Measuring the Benefits and Costs of Public Programs

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Part I. Introduction

- The primary aim of BCA is to figure out if the costs of a program outweigh the costs
- This is more complex when we use the words "government programs":
  - Governments consider more than just profit and loss
  - Involve more complicated issues when pricing and valuing activities
  - As there are limits to government activity, public goods provision always entail tradeoffs

The basis for BCA

- According to Ed Gramlich, BCA is "nothing more than a logical attempt to weigh the pros and cons of a decision. And ultimately, something like it must necessarily be employed in any rational decision."
  - BCA is rational/logical – it fits and is in keeping with rational/comprehensive planning
  - BCA is systematic or rigorous – it uses sound applied scientific principles.
  - BCA is replicable, therefore, reviewable and testable.
  - BCA (or some such decision making method) is a desirable counterweight to other forms of or bases for decision making (namely, political, prevailing opinion, conventional wisdom, fiats, special interest considerations, fads, etc.)
- While logical in its orientation, it is not intended to replace common sense or good judgment.

Time Line of the Evolution and Application of Benefit Cost Assessment

(early 1900s) Navigation primarily

(1930s – New Deal) Applications to dams, irrigation, land reclamation and stabilization, water supplies. There were hosts of public works projects some of which involved, primarily, providing meaningful employment to a severely underemployed workforce: WPA, CCC, etc. There were also public works projects provided in major cities.

(1940s – the war years) The urgencies of the war suspended non-war related public works.

(1950s – boom time) Rapid expansion in state and local government capital on streets, highways, community centers, and the beginnings of urban renewal (especially, in housing).

Timeline continued

(1960s) Widespread expansion of social projects / programs: Income maintenance, nutrition, health care and public health programs, community action, urban renewal, education reforms (like Head Start), and defense programs (war in Viet Nam, the cold war).

(1970s – labor and the environment) More environmental initiatives. Introduction of occupational health and safety initiatives, job training (industrial ability to document costs associated with compliance or noncompliance was limited).

(1980s – deregulation and economic hardship) Application to the effects of regulation. Overall scrutiny of the appropriateness of government intervention in the economy is the basis of much b/c study – especially in areas of product safety, occupational safety and health, workplace hazards, and environmental impacts (industrial ability to document costs is much better as also is society's ability to document new categories of benefits – i.e., the value of enhanced health).

Then

(1990s – the era of "re-inventing government") Lots of buzz words and changes in the ways in which government interacts with society and other governments: decline in the defense industry, expansions in technological investments, and much more state and local direct support of commercial development. There is much less use of BCA in practice and in principle. Much of what passes for evaluative research is simply a calculus apportioning sets of private or market outcomes as a ratio against some mix of public spending. There has been an abandonment of traditional BC criteria in favor of political and perceived expediency in government decision making. Much less principled. Much less concerned with distributive justice. Implicitly plutocratic.

(2000s – an era of private sector dominance over government activity) Many of the changes introduced over the past 20 years for evaluating the environment and the consequences of regulation are restricted further thereby increasing the benefits burden of proof on government. Governments begin to shift away from a "benefits" discussion into the territory of describing government program returns on investment or returns to taxpayers. This shift has seriously obscured if not blurred seriously the definition of a benefit in the classical sense into benefits from either a political or other sense.

