



# Reference Case Guidelines for Benefit-Cost Analysis in Global Health and Development

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\* The views expressed in this document are solely those of the authors, and do not necessarily reflect the views of the organizations with which they are affiliated or their membership.

# Preface

These final *Reference Case Guidelines for Benefit-Cost Analysis in Global Health and Development* represent the conclusion of the “Benefit-Cost Analysis Reference Case: Principles, Methods, and Standards” project, initiated by the Bill & Melinda Gates Foundation in October 2016. The aim of this project is to promote the use, and the usefulness, of benefit-cost analysis. The guidelines are designed to clarify important concepts, aid in implementation, and provide default values for key parameters including options for standardized sensitivity analysis. This main guidelines document is intended for use by practitioners with some training and experience in conducting economic evaluations, including those who work for academic institutions, government agencies, international organizations, nongovernmental organizations, other nonprofit or for profit entities, and independently. Additional materials for diverse audiences are available on our website: <https://sites.sph.harvard.edu/bcaguidelines/>.

In guidance for cost-effectiveness analyses of health and medical interventions, the term “reference case” is often used to refer to a standard set of practices that all analyses should follow to improve their comparability and quality. In benefit-cost analysis, the terms “guidance” or “guidelines” are often used to refer to the same types of best practice standards. Thus we use both terms in this document.

In the first phase of this project, we explored the potential scope of these guidelines. We drafted a report that reviewed available guidance and selected analyses, conducted a stakeholder survey, discussed the issues to be addressed in a May 2017 workshop, and solicited public comments. We then used the results to set priorities for the subsequent phases. The associated reports and workshop materials are available here: <https://sites.sph.harvard.edu/bcaguidelines/scoping/>.

The second phase involved developing methodological recommendations and conducting case studies to test and illustrate these recommendations. The draft methods papers and case studies were posted for public comment, discussed in a November 2017 workshop, and then revised. Several of these papers were then further revised and published in a special open-access issue of the *Journal of Benefit-Cost Analysis* in March 2019. The results form the foundation of these reference case guidelines, although the guidelines deviate from some earlier recommendations as a result of subsequent research and review. The methods papers, case studies, and workshop materials are available here: <https://sites.sph.harvard.edu/bcaguidelines/methods-and-cases/>.

In the third phase, we developed guidelines for implementing the benefit-cost analysis reference case that built on previous work. The draft guidelines were posted for public comment in February 2019 then revised and finalized. They are freely accessible online and designed to be easily updated as new research becomes available and methods are further developed. We also developed recommendations for future work, including conducting outreach, creating tools such as user-friendly spreadsheets and templates, developing research repositories, providing technical assistance and training, preparing additional illustrative case studies, expanding the guidelines to address additional topics, and conducting new primary research. The results of the third phase, along with this final guidelines document, are posted here: <https://sites.sph.harvard.edu/bcaguidelines/guidelines/>.

# Acknowledgements

This work is funded by the Bill & Melinda Gates Foundation (grant number OPP1160057). Lisa A. Robinson is the Principal Investigator and James K. Hammitt is the co-Principal Investigator (Harvard T.H. Chan School of Public Health). Lisa A. Robinson and James K. Hammitt are also the lead authors of these guidelines. The other project Leadership Team members are Dean T. Jamison (University of California, San Francisco) and David de Ferranti (Results for Development Institute). The Gates Foundation Program Officers are Damian Walker and David Wilson.

Our Advisory Group includes Michele Cecchini (OECD), Kalipso Chalkidou (Center for Global Development), Maureen Cropper (University of Maryland), Anil Deolalikar (University of California, Riverside), Patrick Hoang-Vu Eozenou (The World Bank), Frederico Guanais (Inter-American Development Bank), Soonman Kwon (Seoul National University), Jeremy A. Lauer (World Health Organization), Dale Whittington (University of North Carolina, Chapel Hill), and Brad Wong (Copenhagen Consensus Center). The Advisory Group also includes members who are coordinating our work with related efforts in addition to providing advice on this project, including Karl Claxton (University of York) and Thomas Wilkinson (University of Cape Town). We are very grateful to Stephen Resch (Harvard T.H. Chan School of Public Health) for many useful discussions and to Lucy O’Keeffe (Harvard T.H. Chan School of Public Health) for her excellent research assistance.

A series of methods papers and cases studies provided the foundation for these guidelines and we deeply appreciate the many contributions of the authors. The complete set of 13 papers are listed below and posted on our website; eight were further refined for publication in the *Journal of Benefit-Cost Analysis* along with an introduction. Links to each paper are provided in the reference list at the end of these guidelines.

## Introduction

- “Conducting Benefit-Cost Analysis in Low- and Middle-Income Countries,” Lisa A. Robinson, James K. Hammitt, Dean T. Jamison, and Damian G. Walker, *Journal of Benefit-Cost Analysis*, 10(S1): 1-14, 2019.

## Methods Papers

- “Valuing Mortality Risk Reductions in Global Benefit-Cost Analysis,” Lisa A. Robinson, James K. Hammitt, and Lucy O’Keeffe, *Journal of Benefit-Cost Analysis*, 10(S1): 15-50, 2019.
- “Valuing Changes in Time Use in Low- and Middle-Income Countries,” Dale Whittington and Joseph Cook, *Journal of Benefit-Cost Analysis*, 10(S1): 51-72, 2019.
- “Accounting for Timing when Assessing Health-Related Policies,” Karl Claxton, Miqdad Asaria, Collins Chansa, Julian Jamison, James Lomas, Jessica Ochalek, and Mike Paulden, *Journal of Benefit-Cost Analysis*, 10(S1): 73-105, 2019.
- “Valuing Protection against Health-Related Financial Risks,” Jonathan Skinner, Kalipso Chalkidou, and Dean Jamison, *Journal of Benefit-Cost Analysis*, 10(S1): 106-131, 2019.

- *Valuing Nonfatal Health Risk Reductions in Global Benefit-Cost Analysis*, Lisa A. Robinson and James K. Hammitt, Guidelines for Benefit-Cost Analysis Project Working Paper, 2018.
- *Assessing the Distribution of Impacts in Global Benefit-Cost Analysis*, Lisa A. Robinson and James K. Hammitt, with supplement by Matthew Adler, Guidelines for Benefit-Cost Analysis Project Working Paper, 2018.
- *Assessing the Economy-wide Effects of Health and Environmental Interventions in Support of Benefit-Cost Analysis*, Kenneth M. Strzepek, Collins Amanya, and James E. Neumann, Guidelines for Benefit-Cost Analysis Project Working Paper, 2018.

### **Case Studies**

- “Comparing the Application of CEA and BCA to Tuberculosis Control Interventions in South Africa,” Thomas Wilkinson, Fiammetta Bozzani, Anna Vassall, Michelle Remme, and Edina Sinanovic, *Journal of Benefit-Cost Analysis*, 10(S1): 132-153, 2019.
- “Benefit-Cost Analysis of a Package of Early Childhood Interventions to Improve Nutrition in Haiti,” Brad Wong and Mark Radin, *Journal of Benefit-Cost Analysis*, 10(S1): 154-184, 2019.
- “Applying Benefit-Cost Analysis to Air Pollution Control in the Indian Power Sector,” Maureen Cropper, Sarath Guttikunda, Puja Jawahar, Zachary Lazri, Kabir Malik, Xiao-Peng Song, and Xinlu Yao, *Journal of Benefit-Cost Analysis*, 10(S1): 185-205, 2019.
- “Standardized Sensitivity Analysis in BCA: An Education Case Study,” Elina Pradhan and Dean Jamison, *Journal of Benefit-Cost Analysis*, 10(S1): 206-223, 2019.
- *Benefit-Cost Analysis of Community-Led Total Sanitation: Incorporating Results from Recent Evaluations*, Mark Radin, Marc Jeuland, Hua Wang, and Dale Whittington. Guidelines for Benefit-Cost Analysis Project Working Paper, 2019.
- *Contribution of Water Resources Development and Environmental Management to Uganda’s Economy*, James E. Neumann, Collins Amanya, and Kenneth M. Strzepek, Guidelines for Benefit-Cost Analysis Project Working Paper, 2018.

We are thankful for the advice and support provided by the many contributors to this effort, including all of those listed above and the numerous additional individuals who drafted related materials, provided comments, participated in our workshops, and attended our sessions at the International Health Economics Association, Society for Benefit-Cost Analysis, and Society for Risk Analysis meetings and elsewhere. In addition to those previously listed, the individuals identified below and several anonymous reviewers provided many very helpful comments on our draft materials.

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The views expressed in this document are solely those of the authors, and do not necessarily reflect the views of the organizations with which they are affiliated or their membership. More information on this project is available here: <https://sites.sph.harvard.edu/bcaguidelines/>.

# Summary and Key Recommendations

Benefit-cost analysis (BCA) and other forms of economic evaluation are powerful tools, encouraging the systematic collection and assessment of the evidence needed to support sound policy decisions. In low- and middle-income countries, where resources are especially scarce and needs are very great, such decisions are particularly difficult and economic evaluations can be especially useful. If not well conducted and clearly reported, however, these studies can lead to erroneous conclusions. Differences in analytic methods and assumptions can also obscure important differences in policy impacts.

Recognizing these challenges, the Bill & Melinda Gates Foundation is supporting the development of reference case guidelines. These guidelines are intended to increase the comparability of economic evaluations, improve their quality, and expand their use. The resulting analyses will promote understanding of the difficult trade-offs faced within and across sectors and support decisions by the Gates Foundation, other nongovernmental organizations, government agencies, and individuals. In this summary, we provide background information on this effort then describe the recommendations that are discussed in more detail in the guidelines.

The process used to develop these reference case guidelines was designed to encourage extensive involvement from stakeholders, including both BCA practitioners and consumers.<sup>1</sup> The goal is to ensure that the guidance incorporates multiple perspectives and types of expertise, and is both useful and used. In the first phase, we explored the potential scope of the guidelines. We reviewed available guidance and selected analyses, conducted a stakeholder survey, discussed the issues in a public workshop, and solicited comments. In the second phase, we commissioned a series of 13 papers to develop methodological recommendations in key areas and to test them through application to case studies. The drafts were posted online for public comment, discussed in a public workshop, and then revised. The third phase involved developing these guidelines, which are freely accessible online and intended to be easily updated as new research results become available and methods are further developed.

## **S.1 Introduction and Background**

The starting point for this work is the International Decision Support Initiative (iDSI) Reference Case, which was funded by the Gates Foundation to provide general guidance for all types of health-related economic evaluations as well as specific guidance for conducting cost-effectiveness analysis (CEA). The Gates Foundation then funded this project, which expands the iDSI Reference Case to include BCA.

The iDSI Reference Case concentrates on the use of economic evaluation for health technology assessment, including interventions to prevent or treat particular health conditions primarily within the health care system. The goal is to explore the effect of these interventions on health, usually measured

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<sup>1</sup> More information on this project, including related reports, working papers, and workshop materials, is available on our website: <https://sites.sph.harvard.edu/bcaguidelines/>.



as changes in quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs). Both are nonmonetary measures that integrate consideration of health and longevity. In this context, CEA is typically used to determine whether funding a particular intervention is more or less cost-effective than other uses of health care resources.

BCA aims to assess the effects of policies on overall welfare rather than solely on health. It uses monetary values to measure the extent to which individuals are willing to exchange their income – which can be spent on other things – for the health and non-health outcomes they will likely experience if a policy is implemented.<sup>2</sup> The expansion of the reference case to include BCA reflects the goals of the Gates Foundation. While global health continues to be its primary focus, the Foundation also has a strong interest in other sectors such as agriculture, financial services for the poor, water and sanitation, and education. It expects the use of BCA will inform how it and others allocate their resources both within and across sectors.

Whether CEA, BCA, or both should be applied depends on the decision-making context, including the interests of those involved, the nature of the problem to be addressed, and the resources to be reallocated. For example, if the policy question is how to best reallocate the health care budget to improve health, then CEA is usually most appropriate.<sup>3</sup> If the policy question is how to best set the health care budget, reallocate other government spending, adjust tax policies, or design regulations to increase societal welfare, then BCA is often most appropriate. Because any analytic approach will have advantages and limitations that relate to the data and methods available as well as the underlying assumptions, conducting both CEA and BCA provides useful insights in many settings.

While the term “benefit-cost analysis” is used generically to refer to any process for weighing harms and improvements, within welfare economics it has a more precise meaning. Conceptually, it is based on two fundamental normative elements. The first is that each individual is the best, or most legitimate, judge of his or her own welfare. How individuals’ concerns about other peoples’ wellbeing should be incorporated raises complex issues that are not fully resolved. The second is that the preferred policy is that which maximizes social welfare, measured by summing the effects of policy across individuals. The idea is that concerns about who receives the benefits and who bears the costs should be addressed separately, through policies that directly affect distribution such as the tax and income-support system. Those who are not entirely comfortable with these normative underpinnings may still find the methods used and the information generated by this framework useful.

As does the iDSI Reference Case, most BCA guidance recommends that economic evaluation should play a major role in the decision-making process but should not be the sole basis for policy decisions. This

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<sup>2</sup> We use the term “policy” as a generic term to include projects, programs, interventions, and other actions that affect the wellbeing of multiple individuals in a society.

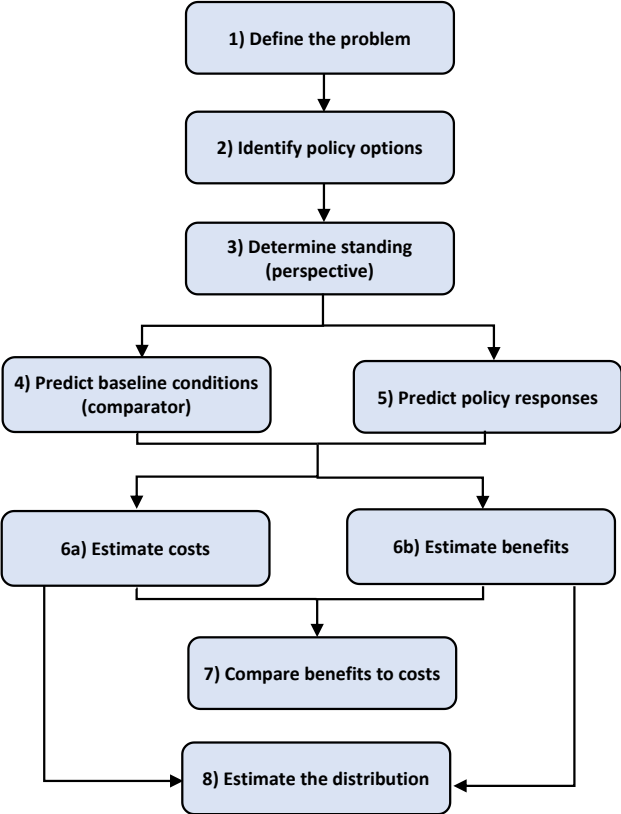
<sup>3</sup> Exceptions include interventions that do not directly address the burden of disease, such as those related to contraception, abortion, palliative care, and cosmetic surgery. Because the outcomes in these cases cannot be easily measured using QALYs or DALYs, BCA may be more useful than CEA in considering how to allocate a health care budget that includes these types of interventions.

recommendation in part stems from the need to address normative issues, such as concerns for others’ wellbeing, that may not be adequately captured in these frameworks. Another concern is the need to examine legal, technical, budgetary, and political constraints. Finally, as is the case with any form of evaluation, addressing data gaps and inconsistencies poses many challenges. Analysts must carefully investigate the evidence, identify and assess the effects of uncertainties (including impacts that cannot be quantified), and clearly communicate the implications for decision-making.

