
I. The evolution and basis for BCA (benefit cost analysis):

- What is BCA?
- Whence did it emanate?
- Why do we do it?
- What, over time, were the political conditions/considerations determining its usage?
- Who were the practitioners and to what ends were BCA applied, and
- Where is the practice today?
Why do we do BCA?

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”:

- Unlike the market 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 Edward 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, fads, special interest considerations, fads, etc.)

While logical in its orientation, it is not intended to replace common sense or good judgment.
Antecedents

BCA as a practice owes its underlying assumptions to the subdiscipline of applied welfare economics, the central ideas of which were established in 1844 by French economist/engineer Jules Dupuit (maybe more about him later).

In the USA the history of BCA goes back to the River and Harbor Act of 1902, which required the U.S. Corps of Engineers to assess federal expenditures for navigation against the benefits received commercially.

More importantly, historically, BCA became more systematically ingrained in federal decision making as a result of the Flood Control Act of 1936, which required that the government undertake projects (for flood control purposes), “if the benefits to whomsoever they may accrue are in excess of the estimated costs.”

Dave Swenson – Iowa State University

Establishing Rules

Standards were hammered out in 1946 by the U.S. Federal Interagency River Basin Committee’s Subcommittee on Benefits and Costs, which produced a report that established agreed-upon principles for BCA entitled “Proposed Practices for Economic Analysis of River Basin Projects,” also known as the “Green Book.”

This effort was highly influential with regard to the establishment of standards, and the first effort to ground BCA in economic theory (Dupuit). Led to the U.S. Bureau of the Budget’s “Budget Circular A-47” (1952), which established guidelines for BCA of all water projects.


Dave Swenson – Iowa State University
Rationalizing Government Choices

One of the more influential early efforts to rationalize the government decision processes came from the book *Economics of Defense in the Nuclear Age* (1960), by Hitch and McKean of the Rand Corporation – a think tank. The book was sometimes referred to as the “bible” of the defense industry. It involved the implementation of Rand-like planning, budgetary, and analytic methods for management and decision making.

Ultimately it came to be known as PPBS (Planning, programming, and budgeting system), and it implemented in the U.S. Defense Department (under then secretary Robert MacNamara). The method was applied to other segments of federal procurement and project development during the Johnson administration.

Elements of PPBS

1. Specification of program objectives
2. Governmental outputs are analyzed
3. Program costs are measured for multiple years
4. Allowances for the comparison of alternative approaches
5. Use of common and accepted analytic techniques
Historical Backdrop

The post WW II era was a time of the rapid evolution of public administration, comprehensive decision making processes, and rational planning professional disciplines. Sometimes called the era of the “rationalization of the social sciences” through the use of positive (usually to mean “measurable”) decision making criteria. Out of which came discourses on

1. Comprehensive decision making (and planning for that matter) -- Herbert Simon, et al.
2. Incremental decision making (planning in the margins or contingent planning) -- Charles Lindbloom, Aaron Wildavski, and others.
3. And the inevitable battle between the Comprehensivists vs Incrementalists -- whole tomes on decision making processes – Peter Drucker, Amatai Etzioni, Warren G. Bennis.

Variations of PPBS

PPBS ultimately proved to be unworkable. But decision rationalizing efforts continued. Under Nixon, for example, we see the implementation of MBO (management by objective criteria for program and project development). Under Carter administration we see the propagation of ZBB or zero-based budgeting (that is, ideally, every project and program must by justifiable from “root to branch” annually or over some established review period).

The underlying bases for many of these movements or trends or fads were that outcomes or public goods were measurable on an annual or project basis when compared to overall public outlays, and that some systematic mechanism was necessary to reasonably chose among competing projects, programs, and ideas.
Continued Developments

In 1969 we get the National Environmental Protection Act, which radically altered our collective view of benefits and costs to society.

In 1973 “Policies, Standards, and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources” were revised to include multi-objective criteria for project evaluation (incorporating elements of PPBS and MBO) to include BCA primarily, and, less rigorously, but no less importantly, environmental impact considerations – Now we are incorporating non-monetary factors.

Dave Swenson – Iowa State University

Controlling Evaluations and Their Impacts

Beginning with Carter (the first serious efforts at deregulation) Executive Order 12044 (1978) required that new regulations be subject to analysis, and that the “least burdensome of the acceptable alternatives” be used. It did not, however, make explicit mention of BCA.

