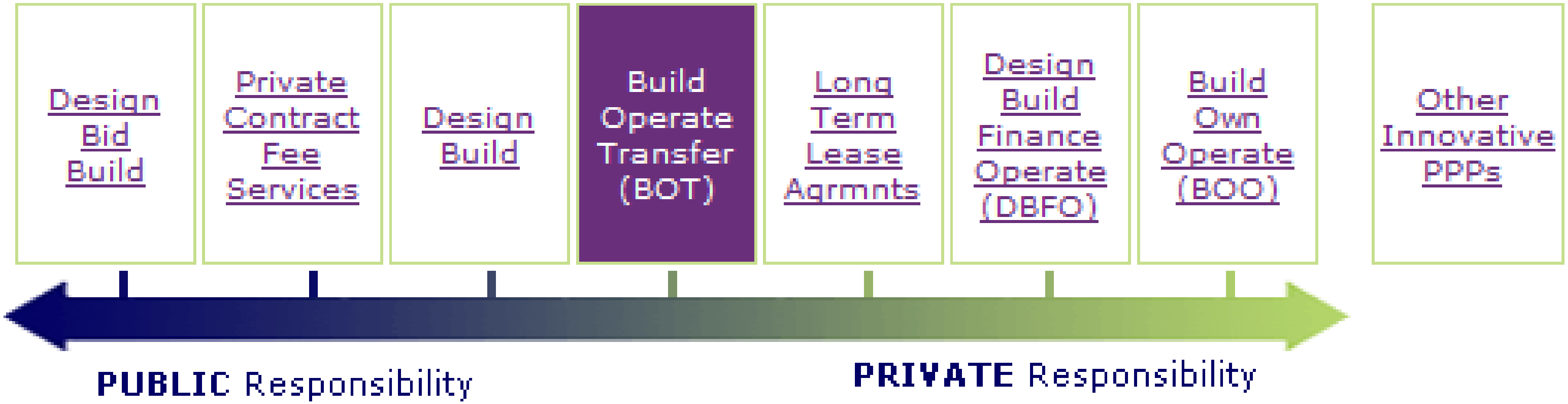
The Nature of Public Projects

Projects should provide benefits for the greater good of the public that *exceed* the costs of providing those benefits.

- The most frequently used method in evaluating government (local, state, or federal) projects is *benefit-cost analysis*.
- Next most frequent is *cost effectiveness analysis*.

Build-Operate-Transfer

- Build-Operate-Transfer expands the private sector role, allowing *public agencies* to tap into *private sector* technical, management and financial resources. This achieves (1) greater cost and schedule certainty, (2) supplements to in-house staff, (3) innovative technology applications, (4) specialized expertise, and (5) access to private capital.



BOT characteristics include:

1. Responsibility
2. Life-cycle costing
3. Procurement process (competitive bid)
4. Standard specifications

Objectives in Public Project Evaluation

- Flood Control Act on June 22,1936: *"… the Federal Government should improve or participate … if the benefits to whomsoever they may accrue are in excess of the estimated costs …."*
- River and Harbor Act of 1902: "*required a board of engineers to report on … the amount of commerce benefited and the cost."*
- Prest and Turvey on benefit-cost analysis: " … *a practical way of assessing the desirability of projects where it is important to take a long view and a wide view; it implies enumeration and evaluation of all relevant costs and benefits."*

Benefit-cost analyses take a "long view" (over time) and a "wide view" (individuals, groups and things) and evaluate monetized benefits, disbenefits, and costs.

Guidelines in Public Sector Evaluation
(from Arrow, et al)

1. B/C analysis is useful to compare favorable and unfavorable effects of a policy
2. B/C analysis is useful in achieving a desired goal at the lowest possible cost
3. Agencies should use B/C analysis to set regulatory priorities
4. B/C analysis should be required for major decisions
5. When costs far exceed benefits in an accepted decision, the “other” factors should be stated
6. B/C analysis should be done on major health, safety, and environmental regulations to inform legislators

Arrow, et al, established six guiding principles for use by those in public service.

U.S. Federal Government Guidelines

The Office of Management and Budget's (OMB) Circular No. A-94, Revised, is the *definitive document* today for those performing benefit-cost analyses.

It is outlined in Appendix 14.A and may be found at

www.whitehouse.gov/omb/circulars/a094/a094.html, or do a search on "A-94"

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Example 14.1

Costs and benefits for a public sector investment program are shown on the next slide. The planning horizon is 10 years and TVOM is i=7%

Note that the PW of benefits is $1,424,102, and the PW of costs is $1,063,987, the net PW of benefits minus costs is $360,115 and the B/C ratio =1.33. So, the program is desirable when considered alone.