**S.2 General Framework**

As conventionally conducted, BCA consists of seven basic components; distributional analysis is a desirable eighth component, as illustrated in Figure S.1. While shown as if it were a sequential process, in reality these steps are iterative. As analysts acquire additional information and review their preliminary findings, they often revise earlier components to reflect improved understanding of the issues. Each of these steps requires consideration of uncertainty as well as non-quantified effects.

**Figure S.1: BCA Components**



We briefly introduce each component below and discuss some general implementation issues. For simplicity, this overview assumes the BCA is conducted from a prospective, *ex ante* perspective, before the policy is implemented. BCA may also be conducted from a retrospective, *ex post* perspective, after

the impacts of the policy have materialized, to compare the results to what would likely have occurred in the absence of the policy.

**(1) Define the problem:** BCA is often motivated by a specific problem or policy goal, which may be identified by the analyst, a policymaker, or others. The problem may, for example, involve more effectively controlling tuberculosis, reducing poor nutrition, increasing agricultural yields, improving educational attainment, or other goals. It may also or instead involve prioritizing spending across interventions in different policy areas. Whatever the goal, the analysis should be comprehensive and include all significant consequences.

**(2) Identify policy options:** While many studies assess only a single option for addressing the problem, considering several reasonable alternatives is preferable. Evaluating only one option can lead decision-makers to ignore others that may be more cost-beneficial.

**(3) Determine who has standing (perspective):** Standing refers to identifying whose benefits and costs will be counted. The analysis may, for example, consider impacts on only those who reside or work in a specific country or region, or may address international impacts. This concept is related to that of “perspective” in CEA. For example, a CEA may be conducted from the societal perspective, in which case all impacts are included, or from the perspective of the health care sector, in which case only the impacts on that sector are considered.

When the question of standing or perspective raises difficult issues, it is often useful to report the results at different levels of aggregation rather than trying to fully resolve these issues prior to conducting the analysis. For example, the results could be reported for a specific region, for the country as a whole, and at the global level, or for the health care system alone and for society at large.

**(4) Predict baseline conditions (comparator):** Each policy option is typically compared to a “no action” baseline that reflects predicted future conditions in the absence of the policy, although other comparators may at times be used. The baseline should reflect expected changes in the status quo. For example, the health of the population and its size and composition may be changing, and the economy may be evolving, in ways that will affect the incremental impact of a policy.

**(5) Predict policy responses:** This component involves predicting the impacts of each option in comparison to the baseline or other comparator. One challenge is ensuring that changes likely to occur under the baseline are not inappropriately attributed to the policy; another is understanding the causal pathway that links the policy to the outcomes of concern. The goal is to represent the policy impacts as realistically as possible, taking into account real-world behavior.

These impacts should be described both qualitatively and quantitatively, comparing predictions under baseline conditions to predictions under the policy. Related measures should include, at minimum, estimates of the expected number of individuals and entities affected in each year, along with

information on their characteristics. For policies that affect health and longevity, the expected number of deaths and cases of illness, injuries, or other disabilities averted in each year should also be reported.

**(6) Estimate costs and benefits:** Whether a consequence is categorized as a “cost” or “benefit” is arbitrary and varies across BCAs. As long as the sign is correct (positive or negative), the categorization of an impact as a cost or a benefit will not affect the estimate of net benefits, but will affect the benefit-cost ratio. Consistent categorization is essential for comparability of benefit-cost ratios, total costs, and total benefits across analysis.

One intuitively appealing option is to distinguish between inputs and outputs. Under this scheme, costs are the required inputs or investments needed to implement and operate the policy – including real resource expenditures such as labor and materials, regardless of whether these are incurred by government, private or nonprofit organizations, or individuals. Benefits are then the outputs or outcomes of the policy; i.e., changes in welfare such as reduced risk of death, illness, or injury.

Under this framework, counterbalancing effects are assigned to the same category as the impact they offset. For example, “costs” might include expenditures on improved technology as well as any cost-savings that result from its use; “benefits” might include the reduction in disease incidence as well as any offsetting risks, such as adverse reactions to medication or post-surgical infections.

These guidelines do not address the estimation of costs in detail. Generally, the same approaches are used to estimate costs in CEA and in BCA; related guidance is provided by the iDSI Reference Case these guidelines supplement as well as by the work of the Global Health Cost Consortium and others.

These guidelines focus largely on the estimation of benefits, particularly those that cannot be fully valued using market prices. For example, valuing changes in health and longevity generally requires the use of revealed- or stated-preference methods. Revealed-preference methods estimate the value of nonmarket outcomes based on the prices paid for related market goods, while stated-preference methods estimate these values based on survey data.

**(7) Compare benefits to costs:** The final step in the BCA involves comparing costs and benefits. As part of this calculation, future-year impacts are discounted to reflect time preferences and the opportunity costs of investments made in different periods. This discounting reflects the general desire to receive benefits early and to defer costs. The monetary values of benefits and costs should be discounted at the same rate.

The results are often reported as net benefits (benefits minus costs). Benefit-cost ratios or the internal rate of return (IRR) may also be used, but must be constructed and interpreted with care. Benefit-cost ratios depend on how components are classified as benefits or costs. The IRR, which is the discount rate at which the present value of net benefits is zero, may not be unique if net benefits change sign more than once over time. The IRR does not exist if net benefits are always positive (or always negative) in every year.

The selection among these summary measures will depend in part on the goal of the analysis. For example, when assessing options for achieving a particular policy goal, estimates of net benefits are likely to be most useful. When prioritizing spending across numerous policies, benefit-cost ratios or IRRs may be informative. It is generally useful to report net benefits along with the benefit-cost ratio or IRR to indicate the magnitude of the impacts.

**(8) Estimate the distribution of impacts:** While often considered to be outside the BCA framework, the distribution of impacts across a population is frequently important to decision-makers and other stakeholders. At minimum, analysts should provide descriptive information on how both the costs and benefits are likely to be allocated across income and other groups, including the variation in net benefits, benefit-cost ratio, or IRR.

Each of the above components requires appropriate consideration of uncertainty, including non-quantified effects. In summarizing the results, analysts should address the extent to which these uncertainties affect the likelihood that a particular policy yields benefits that exceed costs and the relative ranking of the policy options.

Because analytic resources are limited, the ideal analysis will not assess all policy options nor quantify all impacts with equal precision. In some cases, the cost of analyzing a particular option or quantifying a specific impact will be greater than the likely benefit of assessing it, given its importance for decision-making. In other words, the analysis may not sufficiently improve the basis for decision-making to pass an implicit benefit-cost or value-of-information test. Conversely, options and impacts that are important for decision-making should receive substantial attention.

To implement the BCA framework, analysts should begin by listing all potential costs, benefits, and other impacts, then use screening analysis to identify the impacts most in need of further investigation. Screening analysis relies on easily-accessible information and simple assumptions to provide preliminary insights into the direction and magnitude of effects. For example, upper-bound estimates of parameter values can be used to determine whether particular impacts may be significant. Screening aids analysts in justifying decisions to exclude impacts from more detailed assessment and in determining where additional research is most needed to reduce uncertainty. It also provides data that can be used to indicate the rough magnitude of impacts that are not assessed in detail.

#### **S.4 Recommendations**

In addition to an overview of the analytic framework, these guidelines includes specific recommendations in seven areas, focusing on approaches that can be implemented with reasonable ease by analysts working in low- and middle-income countries:<sup>4</sup>

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<sup>4</sup> In addition, a companion methods paper discusses valuing the financial risk protection provided by insurance.

1. Comparing Values Across Countries and Over Time
2. Valuing Mortality Risk Reductions
3. Valuing Nonfatal Health Risk Reductions
4. Valuing Changes in Time Use
5. Assessing the Distribution of Impacts
6. Accounting for Uncertainty and Nonquantifiable Impacts
7. Summarizing and Presenting the Results

Below, we briefly summarize each topic and the recommendations. This summary presumes some familiarity with these concepts and their application on the part of the reader. The main text of the guidelines provides more detailed information on the basis for these recommendations and their application.

**(1) Comparing Values Across Countries and Over Time:** Assessing policy options often requires translating monetary values across currencies and over time, to support within-country policy choices and allow cross-country comparisons. Three conversions are necessary to meet these objectives: (a) inflation adjustments to account for economy-wide price changes, (b) exchange rates to reflect the relative value of different currencies, and (c) discounting procedures to incorporate time preferences. We focus on defaults that analysts can use either in developing their primary estimates or in sensitivity analysis, to allow comparability with other analyses conducted within and across countries. The rates used in these conversions and their sources should be reported along with the results.

**a) Inflation and Real Changes in Value**

- i. Benefits and costs should be converted to real (constant) currency units for a designated currency year using an appropriate inflation index.
- ii. Benefits and costs should be adjusted for changes in real value in future years.

**b) Currency Conversions**

- i. Benefits and costs should be reported in the local currency; when values are transferred across countries, purchasing power parity or market exchange rates should be used as appropriate for currency conversions.
- ii. Total benefits and total costs also should be converted from the local currency to internationally-comparable units, such as U.S. or international dollars.

c) **Discounting**

- i. The distribution of undiscounted costs and benefits over time should be reported.
- ii. A context-specific discount rate should be used to estimate present values in the results highlighted by the authors.
- iii. A standardized sensitivity analysis should be presented to test the implications of different discount rates, including a constant annual rate of 3 percent and a constant annual rate equal to twice the projected near-term gross domestic product (GDP) per capita growth rate. Such analysis is particularly important when uncertainty in the discount rate substantially influences the estimates of net benefits or the rankings of the policy options.

Analysts may also wish to test the sensitivity of their results to other rates, and to the effects of declining rates when important policy outcomes do not fully manifest until many years in the future.

**(2) Valuing Mortality Risk Reductions:** Many policies aim to improve longevity, decreasing the risk of death in each year. The value of these risk reductions is often expressed as the value per statistical life (VSL); at times a value per statistical life year (VSLY) may be used.<sup>5</sup> The VSL concept is widely misunderstood. It is not the value that the analyst, the government, or the individual places on saving an identified life with certainty. Instead, it reflects individuals' willingness to exchange money for a small change in their own risk, such as a 1 in 10,000 decrease in the chance of dying in a specific year.

This individual willingness to pay (WTP) can be divided by the risk change to estimate VSL. VSL is then multiplied by the expected reduction in the number of deaths each year attributable to the policy to estimate the resulting benefits.<sup>6</sup> While many alternatives to the "VSL" terminology have been proposed to clarify this concept, such as the value per standardized mortality unit (VSMU) or the value of reduced mortality risk (VRMR), they have not been widely accepted or used.

Ideally, the value of mortality risk reductions in low- and middle-income countries would be derived from multiple high-quality studies of the population affected by the policy. These values are likely to vary depending on characteristics of the society, the individuals affected, and the risk. Synthesizing the results from multiple studies relevant to that population is desirable because each will have advantages and limitations. However, extrapolation from studies of other populations will likely be necessary in the near-term, given the paucity of studies conducted in these countries. Standardized sensitivity analysis can be used to address associated uncertainties.

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<sup>5</sup> The VSLY reflects individuals' willingness to pay for a change in life expectancy, and is often calculated by dividing a VSL estimate by the life years remaining for the average individual included in the study.

<sup>6</sup> Multiplying VSL by the expected reduction in the number of deaths is a short cut that should approximate the correct result. Conceptually, individuals' values are calculated by multiplying the risk reduction each experiences by their VSL, then summing the results across individuals to calculate the population value. Multiplying an average VSL by the expected reduction in number of deaths produces the same result if VSL and risk reductions are uncorrelated across individuals.

a) **Context-Specific Values**

- i. The value of mortality risk reductions featured as the preferred estimate should reflect the decision-making context, taking into account the characteristics of the individuals affected by the policy and of the risk that the policy addresses.

b) **Population-Average Values**

- i. The analysis should include a standardized sensitivity analysis to facilitate comparison to other studies and to explore the effects of uncertainties. Such analysis is particularly important when uncertainty in the value of mortality risk reductions substantially influences the estimates of net benefits or the rankings of the policy options. The sensitivity analysis should include alternative population-average VSL estimates for the target country, using research conducted in high-income countries as reference values. It should rely on gross national income (GNI) per capita measured using purchasing power parity to estimate income, and on assumed income elasticities to estimate the change in the VSL associated with a change in income. The formula is:

$$VSL_{target} = VSL_{reference} * (Income_{target} / Income_{reference})^{elasticity}$$

The sensitivity analysis should use the following three estimates.

i.a) VSL extrapolated from a U.S. VSL of \$9.4 million and U.S. GNI per capita of \$57,900 (a VSL-to-GNI per capita ratio of 160), using an income elasticity of 1.5. If this approach yields a target country value of less than 20 times GNI per capita, then 20 times GNI per capita should be used instead.

i.b) VSL extrapolated from an OECD VSL-to-GNI per capita ratio of 100 to the target country using an income elasticity of 1.0; i.e.,  $VSL = 100 * GNI$  per capita in the target country.

i.c) VSL extrapolated from a U.S. VSL-to-GNI per capita ratio of 160 to the target country using an income elasticity of 1.0; i.e.,  $VSL = 160 * GNI$  per capita in the target country.

Option (i.a) is generally the preferred default, because it addresses concerns about the resources available for spending on mortality risk reductions in low- and middle-income countries. Options (i.b) and (i.c) are designed to align the results with the ranges applied in other research and explore related uncertainties.

- ii. These VSL estimates should be adjusted for expected growth in real income over time in the target country.



c) **Age and Life Expectancy Adjustments**

- i. If the policy disproportionately affects the very young or the very old, analysts should conduct sensitivity analyses using VSLY estimates derived from one or more of the above VSL estimates as a rough proxy. This constant VSLY should be calculated by dividing the population-average VSL by undiscounted future life expectancy at the average age of the adult population in that country, relying on the age that is equivalent to one-half of life expectancy at birth to approximate this average age if needed. The VSLY should then be multiplied by the expected life year gain attributable to the policy.<sup>7</sup>
- ii. If the policy affects deaths around the age of birth, the VSL and VSLY estimates above can be applied. Analysts should also explore the implications of assigning positive values to mortality risk reductions that occur prior to birth.

**(3) Valuing Nonfatal Health Risk Reductions:** The conceptual framework and general approach for valuing nonfatal health risk reductions is the same as for valuing mortality risk reductions. The major challenge relates to the wide variety of illnesses and injuries that may be of interest, which differ significantly in severity, duration, and other characteristics. Studies of individual WTP are available for only a subset of these diverse risks, even in high income countries.

When suitable WTP estimates of adequate quality are not available, analysts typically approximate these values using estimates of averted costs (often referred to as the cost of illness, COI) alone or in combination with estimates of the change in QALYs or DALYs valued in monetary terms. We recommend that analysts use estimates of averted costs as a proxy when WTP estimates are not available and explore the sensitivity of their results to the use of monetized QALYs or DALYs.

a) **Willingness to Pay Estimates**

- i. The analysis should rely on WTP estimates if suitable estimates of adequate quality are available for the nonfatal health effects of concern.
- ii. Estimates of averted costs not otherwise included in the analysis should be added to these WTP estimates, especially if they are expected to be significant. These additional costs include medical costs paid by third parties as well as the opportunity costs of caregiving provided by family or friends. Costs borne by the individual may be included in the WTP estimate, in which case they should not be added.