In 1981 – new era, a new president -- Executive Order 12991, was more explicit, “Regulatory action shall not be undertaken unless the potential benefits from the regulation outweigh the potential costs to society.” It actually specified that evaluation utilize a single evaluative standard of “maximizing the aggregate net benefits to society,” and, accordingly, implicitly rejected multiple-object considerations of environmental or distributional (fairness) considerations as components of the calculation of net benefits.

Not only the application (and the underlying political/anti-regulatory agenda) of BCA to such issues but the actual practice of BCA came under intense criticism.

Dave Swenson – Iowa State University
BCA has not emerged Unscathed: Some Common Laments

BCA suffers from a variety of ailments, as practiced:

- Vague, restrictive, if not contradictory federal and state guidelines on the application of BCA confound practitioners and confuse the public.
- Theoretical disagreement on its underlying economic justification.
- Absence of alternative evaluative mechanisms.
- Absence of institutions reviewing BCA for appropriateness.
- Incompetent applications, applications by those that are inexperienced, and applications skewed to maximize political or personal gain.

Still ....

It is also important to remember that we are talking about government decision making and BCA and not about private decision making.

Accordingly,

- BCA is concerned with the collective welfare (some of which can be expressed in monetary terms, some of which cannot).
- BCA must consider much more than market values in making decisions (social values must also enter the equation).
- BCA is merely one of many policy measures that government employs. Governments employ other decision making criteria that may or may not be rational in a market sense, but are rational from a governmental standpoint, nonetheless.
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.
II. Welfare Economics

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

![Characteristics of Market Equilibrium](image)

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 P1, there is surplus production (Q2 – 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 – Q1). 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.
Pareto Optimality

When everything is in balance like this, the market is said to be in equilibrium. It implies a Pareto Optimal condition:

Pareto Optimal -- when consumers are unwilling to purchase any more of a good (or any less of another good) at some price/supply level.

Pareto optimality is equivalent to market equilibrium – it implies economic efficiency – that the market is supplying the appropriate mix of private goods and services at appropriate prices.
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/nonexclusive) -- 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 ought not consume). Merit goods can give rise to the public provision of excludable services and goods. In these instances exclusion is potentially dangerous, or socially or ethically intolerable. Vaccinations and public education are examples.
If not traded, what’s their worth?

I propose that there are four methods that we use to directly evaluate the worth of public goods.

1. **Elections.** Biennial and quadrennial assessment of the value of public goods and approval or disapproval of the public costs associated with those goods.

2. **Referenda.** Here the specific issue is put before the voters not in representation choices, but as to actual public policy. Referenda occur where the economic and political structure in a region are somewhat resistant to change. For example, the tax “revolts” of the late 1970s.

3. **Court Decisions.** These usually occur where de facto exclusions are evident, where there is an apparent or undeniable division of public goods thus subverting the equal benefits of citizenship.

4. **“Voting with Our Feet.”** In economics this is the Tiebout hypothesis. It means that we choose the appropriate mix of public goods, services, and other amenities as functions of their costs in a location and the perceived benefits that we would receive from them. Where we live is a measure of our preferences for goods and the costs of the goods.

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**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.
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 – rate regulation

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).
So the Government Steps In

Government intervention, then, is economically efficient if the welfare gains are sufficient to offset all costs. Theoretically, government intervention is justified because it stimulates a Perato improvement.

Rationales from Musgrave and Musgrave --

The market mechanism alone cannot perform all economic functions. Public policy -- the provision of public goods and services, the establishment of legal structures that assure property rights and arbitrate differences, etc. --- is needed to guide, correct, and supplement the market in certain areas. Accordingly, the proper size of government can be viewed as a technical issue rather than an ideological issue.
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).

4 Functions of Government

1. Allocation -- the provision of social goods -- goods that are nonrival and collectively demanded: police and national protection, clean air, education, roads and bridges

2. Distribution -- (absent policy adjustments, the distribution of income depends on factor endowments -- earnings ability, ownership of accumulated and inherited wealth, dumb luck). This distribution may not be what society considers fair or just. Accordingly, government policy redistributes income (and some publicly provided goods along with access to privately provided goods) through tax policy (progressive income tax -- ability to pay) and direct income transfers (or transfers in-kind: food stamps, cost reductions for certain private goods, housing subsidies, transportation subsidies, etc.)
3. Stabilization -- without stabilization the economy can fluctuate strongly. In the current global economy, instability in one country can lead to instability in another. In instances of economic downturn, where price and wages are rigid, there may be the need to stimulate consumption to increase demand across the board. During inflationary times, consumption may need to be curtailed.