Chapter 14 20080326 [Compatibility Mode] - Microsoft Excel

E10 =PV(0.07,A10,,-C10)

	A	B	C	D	E	F
1	EOY	Cost	Benefit	PW Costs	PW Benefits	
2	0	$0	$0	$0	$0	
3	1	$100,000	$0	$93,458	$0	
4	2	$200,000	$0	$174,688	$0	
5	3	$300,000	$50,000	$244,889	$40,815	
6	4	$300,000	$100,000	$228,869	$76,290	
7	5	$200,000	$300,000	$142,597	$213,896	
8	6	$100,000	$400,000	$66,634	$266,537	
9	7	$50,000	$400,000	$31,137	$249,100	
10	8	$50,000	$400,000	$29,100	$232,804	
11	9	$50,000	$400,000	$27,197	$217,573	=PV(0.07,A11,,-C11)
12	10	$50,000	$250,000	$25,417	$127,087	=PV(0.07,A12,,-B12)
13		PRESENT WORTH		$1,063,987	$1,424,102	

Figure 14.2 / Figure 14.3 / Figure 14.4 / Figure 14.5 / Figure 14.6 / Figure 14.8

Systematic Economic Analysis Technique

1. *Identify the (public-sector) investment alternatives*
2. *Define the planning horizon (for the benefit-cost study)*
3. ***Specify the discount rate***
4. ***Estimate the (benefit and cost profiles in monetary terms) cash flows***
5. ***Compare the alternatives (using a measure of worth related to benefits and costs)***
6. *Perform supplementary analyses*
7. *Select the preferred (alternative) investment*

Benefit-Cost and Cost-Effectiveness Calculations

- Benefit-cost analysis typically uses:
  - *B/C* benefit-cost ratio
  - *B-C* benefits minus costs
- Both *B* and *C* are expressed in monetary units as PW or AW (or even FW) where an appropriate discount rate i has been used to calculate PW or AW.

B/C Formula

$$B/C(i) = \frac{\sum_{t=1}^{n} B_t (1+i)^{-t}}{\sum_{t=0}^{n} C_t (1+i)^{-t}} \qquad (14.1)$$

Where t=end of year, n=planning horizon, i=discount rate, B_t is benefits in t, and C_t is costs in t, where both B_t and C_t are expressed in monetary units.

B-C Formula

$$B-C(i) = \sum_{t=1}^{n} B_t (1+i)^{-t} - \sum_{t=0}^{n} C_t (1+i)^{-t} \quad (14.2)$$

Where t=end of year, n=planning horizon, i=discount rate, B_t is benefits in t, and C_t is costs in t, where both B_t and C_t are expressed in monetary units.

Comparing Two Alternatives

- When two project alternatives are being compared using a *B/C* ratio, the analysis should be done on an *incremental* basis.
  - Let the alternative with the lower present worth of costs be Alternative 1 and let the other be Alternative 2.
  - Then , the *incremental benefits* of the second alternative over the first, $\Delta B_{2\text{-}1}(i)$, are divided by the *incremental costs* of the second over the first, $\Delta C_{2\text{-}1}(i)$.

Incremental B/C Ratio

$$\Delta B/C_{2-1}(i) = \frac{\Delta B_{2-1}(i)}{\Delta C_{2-1}(i)} = \frac{\sum_{t=1}^{n} (B_{2t} - B_{1t})(1+i)^{-t}}{\sum_{t=0}^{n} (C_{2t} - C_{1t})(1+i)^{-t}} \quad (14.3)$$

- Incremental *B/C* analysis is like incremental rate of return analysis. Here, you prefer alternative 2 over 1 as long as the $\Delta B/C > 1$. Then, compare alternative 3 to the winner of 1 and 2, and so on
- Do not just select the alternative with the highest overall *B/C* ratio

Comparing Two Alternatives

- When two project alternatives are being compared using *B-C*, no special incremental procedure is necessary
- Just select the alternative that has the highest value of *B-C*

Cost-Effectiveness Analysis

- Use cost-effectiveness analysis whenever each alternative has the same annual benefits or effects. Simply minimize the PW or AW of costs

$$C_{j,preferred}(i) = \min \forall_j \left(\sum_{t=0}^{n} C_{jt}(i) \right) \qquad (14.5)$$

- Or, use C-E analysis when alternatives have the same costs. Maximize the PW or AW of benefits

$$B_{j,preferred}(i) = \max \forall_j \left(\sum_{t=1}^{n} B_{jt}(i) \right) \qquad (14.6)$$

Example 14.2

- Three highway alternatives, A, B, and C
- Benefits are assumed to be all equal, so use Cost-Effectiveness analysis
- For each alternative,

$$AW_{total} = AW_{first/resurfacing} + AW_{maintenance}$$

- See next slide for data and calculations
- Route A wins with lowest cost!