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<sup>7</sup> The use of a constant VSLY leads to total values that decrease as age increases, so that the value of risk reductions that accrue to young children are higher, and the value of risk reductions that accrue to the elderly are lower, than the value of risk reductions that accrue to an adult of average age. This approach is similar to the approach used in CEA, which measures changes in the risk of death as years of life lost (YLLs) (based on life expectancy at the age of death) or gained, typically using QALYs or DALYs.

**b) Proxy Measures**

- i. When WTP estimates are not available, averted costs should be used as a proxy measure, recognizing that this measure is expected to understate the value of the risk reduction. These costs should include those incurred by the individual, household and family members, and third parties.
- ii. Sensitivity analysis should be conducted that uses monetized estimates of the change in QALYs or DALYs to replace the estimates of costs incurred by the individual, especially if including these values is likely to significantly affect the analytic conclusions. This sensitivity analysis should involve estimating the change in QALYs or DALYs attributable to nonfatal risk reductions and valuing them using constant VSLY estimates, calculated as described in the discussion of valuing mortality risk reductions.

**(4) Valuing Changes in Time Use:** How individuals use their time, regardless of whether it involves paid or unpaid work or leisure, is often affected by policies that aim to improve health and development in low- and middle-income countries. Such changes may be categorized as either a cost or a benefit, depending on whether the change contributes to implementation of a policy (a cost) or is among its outcomes (a benefit).

Ideally, the value of changes in time use would be estimated using data that address the specific population and activities affected by the policy. For market work time, compensation for similar individuals in similar occupations generally provides a reasonable estimate of these values. For nonmarket work and leisure, data from nonmarket valuation studies are typically needed. In the absence of studies relevant to the policy context, previous work provides a range of values that can be applied to estimate these values.

**a) Market Work Time**

- i. Changes in market work time should be valued based on compensation data for the population of concern. When the costs to employers include taxes, expenditures on fringe benefits, or other costs in addition to the compensation received by the employee, these additional costs should be included in the estimates.

**b) Nonmarket Work and Leisure Time**

- i. Changes in nonmarket work and leisure time should be valued using WTP estimates, if suitable estimates of adequate quality are available.
- ii. If WTP estimates are not available, 50 percent of after-tax wages should be used as a central estimate, with sensitivity analysis using 25 percent and 75 percent of after-tax wages.

**(5) Assessing the Distribution of the Impacts:** Conventionally, BCA focuses on economic efficiency, comparing a policy's costs and benefits to estimate its net effects. There is widespread agreement, however, that information on how the impacts are distributed across individuals is also needed to support sound decisions. Distributional considerations should be an integral part of the analytic process and include the following.

**a) Individuals and Impacts of Concern**

- i. In consultation with decision-makers and other stakeholders, analysts should identify the characteristics of individuals and impacts of concern. At minimum, the distributional analysis should address the effects of the policy on the health, longevity, and income of members of different income groups, including the distribution of both costs and benefits.
- ii. The effort devoted to the distributional analysis, including its level of detail and degree of quantification, should be proportionate to its importance for decision-making. "Importance" may depend on the likely magnitude of the distributional impacts and concerns about associated inequities; it may also depend on the need to respond to questions likely to be raised by decision-makers and others.

**b) Distributional Metrics**

- i. For each policy option, the analysis should describe the distribution of both benefits and costs across members of different population groups. These results should be reported as monetary values and in physical terms to the extent possible; e.g., as net benefits and as the expected number of individuals who accrue net costs and/or benefits. Measures of inequality, such as the Gini coefficient, may also be used; the advantages and limitations of the selected measure(s) should be discussed along with the results.

**(6) Accounting for Uncertainty and Nonquantifiable Impacts:** All analytic results are uncertain to some degree, due to the characteristics of the available data and models and the difficulties of quantifying some potentially important effects. To ensure that decision-makers and other stakeholders appropriately account for these uncertainties, analysts should disclose all data sources and methods used and discuss their advantages and limitations. Related recommendations include the following.

**a) Uncertainty in Quantified Effects**

- i. The impacts of the policy options should be quantified to the greatest extent practical; sensitivity analysis and/or probabilistic analysis should be used to illustrate the implications of uncertainties. Uncertainties should also be discussed qualitatively, including both those that can and cannot be quantified. Screening analysis should be used to tailor the analytic approach to the magnitude of the impacts and their importance for decision-making.

**b) Nonquantified Effects**

- i. At minimum, the analysis should list significant nonquantified effects and discuss them qualitatively. To the extent possible, the effects should be categorized or ranked in terms of their importance within the decision-making context, including their likely direction (e.g.,

whether they increase or decrease net benefits) and magnitude, and the implications for selecting among policy options. Where some data exist, but are not sufficient to reasonably quantify the effect, analysts should consider whether breakeven or bounding analysis will provide useful insights. Intermediate measures, such as the number of individuals affected, should be reported where available.

**(7) Summarizing and Presenting the Results:** Clear and comprehensive documentation of the analysis is essential both to inform the decision-making process and to allow comparison of the results to the results of other analyses. These guidelines are intended to aid analysts in conducting work that is both useful and used, by clarifying the conceptual framework and recommending approaches for application. However, if the approach and results are not well-documented, the analysis will not fulfill its intended purpose regardless of its underlying quality.

**a) Categorizing Impacts as Costs or Benefits**

- i. Impacts categorized as “costs” should relate to the implementation of the policy; impacts categorized as “benefits” should relate to its consequences. Costs include the required inputs or investments needed to implement and operate the policy – including real resource expenditures such as labor and materials, regardless of whether these are incurred by government, private or nonprofit organizations, or individuals. Benefits include the outputs or outcomes of the policy; i.e., changes in welfare such as reduced risk of death, illness, or injury.
- ii. Counterbalancing effects should be assigned to the same category as the impact they offset. For example, “costs” might include expenditures on improved technology as well as any cost-savings that result from its use; “benefits” might include the reduction in disease incidence as well as any offsetting risks, such as adverse reactions to medications or post-surgical infections.

**b) Summary Measures**

- i. The summary measure highlighted in presenting the analytic results should reflect the decision-making context. These summary measures may include net benefits (benefits minus costs), the ratio of benefits to costs (benefits divided by costs), and/or the IRR (the discount rate at which the net present value is zero).
- ii. Regardless of whether a benefit-cost ratio or IRR is featured, it is generally valuable to also report estimates of net benefits to indicate the magnitude of the welfare gains, along with information on the distribution of the impacts.

**c) Documenting the Approach and the Results**

- i. The analysis should be clearly and comprehensively documented. The documentation must describe the problem the policy is designed to address, the options considered, the analytic approach, and the results, as well as the implications of uncertainties.
- ii. To inform decision-making, the documentation should be written so that members of the lay public can understand the analysis and conclusions. It should also provide enough detail for expert review; ideally, competent analysts should be able to reconstruct the analysis or at minimum explore the implications of changing key assumptions.

Ultimately, these guidelines are intended to aid analysts, decision-makers, and other stakeholders in understanding the implications of different methodological choices, in developing high quality analyses that are consistent and comparable, and in clearly communicating the results and their implications. One theme throughout these recommendations is that we know relatively little about the values held by the populations of low- and middle-income countries. In the near-term, the implications of related uncertainties should be explored through sensitivity analysis and clearly communicated; in the longer term, more primary research is needed.

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# Chapter 1. Introduction and Context

Investing in global health and development requires making difficult choices about what policies to pursue and what level of resources to devote to each initiative. Methods of economic evaluation, including cost-effectiveness analysis (CEA) and benefit-cost analysis (BCA), are well-established and widely-used approaches for quantifying and comparing the impacts of alternative investments.<sup>1</sup> The results of these evaluations can be combined with information on non-quantifiable effects, on legal, technical, budgetary, and political constraints, on ethical concerns, and on other factors, to provide the evidence-base for decision-making.

If not well-conducted and clearly-reported, economic evaluations can lead to erroneous conclusions. Differences in analytic methods and assumptions can also obscure important differences in impacts. To increase the comparability of these evaluations, improve their quality, and expand their use, the Bill & Melinda Gates Foundation is supporting the development of guidelines for economic evaluation, focusing on its application to investments in low- and middle-income countries. These guidelines include principles, methodological specifications, and reporting standards. In combination, they provide a reference case to encourage the completion of high-quality, transparent, and consistent evaluations that address the needs of decision-makers and other stakeholders.

The Gates Foundation initiated this effort by funding development of the International Decision Support Initiative (iDSI) Reference Case (NICE International 2014, Wilkinson et al. 2016), which provides general guidance for all types of health-related economic evaluations as well as specific guidance for the conduct of CEA.<sup>2</sup> It then funded this “Benefit-Cost Analysis Reference Case: Principles, Methods, and Standards” project to expand the iDSI guidance to address BCA.<sup>3</sup> The Gates Foundation is also supporting several related projects to create more detailed methodological guidance and to improve access to useful resources. For example, the Global Health Cost Consortium has created guidance on health services costing (Vassall et al. 2017), and the Health Intervention and Technology Assessment Program (HITAP) has developed a Guide to Economic Analysis and Research (GEAR) which provides links to online resources (Adeagbo et al. 2018).<sup>4</sup> In addition, the iDSI team is now testing implementation of its Reference Case through a series of pilot projects.

These guidelines build on the iDSI Reference Case, which includes general guidance for conducting health-related economic evaluations and specific guidance for assessing cost-effectiveness. We supplement this previous work and focus primarily on analytic components unique to BCA.

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<sup>1</sup> “Benefit-cost analysis” and “cost-benefit analysis” can be used interchangeably; we use the term “benefit-cost analysis” to emphasize that the goal is to identify investments that maximize net benefits (benefits minus costs).

<sup>2</sup> See Appendix A. More information on the iDSI Reference Case is available at:

<http://www.idshealth.org/resource-items/idsi-reference-case-for-economic-evaluation/>.

<sup>3</sup> More information on the BCA project is available at: <https://sites.sph.harvard.edu/bcaguidelines/>.

<sup>4</sup> See <https://ghcosting.org/> and <http://www.gear4health.com/>.



Many of these efforts focus largely on using economic evaluation to support health technology assessment, which is typically understood as involving interventions to prevent or treat particular health conditions primarily within the health care system. The goal is to explore the impacts of these interventions on health, frequently measured using quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs). Both are nonmonetary measures that integrate consideration of health and longevity. In this context, CEA is typically used to determine whether funding a particular intervention is more or less cost-effective than other uses of health care resources.

The addition of BCA expands this focus. BCA aims to assess the effects of policies on overall welfare rather than solely on health. It uses monetary measures to indicate the extent to which individuals are willing to exchange their income – which can be spent on other things – for the health and non-health outcomes they will likely experience if a policy is implemented. We use the term “policy” throughout this document as a generic term to include projects, programs, interventions, and other actions that affect the wellbeing of multiple individuals in a society.

BCA and CEA each provide useful information; whether one or both should be applied depends on the decision-making context. BCA explores preferences for allocating resources across policies that address health and non-health outcomes; CEA aids in prioritizing policies targeted on a specific outcome such as improving health. Each must be supplemented by consideration of legal, budgetary, ethical, and other concerns.

BCA is often applied to policies implemented outside of the health care system that may have significant non-health as well as health consequences. For example, BCA is well-established and widely-used to assess the impacts of government regulations and other policies that affect public health and safety, such as those addressing environmental, transportation, workplace, food, tobacco, and other risks.

Whether CEA or BCA or both should be applied depends on the decision-making context, including the interests of those involved, the nature of the problem to be addressed, and the resources to be reallocated. For example, if the policy question is solely how to best reallocate the health care budget so as to improve health, then CEA may be most appropriate.<sup>5</sup> If the policy question is how to best reallocate government spending, adjust tax policies, or design regulations so as to increase societal welfare, then BCA may be most appropriate. Because any analytic approach will have advantages and limitations that relate to the data and methods available as well as the conceptual framework, conducting both CEA and BCA provides useful insights in many settings.

The remainder of this chapter provides a more detailed overview of the BCA framework and the iDSI Reference Case that these guidelines complement, and introduces the contents of the chapters that follow. These guidelines represent the culmination of a three-phase project, initiated in October 2016. In the initial scoping phase, we reviewed and evaluated the current use of BCA and examined the major

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<sup>5</sup> Exceptions include interventions that do not directly address the burden of disease, such as those related to contraception, abortion, palliative care, and cosmetic surgery. Because the outcomes in these cases cannot be easily measured using QALYs or DALYs, BCA may be more useful than CEA in considering how to allocate a health care budget that includes these types of interventions.

barriers, challenges, and opportunities associated with improving and expanding its application. In the second phase, we commissioned papers to address specific methodological topics, each of which discusses the conceptual framework, reviews the relevant literature, and suggests analytic approaches that can be feasibly implemented in the near-term as well as priorities for future research. We also commissioned case studies to test and demonstrate the implementation of the methods paper recommendations.<sup>6</sup> The project was designed to encourage substantial stakeholder engagement; drafts of the supporting papers as well as materials from our workshops and other activities are available on our website (<https://sites.sph.harvard.edu/bcaguidelines/>)

### 1.1 The BCA Framework

BCA and CEA are both designed to inform policy and other decisions by providing evidence on the consequences of alternative interventions, including their costs and benefits. The primary difference is that in CEA, the costs of an investment are typically divided by a single outcome measure, often QALYs gained or DALYs averted. In contrast, in BCA impacts are measured in monetary units, including both health and non-health outcomes. The summary measure is often net benefits (benefits minus costs), although the ratio (benefits divided by costs) or the internal rate of return (IRR, discount rate at which the present value of net benefits is zero) may also be reported.

By using money as a common metric, BCA in principle allows the simultaneous, integrated consideration of multiple consequences and provides information on the intensity as well as the direction of individual preferences. Money is not important *per se*; rather it is used as a convenient measure of the trade-offs individuals and societies are willing to make. In BCA as in the marketplace, money is a well-established measure of the rate of exchange. By purchasing a particular good or service, an individual forgoes the ability to use that money to purchase other things. Presumably the individual values what he or she has purchased at least as much as the other goods or services he or she could have used that money to buy. Analogously, by selling a good or service, the supplier reveals that the opportunity cost of supply (the labor, materials, and other resources used to produce that good or service, which cannot be used for other purposes) do not exceed the price.

In benefit-cost analysis, money is not important *per se*; rather it indicates the trade-offs individuals are willing to make between spending on policy outcomes (such as improved health) and on other goods and services. The goal is to recognize the opportunity costs; the labor, materials, and other resources that will not be available for other purposes if the policy is implemented.

Denoting values in monetary terms mimics the actual trade-offs implicit in most policy decisions. If a country or other funder chooses to spend more on one initiative, it will have fewer resources available to devote to other purposes – including different initiatives that address the same or similar problems.

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<sup>6</sup> These case studies include Cropper et al. (2019), on air pollution; Neumann et al. (2018) on water resources; Pradhan and Jamison (2019) on education; Radin et al. (2019) on sanitation; Wilkinson et al. (2019) on tuberculosis; and Wong and Radin (2019) on nutrition. Skinner et al. (2019) also address valuing the financial risk protection provided by health insurance.

Economic evaluation addresses these trade-offs, considering how to best allocate resources to promote societal welfare.

In contrast to BCA, CEA can be conducted without estimating the monetary value of the benefits included in the effectiveness measure, such as health and longevity when QALYs or DALYs are used as the denominator. However, monetary valuation is implicit in the decision-making process. Choosing to expend resources on a policy indicates that the decision-maker values the outcomes of that policy at least as much as the costs required to implement it. BCA can inform that process by indicating the extent to which the values held by the individuals affected by the policy may diverge from the values implicit in the decision-making process.