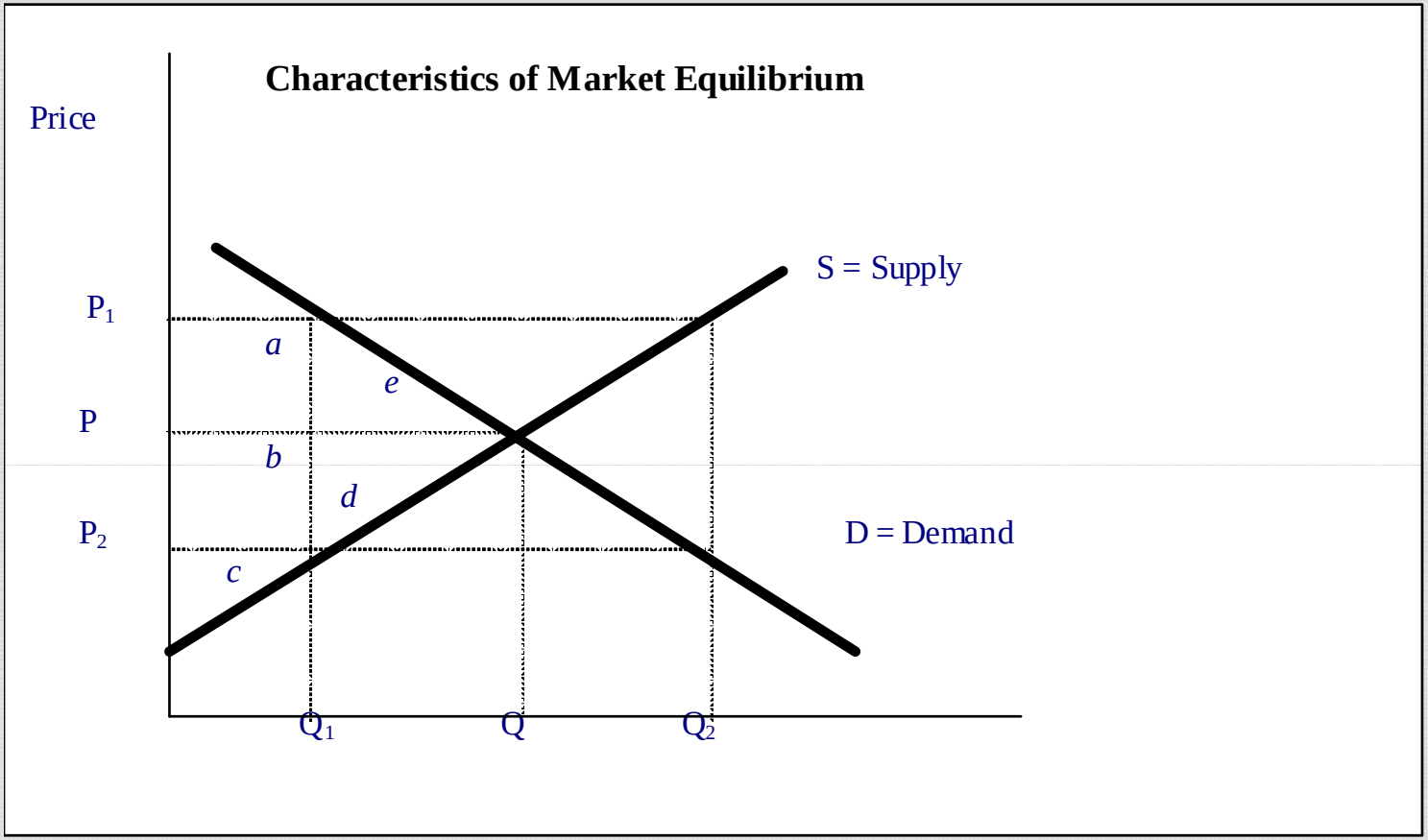
Today

Currently – there's been a re-introduction of BCA principles into several avenues of public policy development to include health prevention, crime and delinquency, educational planning, early childhood education disaster prevention and recovery, environmental and quality of life considerations, and economic and amenity development. Broad studies often now include "meta-analyses" of multiple studies as proxies for actual programmatic research.

Welfare Economics

BCA is merely applied welfare economics. We first look to the market: In the production of private goods, we must assume

- a competitive market,
- that no monopoly profits are being made,
- that consumers have knowledge of alternatives, and
- that the prices paid for the products purchased reflect the consumers' utility (or satisfaction) and the costs of producing the item.



The graph above depicts equilibrium in a market at a price of P and a quantity of Q. If the price is above P, say at P_1, there is surplus production ($Q_2 - Q$). When this happens, there will be competition among suppliers to sell the surplus, which will push price down to P. The surplus production is eliminated because the reduction in price increases the consumption and decreases the production of the commodity until quantity demanded equals quantity supplied. If the price is below P, there is a shortage supplied ($Q - Q_1$). In this instance, competition among buyers will push the price up to P and the quantity supplied to Q. Marginal cost (MC) equals the marginal value (MV), or MV = MC, when production and price are in equilibrium. In such a situation, the quantity of a private good demanded by consumers will be equal to the quantity supplied by producers.

But Private Markets Fail

There are three categories of market failure that we generally address:

1) Public goods
2) Externalities
3) Natural Monopolies

Public Goods

Public goods -- My use does not deter others from using it (it is nonrival/nonexculusive) -- clean air, or clean water , television or radio signals, dam for flood control.

Two types of public goods:

Pure public goods: like clean water, air, public safety -- much like the examples above, and

Merit goods: those that we ought to consume or (nonmerit goods -- demerits -- those that we <u>ought not</u> consume). Merit goods can give rise to the pubic provision of excludable services and goods. In these instances exclusion is potentially dangerous, or socially or ethically intolerable. Vaccinations and public education are examples.

Externalities

Where there are benefits and costs to my private decisions. Generally, an externality is a benefit or a cost of a market transaction that is neither paid for nor received by those making the transaction, and therefore is not explicitly incorporated into the market demand or supply curve . Two Types:

pecuniary -- if people over-consume a commodity, thereby driving up the cost of inputs (like electricity) even though my units demanded have not changed.

real -- something that increases consumers' or productions' real costs, but were caused by someone else, e.g., pollution, requiring more inputs.