Chapter 14 20080326 [Compatibility Mode] - Microsoft Excel

B17 =PMT(B6,B7,PV(B6,10,,B9*B3)+PV(B6,20,,B10*B3))

	A	B	C	D	E
1		**Route A**	**Route B**	**Route C**	
2	**General info**				
3	**Miles**	**26**	**22**	**20.5**	
4					
5	**Government-related info**				
6	**Discount rate**	**8.00%**	**8.00%**	**8.00%**	
7	**Planning horizon in years**	**30**	**30**	**30**	
8	**First Cost $/mi**	**$2,000,000**	**$3,000,000**	**$4,000,000**	
9	**Resurfacing cost $/mi @10 yrs**	**$2,000,000**	**$2,000,000**	**$2,000,000**	
10	**Resurfacing cost $/mi @20 yrs**	**$2,000,000**	**$2,000,000**	**$2,000,000**	
11	**Maintenance $/mi-yr**	**$10,000**	**$12,000**	**$20,000**	
12					
13	**Summary of Annual Equivalent Government Costs**				
14		**Route A**	**Route B**	**Route C**	
15	**Government**				
16	**First cost of highway $/year**	**$4,619,027**	**$5,862,611**	**$7,283,850**	**=-PMT(D6,D7,D8*D3)**
17	**Resurfacing costs $/year**	**$3,130,507**	**$2,648,890**	**$2,468,284**	
18	**Maintenance costs $/year**	**$260,000**	**$264,000**	**$410,000**	**=D11*D3**
19	**Total $/year**	**$8,009,533**	**$8,775,501**	**$10,162,134**	**=SUM(D16:D18)**

=PMT(D6,D7,PV(D6,10,,D9*D3)+PV(D6,20,,D10*D3))

Lowest cost

Figure 14.2 | Figure 14.3 | Figure 14.4 | Figure 14.5 | Figure 14.6 | Figure 14.8

Example 14.3

- Same road project as Example 2, except considering different “benefits” for A, B, and C
- Different numbers of vehicle types considered
- Cost of operation is considered for each type
- Cost of time spent driving, by vehicle, is considered
- Cost of accidents on each route is also considered
- Relevant government and public costs are given on the next slide, and the incremental B/C analysis follows two slides from here. Note that “benefits” here are expressed as “cost *savings*”

Chapter 14 20080326 [Compatibility Mode] - Microsoft Excel

	Route A	Route B	Route C
General info			
Miles	26	22	20.5
Hvy truck speed miles/hour	35	40	40
Other veh speed miles/hour	45	50	50
Accidents/year	105	75	50
Cost/accident	$18,000	$18,000	$18,000
Government-related info			
Discount rate	8.00%	8.00%	8.00%
Planning horizon in years	30	30	30
First Cost $/mi	$2,000,000	$3,000,000	$4,000,000
Resurfacing cost $/mi @10 yrs	$2,000,000	$2,000,000	$2,000,000
Resurfacing cost $/mi @20 yrs	$2,000,000	$2,000,000	$2,000,000
Maintenance $/mi-yr	$10,000	$12,000	$20,000
Public-related info	Vehicles/day	Op cost/mile	Time cost/veh hr
Light commercial trucks	350	$0.70	$25
Heavy commercial trucks	250	$1.10	$25
Motorcycles	80	$0.30	$10
Commercial autos	830	$0.60	$25
Noncommercial autos	2490	$0.60	$10
Total vehicles	4000		
Automobiles	3320		
% commercial autos	25.00%		
% noncommercial autos	75.00%		

Figure 14.2 | Figure 14.3 | Figure 14.4 | Figure 14.5 | Figure 14.6 | Figure 14.8

Relevant government and public costs plus other input data.

Chapter 14 20081002 [Compatibility Mode] - Microsoft Excel

B38 =($B18*$C18+$B19*$C19+$B20*$C20+$B21*$C21+$B22*$C22)*B3*365

	A	B	C	D	E
29	**Summary of Annual Equivalent Government and Public Costs**				
30		**Route A**	**Route B**	**Route C**	
31	**Government**				
32	**First cost of highway $/year**	**$4,619,027**	**$5,862,611**	**$7,283,850**	**=-PMT(D10,D11,D12*D3)**
33	**Resurfacing costs $/year**	**$3,130,507**	**$2,648,890**	**$2,468,284**	
34	**Maintenance costs $/year**	**$260,000**	**$264,000**	**$410,000**	**=D15*D3**
35	**Total $/year**	**$8,009,533**	**$8,775,501**	**$10,162,134**	**=SUM(D32:D34)**
37	**Public**				
38	**Operating costs**	**$24,066,640**	**$20,364,080**	**$18,975,620**	
39	**Time costs**	**$13,335,710**	**$10,119,808**	**$9,429,821**	
40	**Accident costs**	**$1,890,000**	**$1,350,000**	**$900,000**	**=D7*D6**
41	**Total $/year**	**$39,292,350**	**$31,833,888**	**$29,305,441**	**=SUM(D38:D40)**
43	**Benefit B to A**		**$7,458,462**		
44	**Cost B to A**		**$765,968**		
45	**B/C Ratio B to A**	**Prefer B to A**	**9.74**		
47	**Benefit C to B**			**$2,528,447**	**=C41-D41**
48	**Cost C to B**			**$1,386,633**	**=D35-C35**
49	**B/C Ratio C to B**		**Prefer C to B**	**1.82**	**=D47/D48**
51	**=PMT(D10,D11,PV(D10,10,,D13*D3)+PV(D10,20,,D14*D3))**				
53	**=($B18*$C18+$B19*$C19+$B20*$C20+$B21*$C21+$B22*$C22)*D3*365**				
55	**=($B18*$D18/D5+$B19*$D19/D4+$B20*$D20/D5+$B21*$D21/D5+$B22*$D22/D5)*D3*365**				