Valuation is more explicit in CEA when monetary thresholds are used to distinguish between policies that are and are not cost-effective. These thresholds are intended to represent the monetary value of a QALY or DALY, and may be derived using the same concepts and methods as used to value changes in health and longevity in BCA (see Chapters 4 and 5). In that case, the thresholds are often described as “demand-based” or “consumption-based” because they are intended to represent individuals’ preferences for spending on health and longevity. Alternatively, especially when the decision-maker is allocating a fixed budget, these thresholds may be derived by comparing the impact of the new policy to the impacts of any policies it would replace. In this case, the thresholds may be described as “supply-based” or as “health opportunity costs.”<sup>7</sup> We do not discuss these thresholds in detail in these guidelines. There is a large literature on developing and using cost-effectiveness thresholds in global health as well as on their advantages and limitations.<sup>8</sup>

Thus what differentiates BCA from CEA is four characteristics.

1. BCA uses a common metric to value health and non-health outcomes, facilitating comparison.
2. BCA incorporates the preferences of the individuals affected by the policy for spending on health and longevity rather than on other things that money can buy, which can have important implications for policy design and implementation regardless of the role BCA plays in the decision-making process.
3. BCA directly incorporates preferences for the health impacts of concern relative to other goods and services using monetary values, eliminating the need to specify a value per QALY or DALY as a cost-effectiveness threshold.<sup>9</sup>
4. BCA supports calculation of net benefits (benefits minus costs) as well as a benefit-cost ratio or internal rate of return, providing useful information on the magnitude of the benefits and the extent to which they exceed costs.

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<sup>7</sup> The use of the term “opportunity costs” may at times lead to confusion. In economics, opportunity costs reflect the value of a resource in its best (most welfare-enhancing) use. In the literature on cost-effectiveness thresholds, the term is used more narrowly to reference health outcomes.

<sup>8</sup> See, for example, Drummond et al. (2015).

<sup>9</sup> In contrast, CEA typically assumes all relevant health effects can be aggregated using QALYs or DALYs then treats preferences for QALYs or DALYs relative to other goods and services as an external parameter, such as a demand-based cost-effectiveness threshold.

As is true for all types of analysis, BCA is not without limitations. Some of these limitations relate to the normative framework, discussed later in this chapter as well as in Chapter 7. Others relate to the effects of data gaps and inconsistencies on the estimates of parameter values, an issue faced by any form of evaluation. The treatment of these uncertainties when estimating individual parameter values is discussed in the subsequent chapters. Chapter 8 then addresses uncertainty analysis more generally.

Other disadvantages relate to misunderstanding of the underlying concepts and their application. In particular, the use of monetary measures is frequently misconstrued. For example, the values placed on mortality risk reductions are often misinterpreted as the value the government, the analyst, or the decision-maker places on saving a life, rather than the value that the individuals affected by the policy place on small reductions in their own risks (see Chapter 4). Another challenge is that while BCA is well-established and widely-used to assess regulatory and other government policies, it is less frequently applied when allocating health care spending. As a result, BCA concepts and methods are less familiar to some working in the latter context and may be misunderstood.

Both CEA and BCA face other challenges, including the interest of decision-makers and other stakeholders in impacts that are not conventionally addressed by these analyses. These include concerns about non-quantifiable effects; the distribution of costs and benefits; legal, technical, budgetary, and political constraints; ethical issues; and other factors. Thus both types of analyses must be supplemented by other information to fully inform decision-making. In addition, any type of analysis requires careful investigation of the evidence and clear communication of the implications of uncertainties.

Finally, BCA is most well-established and widely-applied within a microeconomic context, focusing on how individuals, households, and firms behave and the implications for resource allocation. It is typically used to assess alternative policies that are not expected to significantly influence prices or the economy at-large. Many questions addressed in the global health and development literature require consideration of larger macroeconomic impacts, such as the effect on gross domestic product (GDP). These questions may relate, for example, to the economic burden associated with pollution, the implications of providing universal health coverage, or the expansion of national income and product accounts to include measures of welfare rather than solely production.

Because our goal is to provide guidance that can be feasibly implemented at the present time given the data, research results, and other resources now available, we focus on defining best practices for BCA as conventionally conducted within this microeconomic framework. Many scholars have proposed ways to improve this approach or to replace it with alternatives (see, for example, the discussion of social welfare functions in Chapter 8). While these innovations are worthy of continued attention, we do not emphasize them here given the substantial investment needed to further develop these approaches and determine how to best implement them. We expect that these guidelines will be subsequently expanded to discuss these and other issues.

## 1.2 The iDSI Reference Case

The results of any analysis depend in part on the analytic approach and the assumptions used to address data gaps and inconsistencies and other methodological challenges. As a result, differences in the consequences of alternative investments can be obscured by differences in the methods used, potentially leading to widely varying conclusions regarding the desirability of a particular policy.

It is not feasible to evaluate every possible policy in every possible setting in a single study. Consensus on methods and assumptions aids in facilitating comparison of results across studies and in supporting evidence-based decision-making. Analysts can then use these approaches as defaults or in sensitivity analysis, discussing the rationale for any differences between their preferred approach and these defaults as well as the implications of these differences for decision-making. The methods and assumptions must be firmly anchored in empirical research and explore related uncertainties, and be clearly communicated, so that decision-makers and other stakeholders can understand the implications of the results.

These guidelines explicitly address this need for high quality, comparable analyses. They build on the existing iDSI Reference Case, which focuses on the economic evaluation of health-related interventions, particularly in low- and middle-income countries (NICE International 2014, Wilkinson 2016). The iDSI Reference Case includes general principles that apply to all types of economic evaluation as well as guidance that focuses more narrowly on issues that arise in the CEA context. The 11 principles are listed in Figure 1.1; each is supported by methodological specifications and reporting standards which are provided in Appendix A.

**Figure 1.1: iDSI Reference Case Principles**

Statements of Principle
1. <b>Transparency:</b> An economic evaluation should be communicated clearly and transparently to enable the decision maker(s) to interpret the methods and results.
2. <b>Comparators:</b> The comparator(s) against which costs and effects are measured should accurately reflect the decision problem.
3. <b>Evidence:</b> An economic evaluation should consider all available evidence relevant to the decision problem.
4. <b>Measure of Health Outcome:</b> The measure of health outcome should be appropriate to the decision problem, should capture positive and negative effects on length of life and quality of life, and should be generalisable across disease states.
5. <b>Costs:</b> All differences between the intervention and the comparator in expected resource use and costs of delivery to the target population(s) should be incorporated into the evaluation.
6. <b>Time horizon and discount rate:</b> The time horizon used in an economic evaluation should be of sufficient length to capture all costs and effects relevant to the decision problem; an appropriate discount rate should be used to discount costs and effects to present values.
7. <b>Non-health effects and costs outside health budget (perspective):</b> Non-health effects and costs associated with gaining or providing access to health interventions that do not accrue to the health budget should be identified when relevant to the decision problem. All costs and effects should be disaggregated, either by sector of the economy or by whom they are incurred.
8. <b>Heterogeneity:</b> The cost and effects of the intervention on subpopulations within the decision problem should be explored and the implications appropriately characterized.
9. <b>Uncertainty:</b> The uncertainty associated with an economic evaluation should be appropriately characterized.
10. <b>Constraints:</b> The impact of implementing the intervention on the health budget and on other constraints should be clearly and separately identified.
11. <b>Equity considerations:</b> An economic evaluation should explore the equity implications of implementing the intervention.

Source: <https://www.idsihealth.org/resource-items/idsi-reference-case-for-economic-evaluation/>, as viewed May 2019.

Many of the principles, methodological specifications, and reporting standards included in the iDSI Reference Case apply equally to BCA and CEA, and hence are not a major focus of these BCA guidelines. In particular, several principles address features that should be present in any high-quality analysis, such as the need for transparency and careful consideration of the available evidence. Others address analytic components that are common to both BCA and CEA. As a result, we generally defer to the iDSI Reference Case guidance on the estimation of costs and build on the approach it suggests for discounting future impacts. We focus primarily on the areas where BCA differs, including the monetary valuation of health and non-health impacts (under Principles 4 and 7, see Chapters 4 and 5), as well as the implications of these methods for other principles, particularly the consideration of heterogeneity and equity (Principles 8 and 11, see Chapter 7) and assessment of uncertainty (Principle 9, see Chapter 8).

### 1.3 Theoretical Foundations

As conventionally conducted, BCA is based in welfare-economic theory. It is a structured method for accounting for all of the significant consequences of a policy and all of the people affected. It is based on the idea that each individual is the best (or most legitimate) judge of how a particular consequence affects his or her wellbeing, and combines effects on multiple individuals by summing their monetary

values for the changes they would experience. The reliance on individual preferences respects individual autonomy. The logic of the aggregation is that increasing the population sum of net benefits increases the available set of goods and services that affect individuals' wellbeing, and hence creates the possibility that everyone will be better off.

### 1.3.1 Justifications for Using BCA

A number of normative justifications for using BCA to support policy decisions have been offered. A textbook argument is that BCA identifies policies that improve social wellbeing, leading to more efficient use of economic resources to produce goods and services. Under this conception, relying on BCA expands the "social pie" (the total quantity of goods and services available) and potentially enables everyone to consume more. The distribution and possible reallocation of the pie can, in principle, be evaluated separately.

BCA can also be described as a practical approximation of a utilitarian social calculus that seeks to maximize the sum of individuals' wellbeing. Utilitarianism focuses on measuring and maximizing utility (wellbeing) rather than economic efficiency as represented by monetary values. As conventionally conducted, BCA is based on the sum of the costs and benefits. It does not take into account the likelihood that an incremental dollar received by a poor person yields a greater increase in wellbeing than the same amount received by a rich person; i.e., that the marginal utilities of income differ. BCA can approximate a utilitarian approach if effects on different individuals or subpopulations are weighted to account for differences in marginal utility of income (see Chapter 7).

While some advocate using BCA to make decisions for normative reasons, in practice it is rarely, if ever, the sole basis for policy choices. Rather its appeal is that it helps decision-makers and other stakeholders recognize and balance the desirable and undesirable consequences of a policy.

Another justification is that BCA can be used as a procedure to help decision-makers recognize and balance the multiple desirable and undesirable consequences of a policy. Instead attempting to aggregate multiple factors informally and holistically runs the risk that decisions will be inconsistent and overly sensitive to factors that appear highly salient. Perhaps the most modest justification is that BCA provides a method of organizing and summarizing information about possible policy consequences and their likely magnitudes.

Each of these justifications has some merits and some drawbacks. In general, these guidelines subscribe to the view that BCA provides useful information for decision-making but its results should not be the sole determinant of these decisions. As noted earlier, both the iDSI Reference Case and the discussion in these guidelines recognize that other types of information are necessary to support sound choices.

Conceptually, we focus on the standard economic-welfare conception of BCA throughout these guidelines. While other frameworks are possible, none are as well-established and the research necessary for their implementation is generally limited or unavailable. For example, as discussed in Chapter 7, some argue that social welfare functions should be used to evaluate both the distribution and

the magnitude of impacts. However, substantial additional work is needed to determine how to best implement this approach and to ensure it will be widely-accepted and used.

### 1.3.2 Individual Preferences and Aggregation

BCA is based on two fundamental elements: the notion that each individual is the best (or the most legitimate) judge of how a change in policy or other circumstances affects his or her wellbeing, and a method to compare improvements for some people against harms (or forgone improvements) to others.

The first element focuses attention on how consequences affect an individual's overall wellbeing, typically summarized by an individual's utility. In principle, utility can be affected by many factors that may be important to an individual. These include not only consumption of goods and services, but also health, satisfaction with one's life, happiness, and factors with which the individual may have no direct experience, such as knowing that certain wild ecosystems persist. A policy improves an individual's wellbeing if and only if its benefits to the individual exceed its opportunity costs to the individual (i.e., the greatest benefits the individual could obtain by redeploying the costs he or she bears).

The second element addresses the question, "under what circumstances is it appropriate to adopt a policy that enhances the wellbeing of some individuals while at the same time diminishing the wellbeing of others?" BCA answers this question using the Kaldor-Hicks potential compensation test. The test is based on the assumption that if the money value of the improvement to individuals whose wellbeing is enhanced exceeds the money value of the decrement to individuals whose wellbeing is diminished, then the policy is a social improvement. In accordance with the first element, money values of increments and decrements are judged by the affected individuals. This situation can be described as one in which the net benefits (defined as the population sum of individuals' benefits minus costs, or equivalently as the population sum of benefits minus the population sum of costs) are positive; i.e., the benefit-cost ratio is greater than 1.0.

BCA reflects two fundamental elements: the notion that each individual is the best (or most legitimate) judge of how a policy affects his or her wellbeing, and the notion that the sum of benefits and harms across individuals appropriately measures the policy's impact on social welfare. The distribution of the impacts (e.g., across rich and poor individuals) is addressed separately.

The logic of the compensation test is that if the net benefits are positive, the individuals who benefit could in principle compensate (with money) the individuals who are harmed. The result would be that everyone would judge himself or herself better off with the policy and receipt of compensation than without the policy and compensation. The policy creates a "potential Pareto improvement." Compensating the people who are harmed converts the outcome to a Pareto improvement, defined as a change such that everyone is better off (or at least not worse off) than without the change.

Several objections to BCA can be raised. Some concern the first element (that evaluation should rely on individuals' judgments of their own wellbeing) and some concern the second (the method of comparing changes in wellbeing between people).



On the first element, one may question whether individuals are the best judges of how a policy affects their wellbeing. Obviously, individuals must be informed about the effects of the policy and able to evaluate them; for this reason, children's and cognitively-impaired adults' evaluations are typically not considered to be relevant. Given limits on available time and knowledge, individuals might reasonably delegate to government or others the task of predicting the effects of a policy and evaluating whether it improves or reduces their wellbeing. Another concern is that individuals often make poor forecasts about how a change in circumstance will affect their wellbeing and behave in ways that are not in their own self-interest, even as self-assessed. This issue is explored extensively in behavioral economics research and is another reason why individuals might delegate evaluation to others.

BCA provides useful information regardless of whether one agrees with its normative underpinnings. In some cases, it may be sensible to depart from the standard assumptions. For example, analysts typically rely on adults to estimate values for benefits that accrue to children, given concerns about children's cognitive capacity and their lack of control over financial resources. In addition, as discussed throughout these guidelines, BCA should be accompanied by information on the distribution of the impacts.

In addition, the conception of wellbeing tends to be self-interested, taking little account of the interactions in wellbeing between individuals. The way in which BCA should incorporate altruism is subtle and not fully resolved; in part, it depends on whether the altruism is "pure" (the altruist cares only about other people's self-assessed wellbeing) or "paternalistic" (the altruist cares about some aspects of other people's wellbeing such as their health, but not about other aspects such as the pleasure or satisfaction they obtain from an unhealthful activity like eating dessert). An alternative justification is that individuals are the "most legitimate" judge of the effects of a policy on their own wellbeing. It could be argued that social decisions should defer to the individual's judgment to respect autonomy, even if the individual was not a particularly good judge of how a policy would affect his or her wellbeing.