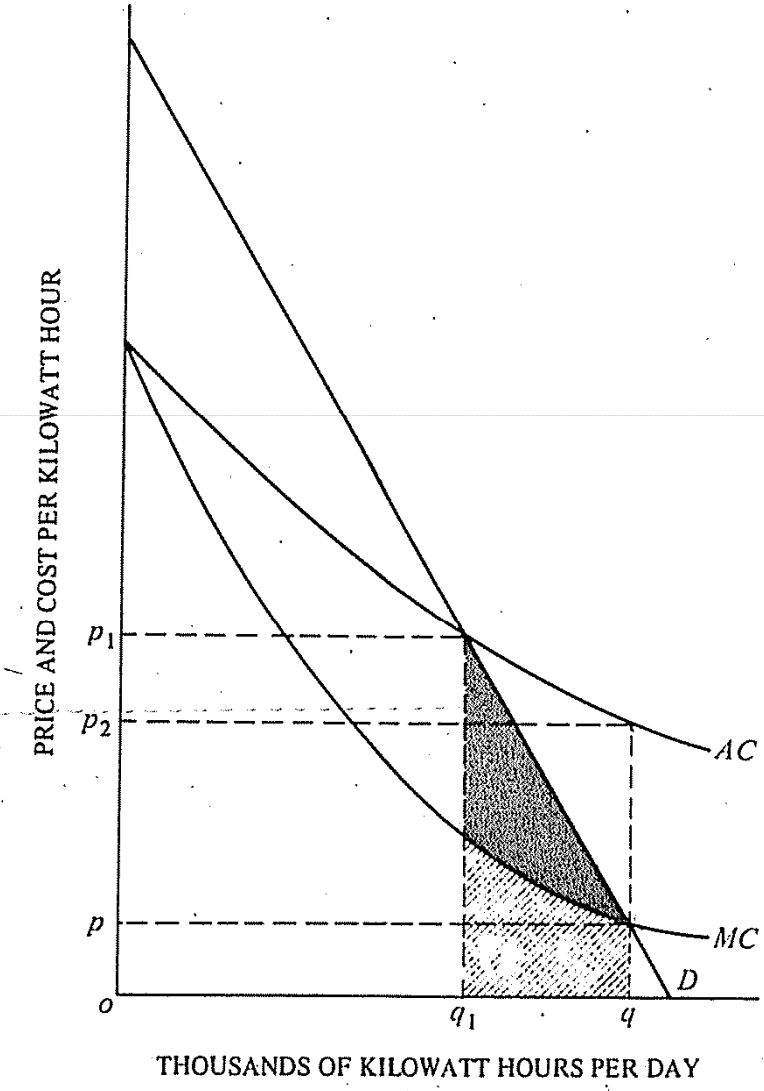
IN BCA we tend to concentrate on real externalities

Natural Monopoly and Declining Costs

Characteristics of declining cost industries:

- High startup costs.
- Consumers continue to realize surplus so long as demand is sufficient enough so that the marginal cost of production equals price.
- Complete utilization of output potential up to mc=p level creates consumer surplus.

FIGURE 3–7
DECREASING COST AND EFFICIENCY



Remedies

Profit maximizing firms will not increase output to the point where mc=p and all potential welfare gains are realized, they will produce at some level less than mc=p. Otherwise they are losing money. Accordingly they become consciously market inefficient in order to maximize profits.

Solution?

- Discriminatory pricing (peak load, other pricing)
- Government production of a good
- Government sets prices

Consumer Surplus

Consumer surplus -- desire or satisfaction achieved beyond the actual price of a commodity. Ways in which consumer surplus is generated:

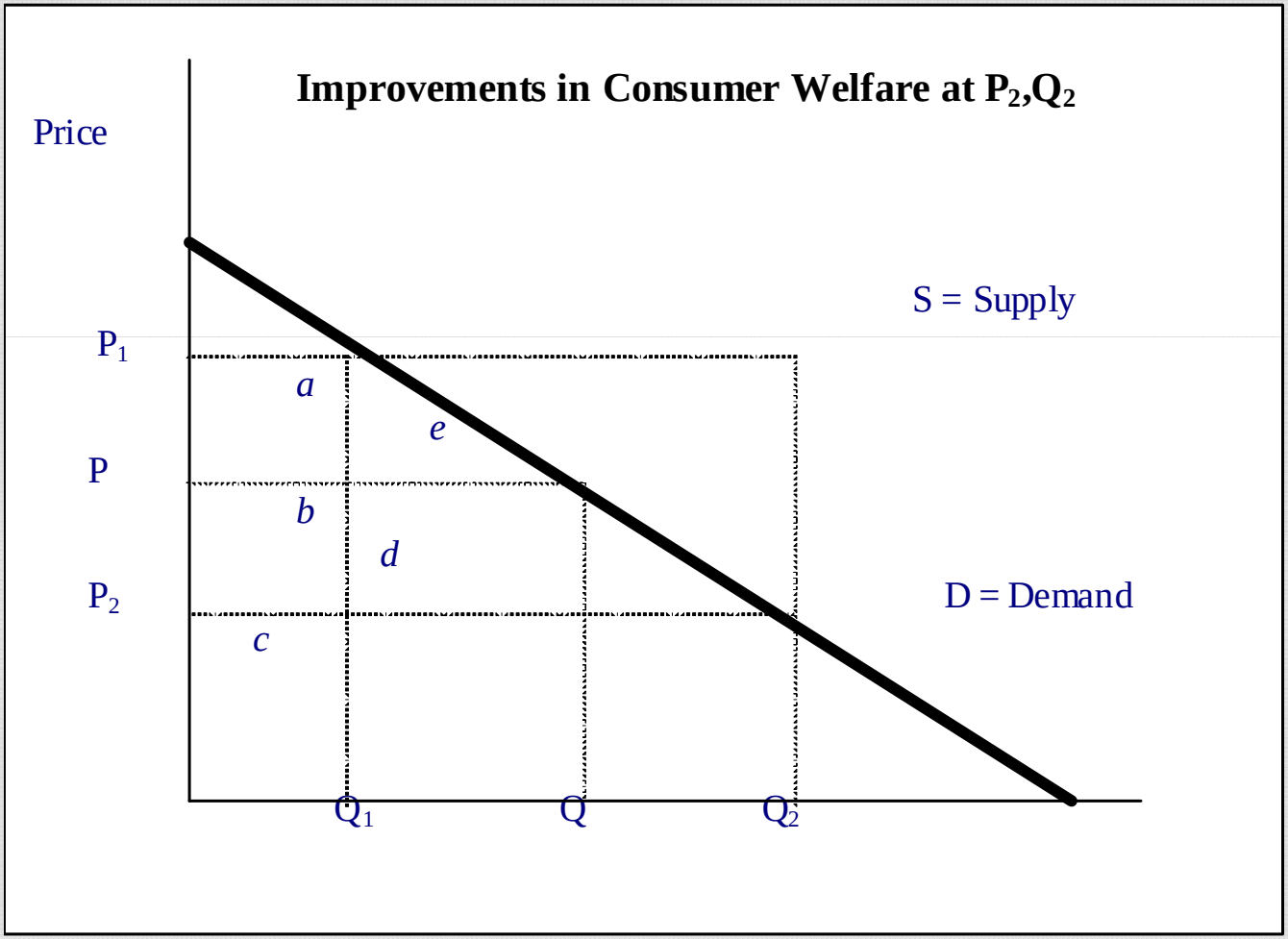
Real increase in earnings or profits.

Decreases in the costs of production due to:

- efficiency gains
- technology
- elimination of social or political trade barriers

Internalization of externalities, which then eliminates the cost/value distortion caused by externalities.

Prudent government action (for example vaccinations, which in turn increase healthiness and productivity).


Improvements in Consumer Welfare at P2,Q2
Price
S = Supply
P1
a
e
P
b
d
P2
c
D = Demand
Q1
Q
Q2

Government intervention in the economy

- It can act to assure competitive markets by preventing trusts and monopolies and otherwise minimizing barriers to competition.
- ✓ It can act where production is inefficient (like natural monopolies).
- The market, *a priori,* needs government to provide the legal structure to resolve property disputes, protect trade and business secrets, and arbitrate disputes.
- ✓ Government provides goods that cannot or will not be provided by the market.
- It can influence the distribution of incomes and social benefits in a society using its taxing and appropriations powers – fairness and equity concerns
- It can help to promote common economic objectives like full employment and socially desirable rates of job or income growth.
- ✓ It can offset market failures with its taxing power, regulatory power, policy making power, or legal power (penalties and fines).

If the government can intervene, then we need to isolate the benefits and costs

Costs are <u>the publics' costs</u>. Generally speaking, the costs of a project or a program include all land, capital, equipment, research, and labor needed to construct, implement, maintain, (and evaluate), and decommission a project. Sometimes forgotten, but necessary, as well, are the costs of borrowing when governments bond for a project. Also, if a project has scrap value at the end of its useful life, that is subtracted from the costs.

The costs that we are talking about are <u>those borne by the public</u>.

<u>Do not confuse private losses with costs</u>. They are, more appropriately, negative benefits. They are often referred to as "disbenefits"

Benefits

Real benefits are determined by the final consumers of the project -- they reflect an addition to the community's net welfare as usually measured as consumer or producer surplus increments.