Figure 14.2 | Figure 14.3 | Figure 14.4 | Figure 14.5 | Figure 14.6 | Figure 14.8 | Figu

Example 14.3, concluded

- Note that *government costs* are given as:

  A: \$8,009,533; B: \$8,775,501; C: \$10,162,134

  - So, incremental costs B to A = \$765,968
  - and incremental costs C to B = \$1,386,633
- Note that *costs to public* are:

  A: \$39,292,350; B: \$31,833,888; C: \$29,305,441

  - So, incremental "Benefit" B to A = \$7,458,462
  - and incremental "Benefit" C to B = \$2,528,447
- $\Delta B/C_{\text{B to A}}$ = \$7,458,462/\$765,968 = 9.74 B wins
- $\Delta B/C_{\text{C to B}}$ = \$2, 528, 447/\$1,386,633 = 1.82 C wins

Example 14.4

- The difference in incremental benefits and costs may be used for Example 14.3
- $\Delta(B\text{-}C)_{B\text{-}A} = \Delta B_{B\text{-}A} - \Delta C_{B\text{-}A} =$

  \$7,458,462 - \$765,968 = \$6,692,494/year

  So, B is preferred to A
- $\Delta(B\text{-}C)_{C\text{-}B} = \Delta B_{C\text{-}B} - \Delta C_{C\text{-}B} =$

  \$2,528,447 – 1,386,633 = \$1,141,814/year

  And, C is preferred to B
- C wins overall – same as in Example 14.3

Notes on Ex. 14.2, 14.3, and 14.4

- Example 14.2 used Cost Effectiveness Analysis, comparing government costs only, since benefits were assumed equal for each of routes A, B, and C
- Examples 14.3 and 14.4 used Benefit-Cost analysis since benefits were assumed different for each of routes A, B, and C
- The incremental *B/C* ratio was used in Example 14.3, and incremental *B-C* analysis was used in Example 14.4

- ***B/C*** **analysis is useful for evaluating one project.**
- **Incremental** ***ΔB/ΔC*** **analysis is required when comparing more than one alternative.**
- ***B-C*** **analysis is useful for one or many alternatives.**

More on Ex. 14.2, 14.3, and 14.4

- Incremental benefits and incremental costs were evaluated using annual worth. Of course, the present worth of all costs would have been perfectly fine to use.

More on Ex. 14.2, 14.3, and 14.4

- More often than not, the benefit-cost ratio *B/C* (or incremental *B/C* ratio) is used. This is unfortunate because, just as in rate of return analyses in the private sector, the benefit-cost ratio *B/C* is easy to misuse and misinterpret
- Also, the *B/C* ratio is very sensitive to the classification of problem elements as "benefits" or "costs." *B-C* is not.

Opportunities for Error…

- … pervade benefit-cost analyses from the initial philosophy through to interpretation. Consider:

1. Point of view (nat'l, state, local, individual).
2. Selection of the interest rate.
3. Assessing benefit-cost factors.
4. Overcounting.
5. Unequal lives.
6. Tolls and fees.
7. Multiple-use projects.
8. Problems with the B/C ratio.

Benefit-cost analyses have their own challenges due to *interpretation* in the "soft" public sector, even though the principles are solid and "hard."

Point of View

- What is the viewpoint of the analyst?
  1. An individual or select group who will benefit or lose.
  2. A particular governmental organization.
  3. A local area such as a city or county.
  4. A regional area such as a state.
  5. The entire nation.
- The viewpoint makes a difference!

Example 14.5

- The Corps of Engineers has a construction project in which the water table must be lowered in the immediate area so work can proceed. Any of several water cutoff or dewatering systems may be employed:

1. Sheet pile diaphragm
2. Bentonite slurry trench
3. Deep-well turbines
4. Eductor system
5. Wellpoints

Example 14.5, concluded

- What is the correct “point of view” to use in evaluating these options?
- The Corps will likely evaluate these different options from a “particular government organization” point of view, since each provides the same service or outcome—a dry construction site.
- Here, the most economical decision from the Corps’ point of view is also correct from the public’s view.

Example 14.6

- County officials must decide whether or not future refuse service should be county owned and operated or contracted out.
- Front-end loaders and roll on / roll off containers are required, as are several trucks and drivers.
- The cost in dollars per ton of refuse collected, removed, and disposed of are given on the next slide.