The second element is the method for aggregating increases and decreases in wellbeing across a population. A fundamental difficulty is that there is no universally accepted method for comparing the effects of a change in circumstances (e.g., consumption, health) on different people's wellbeing. BCA circumvents this problem by using monetary values as an interpersonally comparable measure. This approach can lead to a systematic bias: the money measure of any change in circumstance is likely to be larger for a rich person than a poor one, because the rich person is less constrained in his spending. In practice, this bias may not arise because it is common to use the same monetary values for consequences for all individuals within a society. If the conceptual framework is followed literally, however, one might estimate and apply monetary values for each individual, with the possible result that the population sum of money values of wellbeing will be increased more by providing a health or other improvement to a rich person than a poor one.

The statement in the Kaldor-Hicks compensation test that payment could be made "in principle" includes the assumptions that collecting and making the payment would not impose administrative costs or change behavior. For example, compensation would not be raised through income taxes that discourage paid work. A standard response to the recognition that these assumptions are unrealistic is

to suggest that, if the allocation of wellbeing in society is viewed as inequitable or undesirable, reallocation can be accomplished at less cost by changing taxation and social support systems rather than by altering policies that are primarily directed toward other objectives.

Given the difficulties inherent in making these types of adjustments, however, it is generally desirable to include information on distribution along with the analysis of benefits and costs (see Chapters 2 and 7), for consideration by decision-makers and other stakeholders. Those involved in the decision-making process can then determine whether the distributional effects are significant, and, if so, how to best address them.

#### **1.4 Overview of Subsequent Chapters**

In the following chapters, we first discuss the BCA components in more detail. We next provide specific guidance on particular analytic components, building on the series of methods papers commissioned for this project. We then turn to cross-cutting issues, including accounting for uncertainty and presenting the results. These guidelines conclude with a glossary and list of references, supplemented by appendices that provide more detailed information on selected topics. Our goal is to provide practical guidance that can be feasibly implemented given the data and resources now available to analysts in low- and middle-income countries, as well as references for those interested in further exploring these topics.

Ultimately, these guidelines are intended to aid analysts, decision-makers, and other stakeholders in understanding the implications of different methodological choices; in developing high quality analyses that are consistent and comparable; and in clearly communicating the results and their implications.

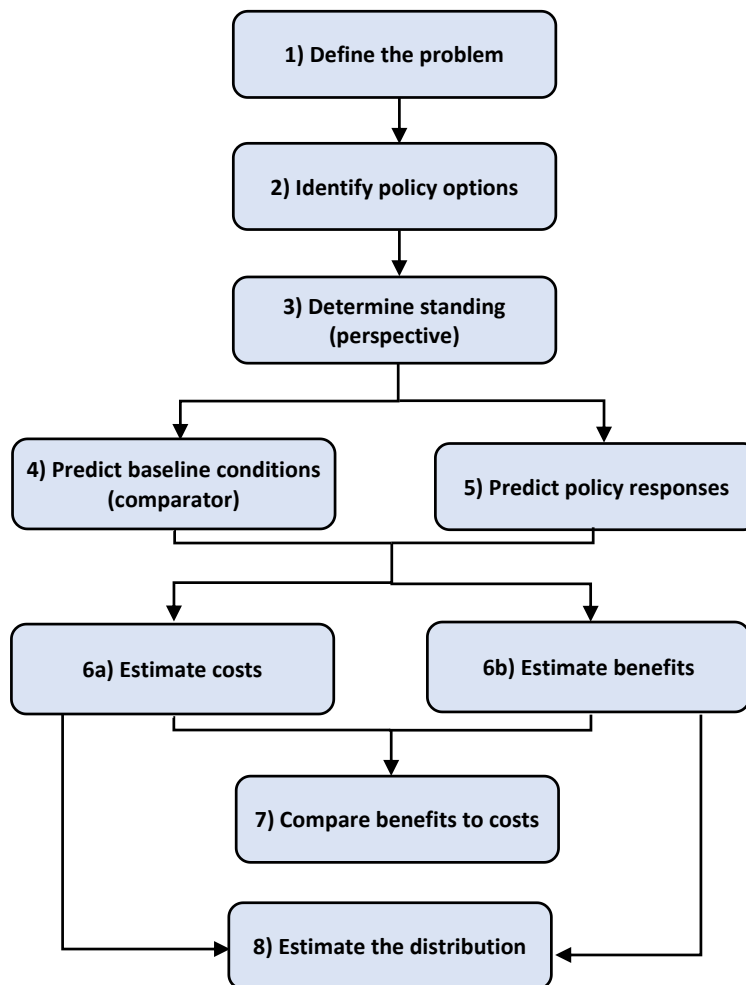
# Chapter 2. General Approach

To frame the discussion in the following chapters, we begin by describing the components of a BCA, discussing the overall approach to the analysis, and introducing the methods used to estimate monetary values.

## 2.1 BCA Components

As conventionally conducted, BCA consists of seven basic components; distributional analysis is a desirable eighth component, as illustrated in Figure 2.1. While shown as if it were a sequential process, in reality these steps are iterative. As analysts acquire additional information and review their preliminary findings, they often revisit and revise earlier decisions to reflect improved understanding of the issues. Each of these steps should involve appropriate consideration of uncertainty as well as non-quantified effects.

**Figure 2.1: BCA Components**



We briefly introduce each component below then discuss some general implementation issues. For simplicity, this overview generally assumes the BCA is conducted from a prospective, *ex ante* perspective, before the policy is implemented. It may also be conducted from a retrospective, *ex post* perspective, after the impacts of the policy have materialized, to compare the results to what would likely have occurred in the absence of the policy.

**(1) Define the problem:** BCA is often motivated by a specific problem or policy goal, which may be identified by the analyst, a policymaker, or others. This may, for example, involve a desire to prevent the transmission of malaria, reduce the prevalence of waterborne diseases, improve agricultural production, enhance educational attainment, or increase infant survival rates. BCA may also be used to aid in prioritizing spending across policies to be implemented in one or in several sectors. For example, it may be used to rank policies focused on reducing environmental health risks, including those that address contamination of the air, water, or land. It also may be used to rank policies across multiple sectors, including health care, agriculture, education, transportation, nutrition, sanitation, environmental quality, and others. BCA may be designed to inform a decision within a particular location or across locations in one or numerous countries. Whatever the goal, the analysis should comprehensively address all significant consequences.

**(2) Identify policy options:** While many studies only assess a single option for addressing the problem, considering several reasonable alternatives is preferable. Evaluating only one option can lead decision-makers to ignore others that may be more cost-beneficial.

**(3) Determine who has standing (perspective):** Standing refers to identifying whose benefits and costs will be counted. The analysis may, for example, consider impacts on only those who reside or work in a specific country or region, or may address international impacts. This concept is related to the concept of “perspective” in CEA. For example, a CEA may be conducted from the societal perspective, in which case all impacts are included, or from the perspective of the health care sector, in which case only the impacts on that sector are considered.

When the question of standing or perspective raises difficult issues, it is often useful to report the results at different levels of aggregation rather than trying to fully resolve these issues prior to conducting the analysis. For example, the results could be reported for a specific region, for the country as a whole, and at the global level, or for the health care system alone and for society at-large. Providing disaggregated results also aids in comparing across analyses, allowing researchers to evaluate the extent to which differences in how standing is defined influence the results.

**(4) Predict baseline conditions (comparator):** In prospective BCA, each policy option is typically compared to a “no action” baseline that reflects predicted future conditions in the absence of the policy, although other comparators may at times be used. The baseline should reflect expected changes in the status quo. For example, the health of the population and its size and composition may be changing, and the economy may be evolving, in ways that will affect the incremental impact of a policy.

In retrospective BCA, the analysis is performed after the impacts of the policy have materialized. The challenge in this case is to separate the impacts of the policy from the impacts of other factors such as changes in the population, economy, or other policies, so as to understand what would have occurred in the absence of the policy of interest.

**(5) Predict policy responses:** This component involves predicting the impacts of each option in comparison to the baseline or other comparator. One challenge is ensuring that changes likely to occur under the baseline are not inappropriately attributed to the policy; another is understanding the causal pathway that links the policy to the outcomes of concern. The goal is to represent the policy impacts as realistically as possible, taking into account real-world behavior.

These impacts should be described both qualitatively and quantitatively, comparing predictions under baseline conditions to predictions under the policy. Related measures should include, at minimum, estimates of the expected number of individuals and entities affected in each year, along with information on their characteristics. For policies that affect health and longevity, the expected number of deaths and cases of illness, injuries, or other disabilities averted in each year should also be reported.

This component focuses on the physical impacts attributable to the policy; the following component focuses on monetary valuation. For example, the policy may lead to changes in behavior (such as safer driving habits) which are expected to lead to changes in health and longevity (such as fewer injuries and deaths due to motor vehicle accidents). The monetary costs and benefits of these changes would be estimated under component 6.

**(6) Estimate costs and benefits:** Whether a consequence is categorized as a “cost” or “benefit” is arbitrary and varies across BCAs. However, consistent categorization is essential for comparability. As long as the sign is correct (positive or negative), the categorization of an impact as a cost or a benefit will not affect the estimate of net benefits, but will affect the benefit-cost ratio. If impacts are categorized inconsistently, total costs and total benefits as well as their ratio cannot be meaningfully compared.

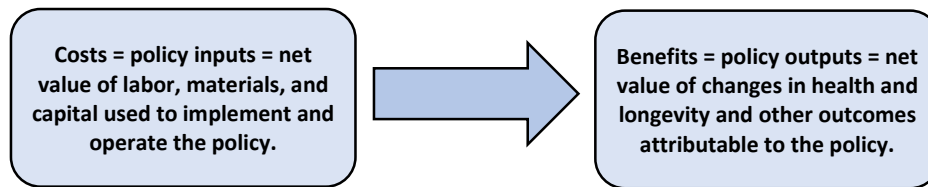
One intuitively appealing option, which we follow in these guidelines, is to distinguish between inputs and outputs. Under this scheme, costs are the required inputs or investments needed to implement and operate the policy – including real resource expenditures such as labor and materials, regardless of whether these are incurred by government, private or nonprofit

organizations, or individuals. Benefits are then the outputs or outcomes of the policy; i.e., changes in welfare such as reduced risk of death, illness, or injury.

Under this framework, counterbalancing effects should be assigned to the same category as the impact they offset. For example, “costs” might include expenditures on improved technology as well as any cost-savings that result from its use; “benefits” might include the reduction in disease incidence as well as any offsetting risks, such as adverse reactions to medications or post-surgical infections.

This categorization is illustrated in Figure 2.2.

**Figure 2.2: Categorization of Impacts as Costs or Benefits**



*(6a) Estimate costs:* When estimating costs, analysts typically concentrate on the reallocation of resources required to implement the policy; i.e., the opportunity costs of using labor, materials, and other resources to carry out the policy rather than for other purposes. These costs may be incurred by private enterprises, government agencies, nongovernmental organizations, other nonprofits, or individuals. Analysts often estimate direct costs based on market prices, although at times these prices may need adjustment to better reflect opportunity costs.<sup>10</sup>

For some policies, the impacts may be large enough to significantly affect these prices, in which case the effects on market supply and demand also should be considered. These guidelines do not address methods for assessing these effects in detail. However, a number of approaches are available that can be applied to estimate these impacts. For example, computable general equilibrium models can be used to estimate economy-wide effects, as discussed in Strzepek et al. (2018) and Neumann et al. (2018).

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<sup>10</sup> Estimating costs involves addressing a number of difficult issues, particularly in cases where markets are distorted. These issues are outside the scope of these guidelines, but are addressed by the iDSI Reference Case and Global Health Cost Consortium referenced earlier as well as other ongoing efforts. Analysts may also wish to review texts such as Boardman et al. (2018) and Drummond et al. (2015).

*(6b) Estimate benefits:* When estimating benefits, prices generally can be used to value marketed goods or services, such as increased agricultural yields or labor market participation. However, improved health and longevity as well as environmental quality and changes in the use of unpaid time require the application of nonmarket valuation methods, as introduced later in this chapter and discussed in more detail in Chapters 4 through 6.<sup>11</sup>

**(7) Compare benefits to costs:** The final step in a BCA involves comparing costs and benefits. As part of this calculation, future year impacts are typically discounted to reflect time preferences as well as the opportunity costs of investments made in different periods. This discounting reflects the general desire to receive benefits early and to defer costs. The monetary value of benefits and costs should be discounted at the same rate, as discussed in more detail in Chapter 3.

The results are often reported as net benefits (benefits minus costs); ratios or rates of return may also be reported. As discussed under component (6) above, consistent approaches should be used to categorize impacts as benefits or costs across analyses to facilitate meaningful comparisons. We return to the selection of summary measures in Chapter 9.

**(8) Estimate the distribution of impacts:** While often considered to be outside the BCA framework, the distribution of the impacts is frequently important to decision-makers and other stakeholders and should be considered throughout the analytic process. At minimum, the analysis should describe how both costs and benefits are likely to be allocated across income and other groups (see Chapter 7).

Each of these components should include appropriate consideration of uncertainty, including non-quantified effects (see Chapter 8 as well as the recommendations for uncertainty analysis in the preceding chapters). In summarizing the results, analysts should address the extent to which these uncertainties affect the likelihood that a particular policy yields positive net benefits and the relative ranking of the policy options.

Because analytic resources are limited, the ideal analysis will not assess all policy options, nor quantify all outcomes, with equal precision. In some cases, the cost of analyzing a particular policy option or quantifying a specific outcome will be greater than the likely benefit of assessing it, given its importance for decision-making. In other words, the analysis may not sufficiently improve the basis for decision-making to pass an informal benefit-cost or value-of-information test. Conversely, options and outcomes that are important for decision-making should receive substantial attention.

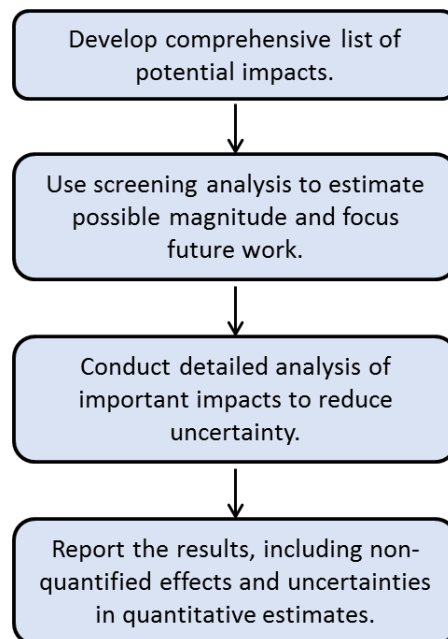
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<sup>11</sup> Based on the results of our initial scoping work and review of the literature, these guidelines provide specific guidance on benefits for which values are often needed, that can be estimated based on substantial empirical research. The guidelines are supplemented by innovative work that addresses the financial risk protection provided by health insurance (Skinner et al. 2019); an important benefit that has not been addressed in previous work. We expect the guidelines will be expanded over time to address additional types of benefits.

## 2.2 Sequencing the Analysis

To implement the BCA framework, analysts should begin by listing all potential costs, benefits, and other impacts, then use screening analysis to identify the impacts most in need of further investigation as illustrated in Figure 2.3. Screening analysis relies on easily-accessible information and simple assumptions to provide preliminary insights into the direction and magnitude of effects. For example, upper-bound estimates of parameter values can be used to determine whether particular impacts may be significant. Screening aids analysts in justifying decisions to exclude impacts from more detailed assessment and in determining where additional research is most needed to reduce uncertainty. It also provides data that can be used to indicate the rough magnitude of those impacts that are not assessed in detail.