Pecuniary benefits and costs come about as the economy adjusts itself to the project (e.g., a road's impact on land prices by increasing access). Pecuniary benefits and costs offset, overtime, and should not be considered in the BCA calculation. Hedonic price models might more appropriately be applied to these types of changes.

Types of Real Benefits

Direct and indirect:

Direct benefits relate closely with the project objectives.

Indirect benefits are linked more broadly to the by-products.

Tangible v Intangible benefits.

Tangible benefits are those that can be valued in the market, whereas those that cannot are viewed as intangible. Social goods and social costs generally are considered intangible (however, contingent valuation methods do allow us to get at some of the intangibles).

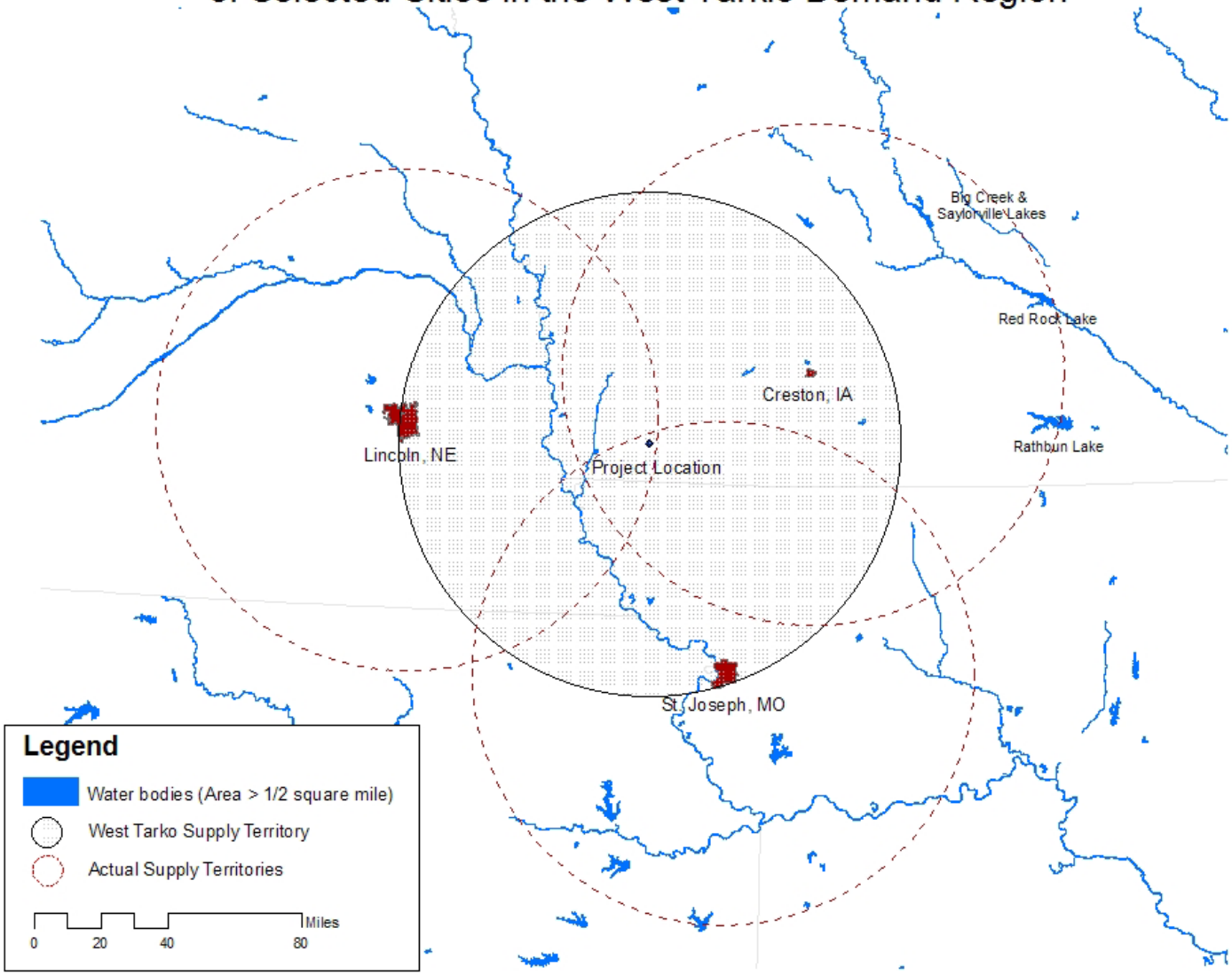
Intermediate v. final

Final, are benefits or goods that consumers use directly, whereas intermediate benefits flow into the production of other goods. (Electricity from a dam, etc.).