Cost per ton of refuse service

Cost of refuse collection, removal, and disposal paid by county	$/ton
Labor	20.32
Materials, supplies, utilities	17.14
Maintenance and repair	18.78
Overhead	11.39
Depreciation	12.06
5% interest on half financed by bonds	6.01
Total cost to county	**$85.70/ton**
Costs avoided by county, but paid by private contractor	**$/ton**
Federal taxes foregone	6.25
State taxes foregone	0.67
Property taxes foregone	5.15
8% return on half financed by tax money	9.62
Total not paid by county	**$21.69/ton**

Example 14.6, continued

- County cost to provide service will be $85.70/ton. The county is not, however, required to pay the additional $21.69/ton, as would a private firm.
- The ramifications of this are several:
  - The county will not pay federal taxes of $6.25/ton, thereby passing this to USA taxpayers.
  - State taxes will be forgone, and the burden must be spread over the state.
  - The county does not pay property tax on facilities and equipment, increasing property tax rates.

Example 14.6, concluded

- A regional or national perspective should be used in evaluating public works projects at every level, from local on up. Experience indicates that this will not happen, and the primary concern of most public officials is their own constituency.
- The best advice for evaluators and decision makers in the public realm is to examine multiple viewpoints.

Selection of the Interest Rate

- The interest rate or discount rate is another factor to be decided upon when evaluating public works projects.
- A discount rate of 7 percent is suggested for public investment in Section 8b of Circular A-94, Revised, in Appendix 14.A.
- The interest rate can significantly affect the PW or AW, thereby affecting the decision made.

Example 14.7

- Three projects each have investments requiring $50,000 . The annual benefits are $15,000, $9,000, and $5,000 for 5, 10, and 20 years, respectively. No project renewal will be performed, and benefits will cease after the time noted. The planning horizon is 20 years. The projects have the economic profile, as a function of the interest rate used, given in Table 14.2 on the next slide.

Analysis of projects using different discount rates

	Project A	Project B	Project C
Initial investment	$50,000	$50,000	$50,000
Annual benefits	$15,000/yr	$9000/yr	$5000/yr
Life in years	5 yr	10 yr	20 yr
	Present value of benefits - costs:		
0.0%	$25,000	$40,000	**$50,000**
1.0%	$22,801	$35,242	**$40,228**
2.0%	$20,702	$30,843	**$31,757**
3.0%	$18,696	**$26,772**	$24,387
4.0%	$16,777	**$22,998**	$17,952
5.0%	$14,942	**$19,496**	$12,311
6.0%	$13,185	**$16,241**	$7,350
7.0%	$11,503	**$13,212**	$2,970
8.0%	$9,891	**$10,391**	-$909
9.0%	**$8,345**	$7,759	-$4,357
10.0%	**$6,862**	$5,301	-$7,432

Example 14.7, concluded

- Different decisions can be made, depending upon the interest rate used in the analysis!
  - Project C is best for low discount rates of 0 percent, 1 percent, and 2 percent.
  - Project B is best for 3 percent through 8 percent.
  - Project A is best at 9 percent and 10 percent due to its benefits being much higher in the early years.
- So, which rate is right?

Financing of Gov't Projects

- There are several ways to come up with money for government projects, including:
  1. taxation (income tax, property tax, sales tax, and road user tax).
  2. issuance of bonds or notes.
  3. income-generating activities such as a municipally owned power plant, a toll road, or activity where a user charge is made to partially offset its cost.

Which Rate Should Be Selected?

- Different philosophies include:
  1. If tax money, use 0% since it is "free."
  2. Reflect society's rate of time preference – house: 6-13%; car: 8-10%.
  3. Match the rate paid by the government for borrowed money
  4. The "opportunity cost" forgone by private investors (R of R on use of private funds).
  5. The "opportunity cost" of investments forgone by government due to budget constraints.

7% specified by OMB Circular A-94, Revised

Selection of the interest rate used in a benefit-cost evaluation is all over the board. Most experts recommend position #4. We agree.

Assessing Benefit-Cost Factors

- On what factors should we place a $ figure?
  1. *Internal effects* are always included. They are direct benefits or direct costs (e.g., a WDC METRO ride is a direct benefit to the user, while construction materials are direct costs to the METRO line).
  2. *External technological (or real) effects* should be included. They are changes in opportunity for consumption or production (e.g., water sport recreation due to a new hydroelectric plant).

Assessing B-C Factors, Cont'd

3. *External pecuniary effects* can usually be ignored. They are changes in the distribution of incomes (e.g., increases in rents near a new subway station are pecuniary since benefits to landlords in increased rent are exactly offset by the costs incurred by tenants).
4. *Secondary effects* are included only if there are incremental incomes or losses. They are changes in supply and demand arising from a project (for example, increased sales income to some stores are likely offset by reduced sales of stores elsewhere, thus no effect).

Example 14.8

- A small dam and reservoir will reduce flood damage to homes and crops. Annual damage = $1,900,000/year. The dam and reservoir will eliminate damage, with no other benefits (e.g., irrigation, power generation, recreation) provided.
- What are the primary and secondary effects?

Example 14.8, continued

- The *primary* benefit to the public is the prevention of the *internal effects* of $1,900,000/year in damage.