**Figure 2.3: Implementation Steps**



To provide useful information for decision-making, analysts should quantify all potentially significant benefits and costs to the greatest extent possible. In this context, “significant” should be defined to include impacts that are large enough to affect the determination of whether benefits are likely to exceed costs. It should also include smaller impacts that are of interest to decision-makers and other stakeholders for reasons other than their magnitude.

For impacts not subject to detailed assessment, analysts should report the results of the screening analysis even if it is only possible to express the results as wide ranges. If it is not feasible to quantify the impact even using a range of estimates, analysts should describe the impact and its likely direction and magnitude qualitatively. In the absence of such information, decision-makers and other stakeholders may weight non-quantified effects in a manner consistent with their own (unarticulated and perhaps unconscious) beliefs, without sufficiently probing the rationale or the weighting.



## 2.3 Estimating Monetary Values

The major difference between the BCA framework discussed above and the approach followed in CEA relates to the use of monetary measures to value all outcomes. Estimates of benefits and costs are typically based on any of four basic methods: market prices, revealed preferences, stated preferences, and economic experiments. The principle distinction is between revealed-preference methods, which use people's behavior in situations with significant consequences to infer their preferences; and stated-preference methods, which use people's responses to survey questions that lack significant consequences. The market-price approach also provides a revealed-preference estimate because buyers and sellers face real consequences that are affected by these prices. Economic experiments have some characteristics of revealed-preference and some characteristics of stated-preference approaches.

One issue that arises is whether values should be based on individual willingness to pay (WTP) or willingness to accept (WTA) compensation. For a beneficial outcome, WTP represents the maximum amount of money an individual would be willing to give up in exchange for the amenity (e.g., for reduction in the risk of dying in the current year); WTA represents the minimum amount the individual would need to be paid to forgo, rather than gain, the improvement. Typically, analysts rely on estimates of WTP rather than WTA to value beneficial consequences, in part because policy options usually provide improvements from the status quo. In addition, WTP is more frequently studied and the estimates are generally considered more reliable; the reasons for the large and variable differences between estimated WTP and WTA are not well understood. WTP and WTA also can be used to value harmful changes, in which case WTP is the maximum an individual would pay to avoid the harm and WTA is the minimum he or she would require to accept the harm.

**Market Prices:** When the consequence to be valued is exchanged in markets (such as increased production of agricultural goods), the market price can provide a useful estimate of its value. In a competitive market (described below), individuals who purchase the good can be inferred to value it at a rate higher than the price per unit they must pay; if not, they should not buy it. Similarly, individuals who do not buy the good can be inferred to value it at a rate lower than the price. For potential sellers who own the good, those who sell can be inferred to value the good less than the price they receive and those who do not can be inferred to value it more than the price. The market price does not provide an exact estimate of any individual's monetary value for the good, but it provides a lower bound for the values of individuals who buy (or hold) it and an upper bound for individuals who do not buy (or sell) it. When using market prices to estimate monetary values, one must consider any factors that produce a difference between the full cost and the market price, such as the cost of traveling to purchase the good or service.

While values based on market-prices are often preferable because they are derived from behaviors with real consequences, market-based estimates are not available for some important outcomes. In these cases, stated-preference research is needed to estimate values. Such research must be carefully designed to encourage valid responses.

A competitive market is one in which individual buyers and sellers cannot influence the price, as when there are many parties on both sides. When there is only one or a few sellers (monopoly or oligopoly), the seller can demand a price that is higher than the cost of the resources needed to produce the good. In this case, the price would not be a good estimate of the value of the resources used to produce the good, but it is still a useful estimate of the value to buyers; as in a competitive market, buyers can be inferred to value the good more than the price and non-buyers to value it less. When there is only one buyer (monopsony) or relatively few buyers, sellers may be pressured to reduce prices below the levels in a more competitive market.

**Revealed Preferences:** When the consequence to be valued is not exchanged directly in markets, it may be exchanged indirectly in the sense that it is bundled with other goods or services. In this case, it may be possible to estimate the value of the consequence by using statistical methods to estimate the relationship between the market price and the monetary value of the consequence, controlling for potential confounders.

The revealed-preference approach derives values by conceiving goods as bundles of attribute levels. For example, it is often used to estimate the monetary value of mortality risk reductions, as illustrated in Figure 2.4 and discussed in Chapter 4. From the worker's perspective, a job can be viewed as a set of tasks, working conditions, health risks, future opportunities, a wage rate, and other factors. When choosing among alternative jobs for which he or she is qualified, the worker can be viewed as comparing the desirable and undesirable features and choosing the job offering the most attractive combination. By using data on job characteristics and wages, researchers can estimate how the wage varies across jobs presenting different fatality risks, controlling for other job and worker characteristics. These studies find that, holding other factors constant, jobs that are more risky pay higher wages.

**Figure 2.4: Revealed-Preference Example**

When choosing among available jobs, workers presumably select the option that offers the combination of desirable and undesirable characteristics that best aligns with their preferences. In wage-risk (hedonic wage) studies, economists use these choices to estimate the value of mortality risk reductions. They match data on job-related fatality rates to data on wages and other worker characteristics by occupation and industry. Statistical techniques are then used to estimate the relationship of changes in wages to changes in fatality risk, controlling for the effects of other personal and job characteristics (see *Viscusi 2013*).

**Stated Preferences:** Stated-preference studies ask individuals what choice they would make in a hypothetical situation, as illustrated in Figure 2.5. For example, individuals can be surveyed about which of several jobs they would choose, given differences in wages, fatality risks, and perhaps other factors. Typically, questions are presented as discrete choices between a small number of alternatives, often two but sometimes three or four. The interpretation of an individual's choice is similar to the interpretation of market prices and the results of revealed-preference studies: the individual is assumed to prefer the option he or she chooses to the available alternatives. At times, stated-preference studies ask respondents to state the maximum additional price they would pay for one good compared with another. However, this "open-ended" format is more difficult to answer and invites individuals to

respond strategically; they may respond as in a negotiation rather than accurately revealing the value they place on the outcome.

**Figure 2.5: Stated-Preference Example**

In stated-preference surveys, economists ask questions such as the following.

“Now I would like to ask you a question about your willingness to pay money for a new safety device that can be installed in cars to protect drivers. It works like an airbag but protects drivers in a side impact rather than in a head-on crash. This device is well tested, safe and reliable. ... Thus, by adding a side-impact airbag, your [yearly chance of dying in a crash] is reduced from 2 in 10,000 to 1.5 in 10,000.

If this device were offered as an option on the next car you buy, would you be willing to pay \$100 more per year in car payments for five years to have this device in your car?” (from Corso, Hammitt, and Graham 2001)

Compared with revealed-preferences, the stated-preference approach has the advantage that one can ask about whatever consequences are relevant; there is no need to identify situations in which the consequence of interest is affected by observable individual choice. For example, the researcher can ask about hypothetical goods or medical treatments that may not yet exist. In addition, the researcher can tailor the sample to represent the population of interest; with revealed preferences, some choices are made by only certain members of the population (e.g., only labor market participants select among jobs). A further advantage is that researchers can specify the alternatives from which the respondent must choose and can provide information about the relevant attributes of the goods. With revealed-preference research, researchers usually cannot know which alternatives an individual considered and what information the individual had about the attributes.

The most important disadvantage of stated-preference methods is that the choices are hypothetical and the respondent faces no significant consequences from his or her response. Hence there is little need for a respondent to think carefully about what he or she would choose in a real situation, or to report accurately. Moreover, the respondent has little incentive (or opportunity) to seek additional information or consult with other people, and so his or her response may be less informed than for a consequential choice. This means that such surveys must be carefully designed and administered to provide reasonably valid results, taking into account the substantial research that has been conducted on best practices.<sup>12</sup>

Empirical evidence suggests that, when both stated-preference and revealed-preference estimates are obtained for the same outcome, there is often good correspondence. However, there are many cases in which stated-preference estimates seem to deviate from the predictions of conventional economic theory, which causes some observers to doubt their validity. For example, some studies of mortality risk reductions find that individuals are not willing to pay noticeably more for larger risk reductions. Yet there are also important examples of consequential behavior that deviate from standard predictions, as chronicled in behavioral economics (e.g., the large difference in enrollment between “opt-in” and “opt-out” retirement plans). For example, individuals often demonstrate that they place larger values on changes that are framed as losses than those that are framed as gains of the same magnitude. Thus

<sup>12</sup> See, for example, Johnston et al. (2017).

relying on revealed preferences does not necessarily eliminate the need to consider the correspondence between actual choices and preferences; i.e., with what an individual perceives as being most consistent with his or her own welfare, given reasonable knowledge and careful reflection.<sup>13</sup>

**Economic Experiments:** Economic experiments have characteristics of both revealed- and stated-preference approaches. In an experiment, individuals are asked to participate in an artificial (laboratory) environment, in which they make multiple economic choices. The set of choices and the information about them are controlled by the experimenter as in stated-preference studies. In general, these choices have real consequences as the individuals are paid to participate and their pay depends on their behavior, as in revealed-preference studies. However, the range of possible payments is often quite modest. Moreover, because the environment is artificial, some question how well behavior in the laboratory predicts behavior in the field; for examples, subjects may treat the money used in the experiment differently than their own money.

Often there are few or no studies of any type that estimate the monetary values for many of the consequences of concern to the relevant population. In practice, analysts extrapolate estimates of costs and benefits from contexts in which they are available to the context of the analysis, a process known as “value transfer.” For example, cost estimates may be transferred from a different country or time period, or derived from engineering estimates rather than market data. For benefits, this value transfer process is typically referenced as “benefit transfer.”

In almost any type of policy evaluation, analysts transfer estimates from research conducted in different settings at different times to the policy context. For example, survival rates may be transferred from research conducted in a particular health care facility in a previous time period to estimate future survival rates among the national population, adjusting for differences in these populations to the extent possible. When estimating benefit values, this approach is typically described as “value transfer” or “benefit transfer.”

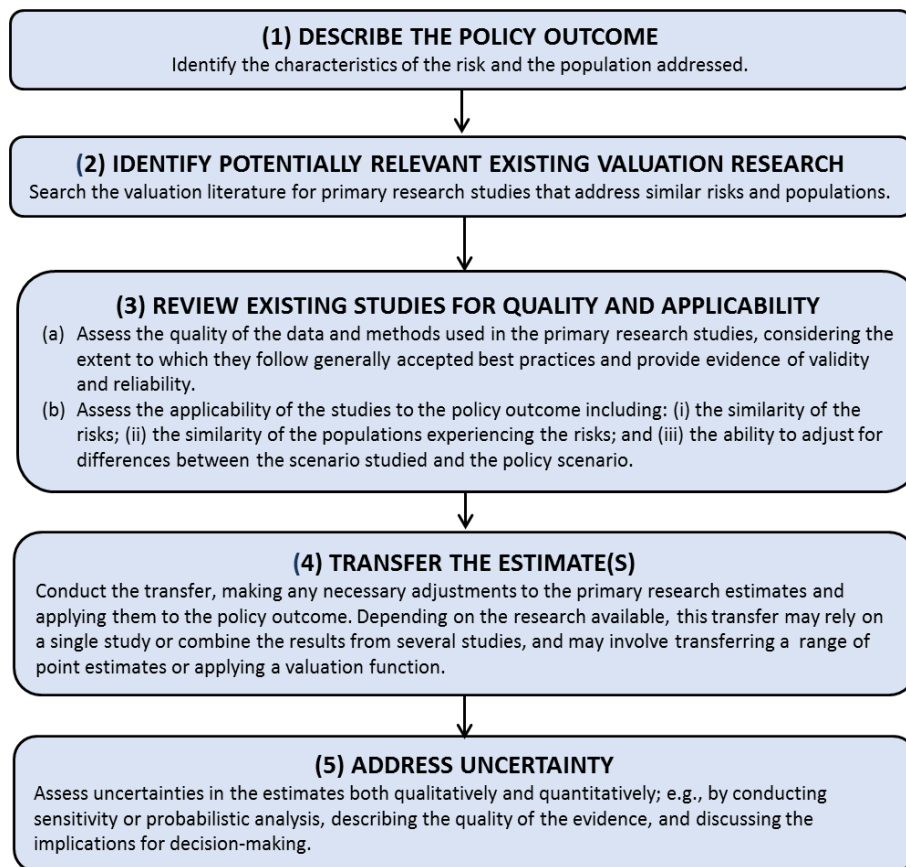
These processes require informed judgment about the quality of the available estimates (which depends in part on the methods used and the rigor with which they were applied) and on the similarity between the context in which the estimates were obtained and the context to which they will be applied (which depends in part on the similarity of the consequences and of the populations). Often, value transfer includes adjusting the original estimates for relevant differences between the study and application context, such as differences in income between the two populations.

Figure 2.6 illustrates the value transfer process in the case of a benefit. Similar to the approach used to estimate almost any parameter in policy analysis, such transfers involve carefully reviewing the literature to identify high-quality studies that are suitable for application in a particular context and clearly addressing the implications of related uncertainties. In some cases, these uncertainties may have relatively little effect on the conclusion that a policy is, or is not, cost-beneficial. In other cases, these uncertainties may have a more profound effect.

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<sup>13</sup> The implications of behavioral economics for the conduct of BCA are explored further in Robinson and Hammitt (2011) and Weimer (2017).

**Figure 2.6: Benefit Transfer Process**



Value transfer often requires significant judgment on the part of the analyst given the complexity of the issues, the limited number of studies available, and the lack of consistent reporting standards for valuation research. As a result, careful documentation of the approach and discussion of its limitations is essential. In the following chapters, we discuss how these approaches can be used to value changes in mortality and morbidity risks as well as changes in time use, after first addressing issues related to translating values across currencies and over time.

# Chapter 3. Comparing Values Across Countries and Over Time

Assessing policy options often requires translating monetary values across currencies and over time. The iDSI Reference Case (NICE International 2014, Wilkinson et al. 2016), and the Global Health Cost Consortium guidance (Vassall et al. 2017), each provide recommendations on addressing these issues when estimating costs, focusing on policies intended to improve health and longevity in low- and middle-income countries. In this chapter, we supplement those discussions to include the monetary valuation of benefits. However, because benefits and costs must ultimately be compared, it is impossible to completely divorce consideration of the approaches used for costs from the approaches used for benefits. Thus the discussion in this chapter has implications for costing as well.

In this chapter as well as throughout these guidelines, we assume that BCAs conducted in low- and middle-income countries have two objectives:

- 1) To support within-country policy choices, which suggests results should be measured in the local currency; and
- 2) to allow cross-country comparisons, which suggests results should be measured in a common currency.

The first objective means that all benefits and costs should be measured in a way that is consistent with local conditions, including the preferences of those affected and the opportunity costs of the policy. The second objective means the analytic results (total costs and total benefits) should be converted into a widely-used and internationally-comparable currency. Which approach is most appropriate will depend on the goals of the analysis and the context in which it is conducted.

We address three conversions necessary to meet these objectives: (a) inflation adjustments to account for economy-wide price changes, (b) exchange rates to reflect the relative value of different currencies, and (c) discounting procedures to incorporate time preferences. We focus on defaults that analysts can use either in developing their primary estimates or in sensitivity analysis, to allow comparability with other analyses conducted within and across countries. We also emphasize the need to report the data and the methods used in enough detail for others to convert the values to different currencies or different years. As elsewhere in these guidelines, our recommendations are intended to provide options that can be implemented by analysts working in low- and middle-income countries, based on data they can easily access. However, the concepts and general approaches are also applicable to analyses conducted in higher-income settings.