Inside v. Outside

Inside are those that are captured within the benefited region, as compared to those that benefit others outside of the region (e.g., flood control downstream). Spillover, no pun intended, or benefits leakage to other jurisdictions is often the case, but measurement is often difficult.

Recreational Opportunities: 75-mile Supply Territories of Selected Cities in the West Tarkio Demand Region



Costs

Legislative conclusion: Tobacco as a controlled substance. Only limited legal uses, but the manufacturing of smoking, chew, or snuff products would no longer be legal, as also would be the distribution of the raw product to other than approved buyers.

Costs: Regulation and compliance. Foregone excise tax revenues. Compensation to private sector? Why?

Benefits

Minus: Losses to producers, manufacturers, and distributors. What else?

Plus: Reduction in public and private health costs, increased life spans, enhanced workplace productivity, smoking-related casualties. What else?

In a nutshell

The historical methods of producing social welfare gains have come from the incremental and timely investment by governments in public goods. Bridges, roads, canals, navigations systems, dams, etc., are all forms of public investments that are designed to produce or enhance welfare gains.

The same can be said of vaccinations, nutrition programs, screening children for disabilities, other important preventive health and social programs.

The gains that are counted are measured as either *producer or consumer surpluses* over some reasonable period of time. Stated very simply, because of the timely and strategic investment by governments, as would be the case in a public works construction project, consumers and producers realize reductions in the costs of obtaining necessary goods and services or in the cost of selling their labor.

In short, their *welfares* are *enhanced because their individual or business costs are lowered yielding higher* incomes and greater price competitiveness among firms.

Over a standard period of time, the sum of those enhancements to welfare (usually consumer surplus as producer surplus in a competitive market results in price declines) can be summed.

BCA Basics

If, over some reasonable period of time, t_0 to t_n

$\sum$ Benefits / $\sum$ Costs $\geq$ 1.0,

Then the program is producing <u>net benefits</u> to society and the program should be funded. By definition the program is producing net benefits and, therefore, society is better off.

If

$\sum$ Benefits / $\sum$ Costs $\leq$ 1.0,

Then the program is producing <u>net costs</u> to society and the program should not be funded unless there is an over-arching non-economic reason for the program.

So

In benefit-cost analysis, the *discounted present value sum* of all benefits over time (say 20 or 30 years) is compared with all public costs in the project over the same time period.

If the benefits exceed the costs, then the project is funded. If two or more projects are being evaluated, governments will look at both the benefit to cost ratio and the total of benefits to be achieved after costs have been accounted (net benefits).

In most instances, choices that yield the most net benefits are most desirable.

Consider the following simple table

Amounts in millions	Gains to Consumers	Losses to Suppliers	Costs to Taxpayers	Net Benefits	Benefit/Cost Ratio
A. Transit (vouchers)	200	50	100	50	1.50
B. Transit (minibuses)	200	50	200	-50	0.75
C. Job Training (daytime)	450	50	300	100	1.33
D. Job Training (nighttime)	100	10	100	-10	0.90
E. Dam -- (recreational uses)	650	0	500	150	1.30

Basic Definitions:

Gross Benefits = Gains to Consumers – Losses to Suppliers
Costs = All Public Costs
Net Benefits = Gross Benefits – Costs
B/C ratio = Gross Benefits / Costs

Constraints to our choices

Average benefits versus marginal benefits (the training example).

Choices cannot be made independent of other decisions.

Political – what does it take to get a bill through. Rarely is the "best" package funded.

Practical/Analytic – there is always an underlying <u>uncertainty</u> that we are in fact accurately estimating benefits and costs.

Time compounds uncertainty

The Time Value of Money

For public projects we have two very common characteristics:

Costs generally are up-front and large (lumpy)

and

Benefits accumulate slowly over time – they trickle in

Given that individuals and communities tend to value present goods instead of future goods, how do we reconcile this problem?

We have to take time and preference into consideration

- First and foremost, money, the thing that we care most about *all protestations to the contrary notwithstanding*, is worth less over time due to inflation
  - that means that purchasing power declines
  - but we do not know how much it will decline

Say, exactly one year from today, in appreciation for superior performance, I will give you

2 oz of gold, or

1,000 gallons of **unleaded gasoline**, or

$3,500

You have to choose today, which would you choose?

It all depends on:

Your current needs versus your sense of future needs -- tension between consumption and saving

Your personal expectations of gain or loss

A bundle of intangibles

What if I said that I'd give you one of these items in 5 years instead of 1?

Discounting

Imagine that your rich, yet very controlling, Aunt Agnes left you a fixed annuity of $10,000 per year for the next 10 years. The first payment is exactly one year from now.