Example 14.8, continued

- *Secondary effects* are the disbenefits to those who would lose income if the dam and reservoir were built, e.g., contractors and service providers who help flood-damaged families.
- *Secondary effects* also include benefits due to the increase in the demand for goods and services in constructing and maintaining the dam.

Example 14.8, concluded

- The *secondary effects* of the flood-control dam and reservoir would be small, if not negligible. This is because the dam's primary benefit is to reduce home and crop damage, which represents the measure of its direct usefulness.
- The *secondary effects* described are considered secondary and diffuse.

Example 14.9

- In Example 14.8, what if the dam and reservoir were to cause a loss of agricultural land for grazing and crops?
- Should this loss be considered in the benefit-cost analysis?
- Yes! This is an external technological (or real) effect causing changes in physical opportunities for consumption or production.

Example 14.10

- A large irrigation project is being considered in cotton country to improve the quantity and quality of cotton grown.
- Additional cotton will depress its price, lowering profitability. Manufacturers of products that may be used in place of cotton items will have to reduce prices. Producers of items that go well with cotton will note increased demand, and possibly price.
- Which of these effects would we include in an evaluation of the irrigation project?

Example 14.10, concluded

- None!
- Each of the effects described relates to changes in the distribution of incomes through changes in the prices of goods, services, and production factors.
- As such, they are considered *external pecuniary effects*, which are not “real” benefits or disbenefits, and therefore are not included.

Overcounting - Example 14.11

- The cotton irrigation system of Ex 14.10 will increase employment and remove a number of persons from welfare.
- Their new wage, the sum of their old welfare payments plus some increment, is an *increase* in real output and constitutes a legitimate national benefit of the project.

Example 14.11, concluded

- What if we then add the *reduction* in welfare payments as another benefit to the country's taxpayers?
- Oops, we would be double-counting welfare payments—once from the standpoint of the recipient and again from the taxpayer's viewpoint.

Unequal Lives

- Examples 14.2, 14.3, and 14.3 are all related to the analysis of alternatives with unequal lives. Assumptions about planning horizon and renewal of alternatives can have a huge effect upon the decisions made.

Example 14.12

- Two projects each have first costs of $200,000, with annual operating costs of $30,000. Project A is a large park, ideal for families to visit. Its life is only 15 years. Project B is a new fairgrounds arena, ideal for people of all ages. Its life is 30 years. Benefits are $60,000/year for the park and $54,000/year for the arena.

Example 14.12, concluded

- First, assume each is a one-shot project.
- Project A, the large park, will have no benefits or costs after year 15.
- Project B, the new arena, will continue to provide benefits for 30 years.
- Suppose the analyst sets the planning horizon at 30 years. Which project is more attractive? See analysis on the next slide.
- Below i=15.8%, prefer arena; otherwise, park as long as PW is positive.

B14 =PV($A14,B$4,-B$3)-B$2

	A	B	C	D
1		A: Park	B: Arena	
2	Initial investment	$200,000	$200,000	
3	Annual benefits	$60,000	$54,000	
4	Life in years	15	30	
5	Salvage value	$0	$0	
6	Planning horizon	30	30	
7	Project renewed	No	NA	
8	Present value of benefits - costs:			
9	0.0%	$700,000	**$1,420,000**	
10	5.0%	$422,779	**$630,112**	
11	10.0%	$256,365	**$309,053**	
12	15.0%	$150,842	**$154,563**	
13	20.0%	**$80,528**	$68,863	
14	15.8%	**$138,080**	**$138,080**	
15		PV Difference at IRR	$0	=B14-C14

Goal Seek

Set cell: C15

To value: 0

By changing cell: A14

OK

Figure 14.4 · Figure 14.5 · Figure 14.6 · Figure 14.8 · Figure 14.9 · Figure 14.10 · Figure 14.11 · Table 14.1 · Table 14.2 · Table 14.3

Example 14.13

- Again, assume each is a one-shot project.
- Project A, the large park, will have no benefits or costs after year 15.
- Project B, the new arena, will continue to provide benefits for 30 years.
- Now, the analyst sets the planning horizon at 15 years, with an arena salvage value of $30,000. See the next slide.
- The park is preferred for all interest rates as long as PW is positive.

	A: Park	B: Arena
Initial investment	$200,000	$200,000
Annual benefits	$60,000	$54,000
Annual costs	$30,000	$30,000
Life in years	15	30
Salvage value	$0	$30,000
Planning horizon	15	15
Project renewed	NA	NA
Present value of benefits - costs:		
0.0%	$\boxed{\$250,000}$	$190,000
5.0%	$\boxed{\$111,390}$	$63,542
10.0%	$\boxed{\$28,182}$	-$10,272
15.0%	-$24,579	-$55,976
20.0%	-$59,736	-$85,841
649354704.0%	-$200,000	-$200,000
	PV Difference at IRR	$0

Example 14.14

- Project A, the park, will be renewed after 15 years, with the same costs repeating.
- Project B, the new arena, will continue to provide benefits for 30 years.
- The analyst sets the planning horizon at 30 years. Which project is more attractive? See the next slide.
- Below i=6.3%, prefer arena; otherwise, prefer park as long as PW is positive.