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3 Instruments of stabilization:
- Monetary -- regulating the money supply (federal reserve) through interest rate changes.
- Fiscal -- tax reduction to stimulate consumption, government borrowing.
- Public works: the financing of public projects to achieve twin goals of public service provision and stimulating private and industrial consumption of market and nonmarket goods.

4. Housekeeping/Administration -- the basics of records keeping and maintenance of the public resources.

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III. From the Previous

We’ve established that there are times when governmental action or policy helps to stimulate improvements in the distribution of resources. These improvements take the forms of

1. More equitable provision of public goods, or
2. The generation of social surplus in the forms of consumer or producer surplus improvements, usually through the generation of a Pareto improvement

In government policy making, we always have tension between equity and efficiency concerns. It is not usually possible to stimulate pure Pareto improvements without one party being made worse off. If gainers can be made to compensate losers either explicitly or implicitly, then we can claim an improvement. Under the Kaldor – Hicks principle an improvement is assumed if gainers could (if they were made to) compensate the losers and still be better off.
Isolating benefits and costs

Costs are the publics' costs. 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. The costs that we are talking about are those borne by the public.

Do not confuse private losses with costs. They are, more appropriately, negative benefits.

Benefits

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

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.
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.
OK more than one nutshell

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 $t_n$

$$\sum \text{Benefits} / \sum \text{Costs} \geq 1.0,$$

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

If

$$\sum \text{Benefits} / \sum \text{Costs} \leq 1.0,$$

Then the program is producing net costs 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 – Kaldor Hicks Principle

Consider the following simple table

<table>
<thead>
<tr>
<th>Amounts in millions</th>
<th>Gains to Consumers</th>
<th>Losses to Suppliers</th>
<th>Costs to Taxpayers</th>
<th>Net Benefits</th>
<th>B/C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Transit (vouchers)</td>
<td>200</td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>1.50</td>
</tr>
<tr>
<td>B. Transit (minibuses)</td>
<td>200</td>
<td>50</td>
<td>200</td>
<td>-50</td>
<td>0.75</td>
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<tr>
<td>C. Job Training (daytime)</td>
<td>450</td>
<td>50</td>
<td>300</td>
<td>100</td>
<td>1.33</td>
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<tr>
<td>D. Job Training (nighttime)</td>
<td>100</td>
<td>10</td>
<td>100</td>
<td>-10</td>
<td>0.90</td>
</tr>
<tr>
<td>E. Dam -- (recreational uses)</td>
<td>650</td>
<td>0</td>
<td>500</td>
<td>150</td>
<td>1.30</td>
</tr>
</tbody>
</table>

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 uncertainty 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 award you

4 oz of gold, or
1,000 gallons of unleaded gasoline, or
$4,000

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?

So no matter what we have to discount the future, but by how much?
Discounting

Imagine that your rich, yet very controlling, Aunt Agnes willed you, bless her soul, 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, even from the grave, and you want to borrow against that annuity and sail the Caribbean this summer with your new-found companion, Enrico, who is quite impressed with your recent good fortune and who just happens to know of a boat for lease from his cousin Edwardo. What might someone be willing to offer for that annuity today?

Annuity Example

We need, then, to compute the present value of that annuity (or benefit or cost) stream: 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:

\[ PV = \frac{FV}{(1 + \text{discount rate})^n} \]

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

<table>
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<tr>
<th>Year</th>
<th>Nominal Value</th>
<th>3%</th>
<th>5%</th>
<th>7%</th>
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<tr>
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<td>$100,000</td>
<td>$85,302</td>
<td>$66,649</td>
<td>$48,840</td>
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<tr>
<td>1</td>
<td>10,000</td>
<td>9,709</td>
<td>9,246</td>
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<td>10,000</td>
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## Elemental

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<th>Project Cost</th>
<th>Benefits</th>
<th>Compute Net Present Values @</th>
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<td></td>
<td></td>
<td>3%</td>
<td>5%</td>
</tr>
<tr>
<td>0</td>
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<td>388,350</td>
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<td>400,000</td>
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<td>341,985</td>
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<td>400,000</td>
<td>366,057</td>
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<tr>
<td>7</td>
<td>400,000</td>
<td>325,237</td>
<td>231,140</td>
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<tr>
<td>8</td>
<td>400,000</td>
<td>315,764</td>
<td>213,721</td>
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<tr>
<td>9</td>
<td>400,000</td>
<td>306,567</td>
<td>197,616</td>
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<tr>
<td>10</td>
<td>400,000</td>
<td>297,638</td>
<td>182,724</td>
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</table>