The nominal value in today's dollars is $100,000. The real value, however, depends on several things

But, you are extremely impatient, hence Agnes's controlling behavior from the grave, and you want to borrow against that annuity to buy a sailboat and sail the Caribbean this summer with your new-found companion who is quite impressed with your recent good fortune and who just happens to know of a boat for sale. What might someone be willing to offer for that annuity today?

Annuity Example

We need, then, to compute the present value of that annuity stream. We need to discount the future values (FV) back to present values (PV). Knowing how and why to do this is fundamental to BCA

So, the present value of any future value is this:

$$\mathbf{PV = FV / (1+ \text{discount rate})^n}$$

We can add a stream of discounted future values to arrive at a total present value of the future amounts

But how much should we discount the future values?

The average rate of **inflation** over the past 10 years ≈ 3.0 %

The average after-tax **return on savings / investments** ≈ 5.0 %

Your own **personal rate of consumption**, which favors spending in the present versus saving for the future ≈ 7.0

		Discount Rate		
Year	Nominal Value	3%	5%	7%
PV (year 0)	$100,000	$85,302	$77,217	$70,236
1	10,000	9,709	9,524	9,346
2	10,000	9,426	9,070	8,734
3	10,000	9,151	8,638	8,163
4	10,000	8,885	8,227	7,629
5	10,000	8,626	7,835	7,130
6	10,000	8,375	7,462	6,663
7	10,000	8,131	7,107	6,227
8	10,000	7,894	6,768	5,820
9	10,000	7,664	6,446	5,439
10	10,000	7,441	6,139	5,083

Choosing the discount rate

The optimal private rate of investment – is hard to know, and it varies: incomes are mal-distributed the costs of borrowing vary greatly (sub-prime crisis).

The average rate of return on several weighted or other rates of capital formation: some average of private and government investment over time. We can call this the overall social rate of investment.

Or

A Social Rate of Preference

We use this term to distinguish between private or market preferences and social preferences. Still, in common parlance, we call it the discount rate.

Factors:

Individuals are myopic, they tend to maximize consumption and minimize the importance of savings. Individuals' discount rates are, therefore, much too high. Governments, acting in their interests, are obliged to apply a lower rate.

The government is the **guardian of future generations** because people don't save enough. There is an active and necessary role for governments to safeguard the future by investing prudently and appropriately.

Factors Continued

Even if people are altruistic, **money is often short**, which further justifies the redistributive and counter-balancing aspects of government action.

Finally we get the **Golden Rule of Public Investment**. This rule equalizes the investment between generations. Its basis is that the current generation should and must invest at least as much in public goods development as to replace what it consumed.

All of these factors suggest the choice of a discount rate significantly below market rates is highly desirable and necessary to stimulate sufficient public benefits, given present rates of consumption, and at rates sufficiently low to realize all future benefits. The rate cannot be so low as to stimulate excessive public investment. When the rate is too low, the present value of benefits is over estimated relative to the near term costs.

Two Benefit Cost Examples -- Fixed and variable benefits and costs over time

			Compute Benefit Net Present Values @			
Year	Project Cost	Benefits	3%	5%	7%	9%
0	**3,000,000**	0	0	0	0	0
1		400,000	388,350	380,952	373,832	366,972
2		400,000	377,038	362,812	349,375	336,672
3		400,000	366,057	345,535	326,519	308,873
4		400,000	355,395	329,081	305,158	283,370
5		400,000	345,044	313,410	285,194	259,973
6		400,000	334,994	298,486	266,537	238,507
7		400,000	325,237	284,273	249,100	218,814
8		400,000	315,764	270,736	232,804	200,747
9		400,000	306,567	257,844	217,573	184,171
10		400,000	297,638	245,565	203,340	168,964

Total Cost	3,000,000	3,000,000	3,000,000	3,000,000
Total Benefit	3,412,081	3,088,694	2,809,433	2,567,063
Net Benefit	412,081	88,694	-190,567	-432,937
Benefit Cost Ratios	1.14	1.03	0.94	0.86

Harder

Year	Project Cost	Benefits
0	3,000,000	-
1	35,000	400,000
2	35,700	420,000
3	36,414	441,000
4	37,142	463,050
5	37,885	486,203
6	38,643	510,513
7	39,416	536,038
8	40,204	562,840
9	41,008	590,982
10	41,828	620,531

$$NPV = \sum_{i=1}^{n} \frac{values_i}{(1+rate)^i}$$

=npv(rate,value1, value 2, …)

	Compute Net Present Values @ 3%	5%	7%	9%
Total Benefits	4,241,012	3,809,524	3,439,051	3,119,373
Total Costs	3,325,338	3,293,584	3,266,228	3,242,542
Net Benefits	915,674	515,940	172,824	(123,169)
Benefit Cost Ratios	1.28	1.16	1.05	0.96

Valuing Inputs and Outputs

Market prices: Are appropriate so long as we are generally satisfied with the distribution of incomes and the overall availability of public and private goods and services. If, however, incomes are maladjusted or maldistributed and market prices reflect these imbalances, then market prices are a poor guide to social policy. Market prices may inappropriately value inputs. Taxes increase the cost of a product. Government subsidy may hide the true cost of a product relative to production costs. Still we have a very strong preference in BCA for market pricing.