	A: Park	B: Arena
Initial investment	$200,000	$200,000
Annual benefits	$60,000	$54,000
Annual costs	$30,000	$30,000
Life in years	15	30
Salvage value	$0	$0
Planning horizon	30	30
Project renewed	Yes	NA
Present value of benefits - costs:		
0.0%	$500,000	**$520,000**
5.0%	$164,970	**$168,939**
10.0%	**$34,929**	$26,246
15.0%	**-$27,600**	-$42,416
20.0%	**-$63,613**	-$80,506
6.3%	**$120,191**	**$120,191**
	PV Difference at IRR	$0

Tolls, Fees, and User Charges

- Examples of the effect of tolls, fees, and user charges are shown in Ex. 14.15 and 14.16.
- Two primary takeaways include:
  – Tolls, fees, and user charges reduce the net benefit of the user, and also reduce the net cost to the government agency.
  – If tolls, fees, and user charges exceed the perceived benefits of a group of users, they will not participate, and there will be no benefits to them or revenue received from them.

Example 14.15

- Outdoor activities at a reservoir area are enjoyed by 35,000 people/year. The equivalent uniform annual cost of the area is $150,000/year. The people, on average, receive recreational benefits in the amount of $6 each. The *B/C* and *B−C* metrics are
- *B/C* = $6(35,000)/$150,000 = 1.4
- *B−C* = $6(35,000) − $150,000 = $60,000/year.
- The reservoir appears worthwhile.

Example 14.15, continued

- Suppose a fee of \$3.50/person is charged. The net benefits are now \$6.00 − \$3.50, or \$2.50/person, and the government cost is reduced by \$122,500/year. The *B/C* and *B-C* measures are now:
- *B/C* = (\$210,000 − \$122,500)/(\$150,000 − \$122,500) = 3.18
- *B−C* = (\$210,000 − \$122,500) − (\$150,000 − \$122,500) = \$60,000/year
-

Example 14.15, concluded

- Note that *B/C* changed while *B−C* did not. This phenomenon is discussed in section 14.8.8, “Problems with the B/C Ratio.”
- We might conclude that tolls, fees, and user charges are irrelevant, at least with respect to the B−C measure of merit. This, however, is not true if the number of users or degree of use is linked to the fee charged, as it almost always will be.

Example 14.16

- Now, suppose that the 35,000 users in Ex. 14.15 receive different levels of benefits, averaging out to $6/person. The actual breakdown is: 28,000 persons perceive $3 worth of enjoyment; 3,500 perceive $6 worth, and 3,500 derive $30 in benefits.
- With a user fee of $3.50/person, however, only 7,000 will patronize the facility.
- What happens now to *B/C* and *B-C*?

Example 14.16, concluded

- B/C = [\$30(3,500) + \$6(3,500) − \$3.50(7,000)]/[\$150,000 − \$3.50(7,000)] = \$101,500/\$125,500 = 0.81
- $B-C$ = [\$30(3,500) + \$6(3,500) − (\$3.50)(7,000)] – [\$150,000 – (\$3.50)(7,000)] =−\$24,000/year.
- When tolls, fees, and user charges are considered, their effect on user demand, total user benefits, revenues, and costs must be taken into account.

Multiple-Use Projects

- Examples 14.17 and 14.18 illustrate the treatment of multiple-use projects.
- Note that when one single-use project is considered worthwhile and another (or more) single-use projects are not feasible, incremental changes to the design of the worthwhile project may be made to include the benefits from uses that were previously infeasible.

Example 14.17

- An irrigation dam with reservoir will provide PW benefits of $80 million. The PW cost will be $46.5 million. Acceptable!
- A single-purpose flood-control dam providing PW benefits of $19 million would have a PW cost of $28.8 million. Unacceptable!
- Design changes to the irrigation dam to provide flood-control benefits, too, at a PW cost of $59 million. What should be built?

Example 14.17, concluded

- For the irrigation project, the B/C ratio is $B/C_{\text{irrigation}}$=$80,000,000/$46,500,000=1.72.
- The flood-control dam yields a B/C of only $B/C_{\text{flood cont}}$=$19,000,000/$28,800,000=0.66.
- As a multiple-use facility, it may be possible to have both irrigation and flood-control.
- $\Delta B/\Delta C_{\text{multi-use over irrigation}}$ = $19,000,000/($59,000,000−$46,500,000)=1.62.
- The irrigation dam and reservoir, modified to include flood control, is worthwhile.

Example 14.18

- The Covanta Alexandria/Arlington Waste-to-Energy facility burns trash to generate electricity. It includes recycling to separate out paper, aluminum, glass, etc.
- When a city's refuse is used to fire a power-generation facility, this is a clear multiple-use project: (1) Electrical power is supplied to the city, and (2) the burning of refuse reduces the need for a landfill.
- All costs must be covered for self-sufficiency.