## 3.1 Inflation Adjustments

When prices rise throughout the economy, monetary values in different years are not necessarily comparable. If there is inflation, the quantity of goods one can buy per monetary unit (e.g., for \$1.00)

decreases over time. Conversely, deflation means that the amount one can buy increases.<sup>14</sup> Thus the first step in estimating values is to convert all values to a single currency year. This is typically at least one year before the year when the analysis is conducted, because inflation data will not yet be available for the current year.

We use the term “currency year” rather than “base year” when discussing the treatment of inflation, to avoid confusion with the “base year” referenced in the discussion of discounting. When discounting to calculate present or annualized values, the “base year” should be the first year in which the policy is implemented; i.e., when costs or benefits first begin to accrue, assuming the analysis is prospective. Thus the base year when discounting will be a future year rather than the past year used in the inflation adjustments.

If an economy is affected by inflation but there is no change in relative prices, all prices will rise but the rates of exchange across goods and services will not be altered. To focus attention on real changes in value, all monetary values should first be adjusted to a single currency year. All future values should be measured in the same year currency.

Once values are adjusted to the same currency year, all estimates should be reported in real terms. For example, if the currency year is 2018 and the analysis projects changes in income through the year 2028, the projections should be measured in 2018 currency and include only real increases or decreases in value. Real (constant or inflation-adjusted) values net-out the effect of inflation so that monetary units have equal purchasing power over time and are comparable across different periods. Working in real terms avoids the difficulties associated with predicting future inflation and allows analysts and stakeholders to focus on changes in real value.<sup>15</sup> Prices observed in the marketplace are measured in nominal (current-year) units; working instead with real values based in a single currency year avoids misleading comparisons.<sup>16</sup>

Typically either a gross domestic product (GDP) deflator or a consumer price index (CPI) is used to adjust for inflation over a specified time period. The GDP deflator measures the change in the price level for all domestically-produced final goods and services in a country. The CPI measures the change in the price level for a market basket of consumer goods and services. The World Bank reports CPIs and GDP deflators for 217 countries.<sup>17,18</sup>

Because benefits, such as the changes in mortality or morbidity risks discussed in Chapters 4 and 5, are presumably consumed by the local population, the CPI seems to provide the appropriate adjustment.

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<sup>14</sup> In these guidelines, we assume that inflation or deflation is not significant enough to have detrimental effects on the economy that need to be taken into account in the analysis.

<sup>15</sup> This does not imply that values should be constant over time. Real values may change as a result of changes in the technology available and in productivity more generally as well as other economic factors.

<sup>16</sup> We discuss adjusting the value of mortality risk reductions and nonfatal risks reductions for changes in real income in Chapters 4 and 5. Similarly, other values should be adjusted to reflect expected real changes to the extent possible.

<sup>17</sup> For CPIs using 2010 as the base year, see <https://data.worldbank.org/indicator/FP.CPI.TOTL>.

<sup>18</sup> For GDP deflators, the base year varies; see <https://data.worldbank.org/indicator/NY.GDP.DEFL.ZS>.

For costs, the appropriate deflator may depend on whether the good is produced locally or elsewhere. Analysts should consult the iDSI and Global Health Cost Consortium reference cases for guidance on inflating costs.<sup>19</sup>

When a BCA relies on cost or benefit values originally estimated in another currency, analysts must also determine how to sequence the inflation adjustments and the currency conversions. The analyst faces two options: to first inflate the value in the original source-country currency to the common currency year then convert to the target currency, or to first convert the value to the target currency then inflate to the currency year using the target-country index. These alternatives may not produce the same result. Because the values reflect production and consumption opportunities in the country from which they are derived, it seems sensible to first inflate in the original currency and then convert the resulting value into the target currency.

### 3.2 Currency Conversions

As noted in the introduction to this chapter, often analyses are intended to inform decisions in an individual country, in which case benefit and cost estimates should reflect local conditions and be measured in local currency.<sup>20</sup> However, if values for some impacts are not available for the target country, it may be necessary to convert a value measured in a different currency. In addition, to support comparisons across countries and across analyses, the resulting estimates of total costs and total benefits also should be converted into internationally comparable units. Often, U.S. dollars or international dollars are used for this purpose.

If values must be both inflated and converted to another currency, they should first be inflated to the currency year using an index for the country in which they originated, then converted to the other currency.

Two frequently used conversion methods are: (1) market exchange rates; and (2) purchasing power parity. The first reflects market demand and supply for different currencies, the latter is an index designed to represent what money can purchase in different economies, measured in international dollars.<sup>21</sup> In the country of concern, an international dollar would buy a comparable quantity of goods and services as a U.S. dollar would buy in the United States.

To convert values from elsewhere into the local currency, the appropriate approach will depend on the characteristics of the cost or benefit. Purchasing power parity often provides the most appropriate comparison relative to other goods and services, if the cost or benefit is a non-marketed good (such as the mortality risk reductions discussed in chapter 4) or if it is a marketed good not traded outside the

<sup>19</sup> See: <http://www.idsihealth.org/resource-items/idsi-reference-case-for-economic-evaluation/> and [https://ghcosting.org/pages/standards/reference\\_case](https://ghcosting.org/pages/standards/reference_case). Standard texts, such as Boardman et al. (2018) and Drummond et al. (2015), also provide useful information.

<sup>20</sup> In countries where the local currency is particularly unstable, the approaches for assessing uncertainty described in Chapter 8 can be used to explore the implications if this instability if it is likely to affect the BCA results.

<sup>21</sup> For more information on the calculation of purchasing power parity rates, see World Bank (2017).



local context (such as local labor or the changes in daily time use discussed in chapter 6).<sup>22</sup> For market inputs that are traded outside the local context, such as globally-traded commodities like petroleum, market exchange rates likely provide a better measure of opportunity cost. Thus when converting values into the local currency, either purchasing power parity or market exchange rates should be used depending on the characteristics of the relevant market.

To compare the results across different countries, total benefits and total costs should be converted from the local currency to a standard, such as U.S. or international dollars, using the same exchange rate. Either market-exchange rates or purchasing-power parity may be suitable, depending on the objective of the comparison. Market exchange rates may be most appropriate when considering the quantity of local currency or internationally-traded goods an outside donor could provide; they are also appropriate when comparing the economic efficiency of investments across different countries.<sup>23</sup> Alternatively, if the analysis is primarily concerned with comparing the effects of projects implemented in different countries on wellbeing, purchasing power parity may be more appropriate since it better measures real consumption and wellbeing.

### 3.3 Time Preferences

Another question is how to compare real benefits and costs that accrue in different time periods (see Claxton et al. 2019 for more discussion). There are two interrelated reasons why values are not likely to be weighted equally over time. One is the opportunity cost of capital; that is, the ability to shift monetary amounts through time at a real interest rate that is usually positive. Money received now can be invested in exchange for receiving more money later; future obligations can hence be satisfied by investing a smaller amount of money now. The second reason is related: people generally prefer to receive benefits early and to pay costs later, which is part of the reason why interest rates are typically positive.

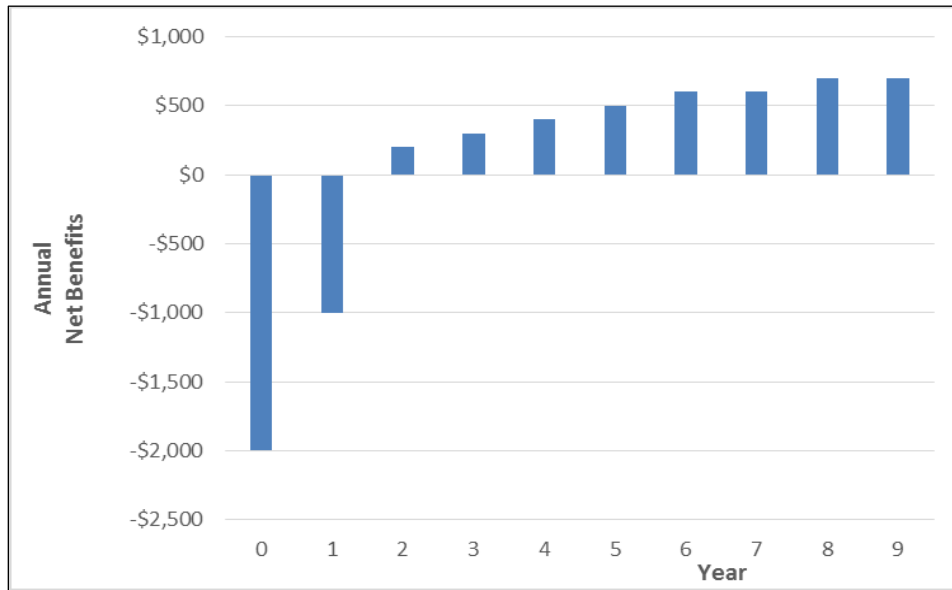
The starting point for estimating the effects of timing is to report the undiscounted costs and benefits that accrue each year. These data are used for the subsequent calculations and also aid decision-makers and other stakeholders in understanding the impacts of the policy. The allocation of impacts over time is often best communicated using a table or graphic, such as the example in Figure 3.1. The example reports net benefits; the distributions of costs and benefits by year should also be reported.

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<sup>22</sup> Purchasing power parity may not be appropriate in countries where limited price data are available or where consumption differs significantly from the mix of goods and services included in the calculations. In such cases, analysts should note related uncertainties in presenting the results.

<sup>23</sup> Assuming the goal is to explore whether the policy passes the Kaldor-Hicks potential compensation test, i.e., whether those who gain under the policy could in theory compensate those who lose (see Chapter 1), then the approach to currency conversions should reflect the likely (hypothetical) source of compensation. In cross-country comparisons, the potential compensation would presumably be arranged using market exchange rates.

**Figure 3.1: Illustrating the Distribution of Undiscounted Net Benefits Over Time**



To evaluate consequences occurring at different dates, analysts conventionally calculate the present value, defined as the value of a consequence occurring at the present time that has the same effect on wellbeing as the future consequence.<sup>24</sup> The present value is calculated by discounting the monetary value of each future consequence by a factor that depends on the date it occurs. Figure 3.2 provides the formula for calculating present values, using a constant discount rate per period. Note that if values are expressed in real terms, then a real discount rate must be used that excludes the effects of inflation.

**Figure 3.2: Calculating Present Values**

If:

- PV = present value as of the base year
- $FV_t$  = future value in the year (t) when the benefit or cost accrues
- NPV = net present value of benefits and costs combined across all time periods
- r = discount rate (annual)
- t = number of years in the future (measured from the base year) when the cost or benefit accrues
- n = number of years included in the analysis

Then the discount factor for costs or benefits that accrue at the end of year t is:

$$1/(1+r)^t$$

The present value of a future cost or benefit that accrues in year t is:

$$PV = FV (1/(1+r)^t)$$

The net present value for a stream of future benefits and costs is:

$$NPV = V_{t=0} + (FV_{t=1} / (1+r)) + (FV_{t=2} / (1+r)^2) + (FV_{t=3} / (1+r)^3) \dots (FV_{t=n} / (1+r)^n)$$

<sup>24</sup> Most handheld calculators and spreadsheet programs automate these functions. Some economics texts also provide look-up tables that report discount and annualization factors for a range of frequently-used rates.

It is often useful to also express benefits and costs on an annualized basis to facilitate comparisons across analyses that cover different time periods. The annualized value of a stream of benefits, costs, or net benefits is the constant annual amount that, if maintained for the same number of years as the initial stream, has the same present value. In other words, annualization spreads the costs, benefits, or net benefits equally over the time period, taking the discount rate into account. It is similar to amortization of a loan, in which the principal and interest are paid through a series of constant payments. Figure 3.3 provides the formula for annualization; the expression in brackets transforms a value into an annuity of  $n$  years at discount rate  $r$ . Note that applying this formula requires first estimating the present value, following the approach in Figure 3.2.

**Figure 3.3: Estimating Annualized Values**

If:

- PV = net present value of costs, benefits, or net benefits
- $r$  = discount rate (annual)
- $n$  = number of years included in the analysis
- AV = annualized value

The annualized value is:

$$AV = PV * [(r * (1 + r)^n) / ((1 + r)^n - 1)]$$

In Figure 3.4, we provide a hypothetical example that illustrates both the net present value calculation and annualization, using the same values as illustrated in Figure 3.1.

**Figure 3.4: Example of Net Present Value and Annualization**

Without discounting, the stream of net benefits accrues over time as follows:

YEAR	0	1	2	3	4	5	6	7	8	9	TOTAL
Net Benefits	(\$2,000)	(\$1,000)	\$200	\$300	\$400	\$500	\$600	\$600	\$700	\$700	\$1,000

Assuming a discount rate of 3 percent per year,\*

- The net present value is \$538;
- The annualized value is \$41.

\* See text for discussion of appropriate discount rates.

One question that arises in this context is the time horizon over which the costs and benefits should be estimated. In general, the analysis should start at the date when the policy first begins to be implemented and cover a long enough period for both its costs and benefits to fully manifest. For example, a program may need to operate for several years before its health and other effects become apparent. However, assessing policies over long time horizons requires addressing significant uncertainties regarding future impacts. Some of these uncertainties relate to the context within which the policy is implemented, such as the evolution of the population, the economy, and the health care

system. Other uncertainties relate to the program itself. For example, medical treatments implemented today to treat a disease are likely to be quite different from those available many years in the future.<sup>25</sup> For many policies, a 10 to 20 year time horizon may suffice; shorter periods should be used if the policy is expected to end sooner.<sup>26</sup>

The most difficult component of these calculations is determining the appropriate discount rate, which depends on several factors.<sup>27</sup> First, there is an opportunity cost to spending, equal to the returns forgone by not saving and investing the funds. This opportunity cost is equal to the rate of return that could be earned; for example, the interest rate associated with depositing the money in a bank account or investing in government bonds. Second, individuals often prefer to receive benefits sooner rather than later; this preference is part of the reason banks, governments, and other borrowers must pay interest to attract savings or investments from individuals. Third, the time period matters. Impacts that accrue over generations rather than within the current generation (often designated as within 30 years of the present), raise difficult issues related to intergenerational equity as well as to estimating long-term economic growth and other factors. The discount rate may be different in different periods; for example, it may be higher in periods of rapid economic growth or lower over longer time horizons. In such cases, the formula for the discount factor above describes the relationship between the discount factor and the average discount rate over the period from the present to  $t$  years in the future.

Given these concerns, analysts will often wish to feature a discount rate that reflects local conditions and the characteristics of the policy, such as its time horizon and the alternative investments likely to be displaced. For comparability to other analyses as well as to explore related uncertainties, analysis of the sensitivity of the results to alternative rates is desirable.

This sensitivity analysis should at minimum consider the impacts of applying a constant annual discount rate of 3 percent, because it is the rate frequently used in health-related economic evaluations and recommended in the iDSI Reference Case (see Principle 6 in Appendix A). This default rate is also recommended in U.S. guidance on cost-effectiveness analysis of health and medical interventions (Gold et al. 1996, Neumann et al. 2016a) and was derived in part from the rate of return on risk-free securities as well as other research. It is unclear whether time preferences in low- and middle-income countries differ from those found in this and other research targeted on high-income countries.

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<sup>25</sup> Uncertainties in these parameter values should be addressed when estimating these values (see Chapter 8 for more discussion), not by adjusting the discount rate or procedure.

<sup>26</sup> The time horizon for the analysis should not be confused with the time horizon for assessing the impact on an individual. For example, assume the policy reduces the risk of experiencing an illness that would have lifetime effects. The present value of these future effects should be taken into account in estimating the value of reducing the incidence of that illness. In other words, reducing incidence in year 1 will reduce the lifetime consequences of each incident case; the benefits estimates for year 1 should include the present value of these future (lifetime) effects. If, for example, the analytic time horizon is 10 years and the remaining life expectancy of those affected is 50 years, the present value of the change in health over the 50 years would be counted for each incident case averted in each of the 10 years.