Net Present Values --> 3,000,000

NPV --> 3,412,081 | 2,665,968 | 1,953,580 | 1,380,366

Net Benefits | 412,081 | (334,032) | (1,046,420) | (1,619,634)

Benefit Cost Ratios | 1.14 | 0.89 | 0.65 | 0.46

Dave Swenson – Iowa State University
### Harder

Compute Net Present Values @

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

\[ NPV = \sum_{t=0}^{n} \frac{values_t}{(1 + rate)^t} \]

\[ =npv(rate, value1, value2, ...) \]

<table>
<thead>
<tr>
<th></th>
<th>Total Benefits</th>
<th>Total Costs</th>
<th>Net Benefits</th>
<th>Benefit Cost Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4,241,012</td>
<td>3,325,338</td>
<td>915,674</td>
<td>1.28</td>
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<tr>
<td>1</td>
<td>3,809,524</td>
<td>3,293,584</td>
<td>515,940</td>
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<tr>
<td>2</td>
<td>3,439,051</td>
<td>3,266,228</td>
<td>172,824</td>
<td>1.05</td>
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<tr>
<td>3</td>
<td>3,119,373</td>
<td>3,242,542</td>
<td>(123,169)</td>
<td>0.96</td>
</tr>
</tbody>
</table>

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### 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) – some measure of revealed preferences.

**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.

**Dave Swenson – Iowa State University**
Coming up with future benefits

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 shift of shares analysis
- computable general equilibrium models that may be driven by sets of exogenous changes
- estimates of changes in price/demand elasticities given different conditions or constraints

How to determine?

Private Market Rates. In a perfect market, the private rate would reflect consumers’ choice between present and future consumption. The private market rate would equal (a) the marginal efficiency of investment and (b) interest costs would be at their efficient level.

But, we don’t have perfect markets:

- highly differential access to capital
- therefore, different people pay different rates

Uncertainty is also a factor. Uncertainty is merely unquantified risk. Accordingly, short and long term interest rates are different.
A Social Rate of Preference

We use this term to distinguish between private or market preferences and social preferences. 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.

Discount Rates

Some guidance to choosing the right discount rate. Insights might be gained by considering these factors:

1. Gross/before tax rate of interest on private investment
2. A weighted average of gross and net rates of return
3. A socially optimal discount rate – ultimately a political construct
4. Hybrid approach
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.

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)

<table>
<thead>
<tr>
<th></th>
<th>3-Year</th>
<th>5-Year</th>
<th>7-Year</th>
<th>10-Year</th>
<th>20-Year</th>
<th>30-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Year</td>
<td>4.9</td>
<td>4.9</td>
<td>4.9</td>
<td>5.0</td>
<td>5.1</td>
<td>5.1</td>
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</table>

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

<table>
<thead>
<tr>
<th></th>
<th>3-Year</th>
<th>5-Year</th>
<th>7-Year</th>
<th>10-Year</th>
<th>20-Year</th>
<th>30-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Year</td>
<td>2.5</td>
<td>2.6</td>
<td>2.7</td>
<td>2.8</td>
<td>3.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Dave Swenson – Iowa State University
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


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


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

<table>
<thead>
<tr>
<th></th>
<th>Current Path</th>
<th>Alternative Path</th>
<th>Avoided Costs</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Amount</td>
<td>Percent</td>
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<tr>
<td>Treatment Expenditures</td>
<td>0.8</td>
<td>0.6</td>
<td>0.2</td>
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<tr>
<td>Lost Economic Output</td>
<td>3.4</td>
<td>2.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Total</td>
<td>4.2</td>
<td>3.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table 4
Mortality Costs of Smoking (2000 dollars)

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
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<tbody>
<tr>
<td>Panel A: Total Costs</td>
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</tr>
<tr>
<td>VSL cost estimate</td>
<td>1,538,631</td>
<td>563,299</td>
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<tr>
<td>VSLY cost estimate</td>
<td>561,665</td>
<td>258,792</td>
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<tr>
<td>Panel B: Costs per pack</td>
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<tr>
<td>VSL cost estimate</td>
<td>189.35</td>
<td>80.09</td>
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<tr>
<td>VSLY cost estimate</td>
<td>69.12</td>
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