Example 14.18, concluded

- Here, allocation of benefits and costs gets interesting. Arguments for cost allocation range from: (1) no costs should be allocated to refuse disposal, because it is being used in place of fuel oil or coal; rather, a credit should be issued, to: (2) refuse disposal rates should be higher that for conventional disposal due to the aesthetic benefits of no unsightly landfill.
- These extremes in arguments have actually been used by public officials of one major city.

Problems with the *B/C* Ratio

- The *B/C* ratio has already been noted as having some quirks that can lead to (1) misinterpretation, (2) incorrect analysis, and worst of all, (3) "playing games with the intent to deceive."
- Examples 14.19, 14.20, and 14.21 illustrate some potential mine fields in the use of the *B/C* ratio.
- *B-C* analysis is not affected.

Example 14.19

- A project provides annual benefits of $200,000 to some of the public, annual disbenefits of $100,000 to others, and annual costs of $25,000 paid by the government agency. What is the B/C ratio?
- B/C = ($200,000 − $100,000)/$25,000 = 4.0
- Another analyst *incorrectly* counts the $100,000 in disbenefits as a cost, calculating B/C = $200,000/($25,000 + $100,000) = 1.6
- Very different *B/C*s, and yet the same project!

Example 14.20

- Remember the very different *B/C* ratios for the same project in Example 14.19?
- Now, let's use *B-C*. Recall benefits are \$200,000, disbenefits are \$100,000 and costs are \$25,000.
- $B-C$ = (\$200,000 − \$100,000) − (\$25,000) = \$75,000/year
- The second analyst *incorrectly* calculates $B-C$ = (\$200,000) − (\$25,000 + \$100,000) = \$75,000/year
- *B-C* values are the same! *B-C* is forgiving.

Example 14.21

- In Ex. 14.17 , B/C for irrigation only was
- $B/C_{\text{irrigation}}$ = \$80,000,000/\$46,500,000 = 1.72.
- *B/C* for irrigation plus flood control is

  $B/C_{\text{multi-use}}$ = (\$80,000,000 + \$19,000,000)/\$59,000,000 = 1.68
- To compare the 1.68 against the 1.72 would cause us to select irrigation only, in error. The incremental analysis in Ex 14.17 is correct, and multi-use is chosen.

Pit Stop #14 – Same Thing; Different Look

1. **True or False: Benefit-cost analysis is primarily used by regulated utilities.**

2. **True or False: Build-Operate-Transfer (BOT) makes use of a public-private partnership.**

3. **True or False: Benefits and disbenefits must be converted to monetary values to use benefit-cost analysis.**

4. **True or False: OMB's Circular No. A-94, Revised is the definitive document for benefit-cost analysis.**

5. **True or False: The seven step SEAT is only applicable to public sector evaluation after *extensive* modification.**

Pit Stop #14 – Same Thing; Different Look

6. True or False: The B/C ratio is directly applicable to evaluation of one or many alternatives.

7. True or False: The B-C evaluation is directly applicable to evaluation of one or many alternatives.

8. True or False: Some in the public sector recommend using an interest rate of 0% on any money from outside sources.

9. True or False: The Revenue Requirements method is not economically equivalent to the industrial ATCF approach.

10. True or False: The Revenue Requirements method determines the income that exactly "pays" for costs, depreciation, interest on borrowed money, taxes, and a desirable return to owners.

Pit Stop #14 – Same Thing; Different Look

1. True or False: Benefit-cost analysis is primarily used by regulated utilities. False. It is used in the public sector. Revenue Requirements analysis is used by regulated utilities.

2. True or False: Build-Operate-Transfer (BOT) makes use of a public-private partnership. True, in order to utilize the strengths of both public and private sectors.

3. True or False: Benefits and disbenefits must be converted to monetary values to use benefit-cost analysis. True. Then, the PW or AW values are used in the benefit-cost analyses.

4. True or False: OMB's Circular No. A-94, Revised is the definitive document for benefit-cost analysis. True in the United States of America.

5. True or False: The seven step SEAT is only applicable to public sector evaluation after *extensive* modification. False. SEAT is applicable as-is, and explanation is facilitated by only minor modification to some wording.

Pit Stop #14 – Same Thing; Different Look

6. True or False: The B/C ratio is directly applicable to evaluation of one or many alternatives. False. The B/C ratio is applicable to evaluation of one alternative, but multiple alternatives require incremental B/C analysis.

7. True or False: The B-C evaluation is directly applicable to evaluation of one or many alternatives. True. B-C analysis is very robust. Unfortunately, the B/C ratio is more often used.

8. True or False: Some in the public sector recommend using an interest rate of 0% on any money from outside sources. True, unfortunately. This can lead to acceptance of projects that should never see the light of day.

9. True or False: The Revenue Requirements method is not economically equivalent to the industrial ATCF approach. False. While it follows a different analysis format, both methods are completely equivalent .

10. True or False: The Revenue Requirements method determines the income that exactly "pays" for costs, depreciation, interest on borrowed money, taxes, and a desirable return to owners. True. This is known as the *minimum revenue requirement*.