Short of that, we want to assign a **willingness to pay** value (WTP)

Surveys. The most common approach is **contingent valuation** surveying. Here people are asked to place a value on a particular good that is not traded, but people have difficulty assigning market-like values to public goods.

DISCOUNT RATES FOR COST-EFFECTIVENESS, LEASE PURCHASE, AND RELATED ANALYSES (OMB-January 2007)

Nominal Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
4.9	4.9	4.9	5.0	5.1	5.1

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
2.5	2.6	2.7	2.8	3.0	3.0

OMB Discount Rates 2011

Nominal Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
1.4	1.9	2.4	3.0	3.9	4.2

Real Discount Rates. A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2012 Budget is presented below. These real rates are to be used for discounting constant-dollar flows, as is often required in cost-effectiveness analysis.

Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in percent)

3-Year	5-Year	7-Year	10-Year	20-Year	30-Year
0.0	0.4	0.8	1.3	2.1	2.3

Analyses of programs with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Programs with durations longer than 30 years may use the 30-year interest rate.

Coming up with future benefits

How do we come up with reasonable future year benefit estimates?

Government agencies and private corporations engage in a variety of forecasts of the economy and of expected demographic changes. Planners and project managers may rely on and interpolate from a variety of these forecasts to estimate benefits. Some factors might include:

- population change
- cohort compositional changes in the population
- personal income
- price changes or trends for specific commodities
- consumption patterns and changing preferences
- history, for what it's worth
- localization of statewide or national changes using location quotients or some other meaningful shares analysis
- computable general equilibrium models that may be driven by sets of exogenous changes
- estimates of changes in price/demand elasticities

Issues, Other Approaches, State of the Art

Meta-analysis

- Either super-assessing a whole slough of similar research results and applying a current benefits calculation (Washington Study – Dept. of Interior – Biofuels energy values)
- Assessing a set of benefits conclusions and arriving at the mean or median value (Average effects)

Life-cycle calculations (usually much more appropriate to cost effectiveness)

Meta-Analyses

Example: BENEFITS AND COSTS OF PREVENTION AND EARLY INTERVENTION PROGRAMS FOR YOUTH, Washington State Institute for Public Policy, 2004.

Does prevention pay? Can an ounce of prevention avoid (at least) an ounce of cure?

More specifically for public policy purposes, is there credible scientific evidence that for each dollar a legislature spends on “research-based” prevention or early intervention programs for youth, more than a dollar’s worth of benefits will be generated? If so, what are the policy options that offer taxpayers the best return on their dollar?

Specifically to

(1) Reduce crime;

(2) Lower substance abuse;

(3) Improve educational outcomes such as test scores and graduation rates;

(4) Decrease teen pregnancy;

(5) Reduce teen suicide attempts;

(6) Lower child abuse or neglect; and

(7) Reduce domestic violence.

searched electronic research databases and located study references in narrative and systematic reviews conducted by other researchers, assembling and reviewing a collection of over 3,500 documents.

Life-cycle summations

The Mortality Cost to Smokers. W. Kip Viscusi, Joni Hersch. NBER Working Paper No. 13599. November 2007

Estimates the mortality cost of smoking based on the first labor market estimates of the value of statistical life by smoking status. Using these values in conjunction with the increase in **the mortality risk over the life cycle due to smoking**, the value of statistical life by age and gender, and information on the number of packs smoked over the life cycle, **produces an estimate of the private mortality cost of smoking of $222 per pack for men and $94 per pack for women in 2006 dollars, based on a 3 percent discount rate. At discount rates of 15 percent or more, the cost decreases to under $25 per pack.**

Figure 12 :: Projected Annual Costs of Chronic Diseases, 2023

US$ Trillions

	Current Path	Alternative Path	Avoided Costs	
			Amount	Percent
Treatment Expenditures	0.8	0.6	0.2	27.8
Lost Economic Output	3.4	2.5	0.9	26.8
Total	4.2	3.1	1.1	27.0

Table 4
Mortality Costs of Smoking (2000 dollars)

	Males	Females
Panel A: Total Costs		
VSL cost estimate	1,538,631	563,299
VSLY cost estimate	561,666	258,792
Panel B: Costs per pack		
VSL cost estimate	189.35	80.09
VSLY cost estimate	69.12	36.79