<sup>27</sup> These and other issues are discussed in more detail in the Claxton et al. (2019) methods paper on discounting prepared for this project.

Recently, attention has shifted to rates that better reflect time preferences given the effects of changes in wealth and hence consumption opportunities for those affected by the policies especially over periods of several decades or more. In particular, Ramsey discounting reflects two factors. The first is the pure time preference for utility (welfare) gains in different periods. The second is the effects of changes in wealth on how much utility is produced by a benefit or cost measured in monetary units. Assuming diminishing marginal utility (that the effect of a dollar of consumption on utility is smaller when wealth is larger) and that wealth will grow over time, a dollar of income will have less effect on utility in a future period than the current period. This implies that future benefits and costs should be weighted less if the objective is to maximize wellbeing over time.

Under this Ramsey framework, the magnitude of the discount rate depends on the product of the rate at which marginal utility decreases with wealth and the rate at which wealth will grow, and on the rate at which utility is discounted. The growth rate is a prediction; the other two parameters depend on preferences. Using reasonable values of these terms implies that the discount rate should be twice the near-term GDP per capita growth rate.<sup>28</sup> This rate can be used as an alternative in testing the sensitivity of the analytic conclusions to different rates.<sup>29</sup>

For inter-generational effects, rates that decrease over time may also be appropriate because of uncertainty about future growth rates. Observed interest rates provide little guidance in this case, because they generally reflect returns over a shorter time horizon. Moreover, uncertainty about the discount rate implies that the average discount rate over a period decreases with the length of the period; the discount factor is not a linear function of the discount rate.

The monetary value of all consequences (both benefits and costs) occurring at the same date must be discounted by the same factor. This value is the amount of money paid or received at that time that has the same effect on wellbeing as the consequence; hence all monetary values at a common date are comparable and must be treated equivalently. This does not imply that consequences measured in non-monetary units must be discounted using the same factor. For example, if individuals become wealthier over time, the monetary value they place on a health improvement is likely to increase and the effective discount rate on health (that describes how they would trade future health for current health) is smaller than the discount rate for money.

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<sup>28</sup> Under the Ramsey framework, there is significant variation in the values recommended in the literature. The assumptions we adopt are that the pure rate of time preference (at which utility should be discounted) is zero or near-zero, and that the elasticity of marginal utility with respect to consumption is about 2. This adjustment assumes a declining marginal utility of income, an assumption that is not incorporated when evaluating effects at the same point in time or in other components of the analysis (see Chapters 1 and 7). Alternative assumptions may also be reasonable, and should be included either as the featured estimate or in sensitivity analysis where appropriate.

<sup>29</sup> Long-term GDP per capita growth rates may be found in the International Monetary Fund's World Economic Outlook reports, available at <https://www.imf.org/en/publications/weo>.

More generally, it is unclear whether future health effects (for example, as measured by life-years, QALYs, or DALYs) should be discounted at the same rate as money values. Part of the above logic for discounting monetary values is that one can shift money through time via saving or borrowing at a positive interest rate. But life years or health cannot necessarily be shifted over time, so there is no parallel argument; the appropriate approach depends on individual preferences for years lived or health experienced at different times. These preferences are uncertain and likely vary across populations and across individuals. In Chapters 4 and 5, we return to this issue and discuss the role of discounting in valuing changes in life expectancy and in using the resulting estimates to value changes in nonfatal risks.

### 3.4 Summary and Recommendations

The BCA results should be presented in both the local currency to support in-country decisions and in a common currency to support cross-country comparisons. Estimating these values requires adjusting for economy-wide inflation, for differences in currency values, and for time preferences. For each of these conversions, sufficient information should be reported to allow others to adjust the results to different currency years, currencies, or base years. These data include the estimates used as a starting point, the year in which impacts accrue, the rates used, and their sources. Review of related issues leads to the following recommendations.

- **Recommendation 3(a): Inflation and Real Changes in Value**
  - i. ***Benefits and costs should be converted to real (constant) currency units for a designated currency year using an appropriate inflation index.*** For nonmarket goods and market goods not traded internationally, the CPI for the country from which the estimate was originally derived should be used to reflect local conditions. For market goods that are traded internationally, the appropriate inflator will vary, and analysts should consult the iDSI and Global Health Cost Consortium reference cases for related guidance. Where values must be converted across currencies as well as adjusted for inflation, they should first be inflated in the original currency then converted to the target currency.
  - ii. ***Benefits and costs should be adjusted for changes in real value in future years.*** While it often may be reasonable to assume that the real value of costs and benefits will be constant over the time period addressed (excluding the effects of inflation), the analysis should take into account any significant expected changes. For example, as discussed in Chapter 4, the analysis should include the change in the value of mortality risk reductions associated with changes in real income.
  
- **Recommendation 3(b): Currency Conversions**
  - i. ***Benefits and costs should be reported in the local currency; when values are transferred across countries, purchasing power parity or market exchange rates should be used as appropriate for currency conversions.*** For benefit values estimated using nonmarket valuation methods as well as other inputs or outcomes that are not traded outside the local context, purchasing power parity should be used to convert values to the local currency. For market inputs that are traded outside the local context, market exchange rates should be used.

- ii. **Total benefits and total costs should be converted from the local currency to internationally comparable units.** To facilitate comparison to the results for analyses conducted in other contexts, total costs and total benefits also should be converted to U.S. dollars based on market exchange rates or to international dollars using purchasing power parity. Because the most appropriate measure will depend on the decision-making context, it may be useful to report both values. The exchange rate and its source should be reported, so that the estimates can be easily converted into other currencies as needed.
- **Recommendation 3(c): Discounting**
    - i. **The distribution of undiscounted costs and benefits over time should be reported.** The costs and benefits that accrue in each year should be displayed for inspection by decision-makers and other stakeholders; this information also provides the starting point for calculating discounted present values.
    - ii. **A context-specific discount rate should be used to estimate present values in the results highlighted by the authors.** The estimates of costs and benefits featured as the preferred estimates should rely on a discount rate that reflects the decision-making context, including current and potential future local economic conditions and the extent to which the impacts are assessed over an intra-generational or inter-generational time frame. For impacts that accrue to future generations; i.e., more than 30 years in the future, analysts may wish to consider rates that decline over time rather than remain constant.
    - iii. **A standardized sensitivity analysis should be presented to test the implications of different discount rates.** These rates should include:
      - a. **a constant annual rate of 3 percent**, consistent with the default recommended in the iDSI Reference Case; and
      - b. **a constant annual rate equal to twice the projected near-term GDP per capita growth rate**, as an example of following the Ramsey framework.

Sensitivity analysis is particularly important when uncertainty in the discount rate substantially influences the estimates of net benefits or the rankings of the policy options. Analysts may also wish to test the sensitivity of their results to other rates. These recommendations address monetary values; the discounting of non-monetary measures of health and longevity is discussed in chapters 4 and 5.

# Chapter 4. Valuing Mortality Risk Reductions

Increasing life expectancy is a major goal of many policies. As a result, the value of reducing mortality risk has been extensively studied and several organizations and individuals have developed recommendations for estimating these values. However, both the recommendations and the underlying research primarily address high-income settings, raising questions about the extent to which the results are applicable in low- and middle-income countries. The recommendations are also diverse, reflecting differing methodological choices as well as differing policy contexts.

In this chapter, we discuss the conceptual framework for valuing mortality risk reductions, summarize the literature review described in Robinson, Hammitt, and O’Keeffe (2018, 2019a), and provide recommendations. We focus on valuation; the expected number of deaths averted in each year should also be reported along with data on the characteristics of those affected. We address estimates applicable in low- and middle-income countries, providing estimates for each country in Appendix B. Our recommended values are based on currently available research and should be revisited as additional research is completed. For high-income countries, analysts should identify appropriate estimates based on review of research conducted in those countries as well as guidance developed by relevant government agencies and other organizations, some of which is cited in this chapter.

## 4.1 Conceptual Framework

As discussed in Chapter 1, BCA is conventionally based on respect for individual preferences. Value is derived from the willingness of the individuals affected by the policy to exchange money for the benefits each would accrue. Spending on mortality risk reductions means that individuals – and the society of which they are a part – will have fewer resources available to spend on other things.

This concept of individual willingness to pay (WTP) for small changes in one’s own mortality risk has been obscured by the language economists use to describe these values. A reduction in mortality risk that accrues throughout a population decreases the expected number of deaths within a specified time period. Economists correspondingly convert estimates of individual WTP into estimates of the value per “statistical” life (VSL).<sup>30</sup>

The “value per statistical life” (VSL) is often misinterpreted as the value the government or the researcher places on saving a life. In reality, it reflects individuals’ willingness to exchange their income for small changes in their own risk, such as a 1 in 10,000 decrease in the chance of dying in a specific year. We often make decisions that demonstrate these preferences; for example, by spending more for a safer product.

The term “statistical” refers to small changes in the chance of dying, but is often misinterpreted. VSL is not the value that the individual, the society, or the government places on averting an identified death

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<sup>30</sup> Technically, VSL is the marginal rate of substitution between money and mortality risk in specified time period for an individual. This conceptual framework is discussed in more detail in Hammitt (2000) as well as in several of the sources cited in this chapter. Here, we focus on empirical estimation and application.



with certainty. Rather, it represents the rate at which an individual views a change in the money he or she has available for spending as equivalent to a small change in his or her own mortality risk within a specific time period, such as one year. A closely-related concept is the value per statistical life year (VSLY): the rate at which an individual is willing to trade spending on small changes in his or her own life expectancy for spending on other goods and services.

Such trades are commonplace. They include, for example, choosing whether to buy protective equipment such as bicycle or motorcycle helmets, or to use more expensive but less polluting fuels, rather than spending the money on other things. They also include individuals' willingness to exchange time for small risk reductions; this time could be used to generate income or for other beneficial activities. Examples include choosing whether to reduce risk by driving more slowly or by walking farther to draw water from a less contaminated source.

VSL is typically calculated by taking an estimate of an individual's WTP for a small change in his or her own mortality risk and dividing it by the risk change.<sup>31</sup> For example, if individual WTP is \$300 for a risk reduction of 1 in 10,000, then VSL is \$3 million (\$300 divided by 1 in 10,000). This translation of individual WTP into VSL can obscure the fundamental concept: the values should reflect individual preferences for the effect of a policy – the \$300 for a 1 in 10,000 risk reduction in this case. Figure 4.1 provides a simplified illustration of these calculations, assuming that both the risk reduction and the VSL are constant throughout the population.<sup>32</sup>

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<sup>31</sup> For context, in the U.S., on average, an individual's likelihood of dying in the current year is about 4 in 10,000 between ages 1 and 2 and increases to about 9 in 1,000 between ages 60 and 61 conditional on surviving to that age (Arias et al. 2017). By age 90, the likelihood of dying in the current year increases to about 1.4 in 10. In lower income countries, this population-average risk of mortality conditional on year of age is often much greater, as documented by the World Health Organization's Global Health Observatory: <http://apps.who.int/gho/data/view.main.60630?lang=en>.

<sup>32</sup> Multiplying VSL by the expected reduction in the number of deaths is a short cut that should approximate the correct result. Conceptually, individuals' values are calculated by multiplying the risk reduction each experiences by their VSL, then summing the results across individuals to calculate the population value. Multiplying an average VSL by the expected reduction in number of deaths produces the same result if VSL and risk reductions are uncorrelated across individuals.

**Figure 4.1: Example Calculation of Mortality Risk Reduction Benefits**

If a policy reduces the risk of dying in a given year by 1 in 10,000 for everyone in a population of 40,000, the expected number of deaths averted in that year will be four.

$$40,000 \text{ individuals} * 1/10,000 \text{ individual mortality risk reduction} = 4 \text{ expected deaths averted}$$

If each individual in that population is willing to pay \$300 to reduce their risk of death by 1 in 10,000, then each individual's VSL would be \$3,000,000.

$$\$300 \text{ individual WTP} \div 1/10,000 \text{ mortality reduction} = \$3,000,000 \text{ VSL}$$

To estimate the benefits of the policy, individual WTP is summed.

$$40,000 \text{ individuals} * \$300 \text{ individual WTP} = \$12,000,000 \text{ in benefits}$$

Alternatively, the VSL may be multiplied by the expected deaths averted.

$$\$3,000,000 \text{ VSL} * 4 \text{ expected deaths averted} = \$12,000,000 \text{ in benefits}$$

Over the years, many alternative terms have been suggested, but none have been widely accepted or used.<sup>33</sup> For example, some authors have recommended terms such as the “value of a standardized mortality unit” (VSMU) (Jamison et al. 2013) or the “value of reduced mortality risk” (VRMR) (Simon et al. 2019) to refer to an individual’s willingness to exchange income for mortality risk. These terms drop the reference to a “statistical life,” so the size of the risk reduction to which the value applies must also be defined. Jamison et al. (2013) define the VSMU as individual WTP for a mortality risk reduction of 1 in 10,000. Similarly, Howard (1989) used the term “micro-mort” to refer to the value of a 1 in 1 million risk change. In contrast, Simon et al. (2019) do not associate the VRMR with a specific risk reduction, which would need to be specified. To connect the concepts and estimates presented in these guidelines with the well-established VSL literature, we use the term VSL where relevant, but more generally refer to the value of mortality risk reductions.

Individuals’ WTP presumably takes into account all of the impacts of a small risk change on their wellbeing – including both the pecuniary effects (such as avoided out-of-pocket medical costs and losses in future earnings) and the non-pecuniary effects (such as continuing to experience the joys of life itself and delaying the pain and suffering associated with dying).<sup>34</sup> It also reflects the trade-off between spending while alive and bequeathing money to others at death. These values vary across individuals and across different types of risk; there is no single value that is applicable to all contexts.

<sup>33</sup> In the United Kingdom, VSL is usually described as the value of a prevented fatality (VPF) and VSLY as the value of a life year (VOLY).

<sup>34</sup> VSL addresses a change in mortality risk assuming all else is held constant; i.e., it does not reflect other changes in wellbeing that may be attributable to the policy. For example, if an intervention (such as increased education) simultaneously increases future earnings and reduces mortality risk, the value of the increase in earnings also should be included when estimating benefits.

Because mortality risk reductions are not directly bought and sold in the marketplace, WTP estimates are usually derived using stated- or revealed-preference methods. As introduced in Chapter 2, stated-preference studies typically employ survey techniques to ask respondents about their WTP for an outcome under a hypothetical scenario, while revealed-preference methods infer the value of nonmarket outcomes from observed behaviors and prices for related market goods. Conducting new primary research requires substantial time and expense. Typically, analysts instead rely on existing valuation studies, applying the benefit transfer framework illustrated in Figure 2.6.

#### 4.2 Population-Average Values

The value of mortality risk reductions is relatively well-studied; recent reviews suggest that over 200 studies have been completed globally. Because of the importance of these estimates, substantial attention has been paid to developing criteria for evaluating study quality and applicability, particularly in high-income settings. Relatively few studies have been conducted in low- and middle-income countries, however.

When evaluating policies to be implemented in lower-income countries, analysts typically rely on one of two approaches: (1) they use the results of studies conducted in the country of concern if available; (2) they extrapolate from values in higher-income countries, adjusting for differences in income. While the first option is preferable when studies from the country are of sufficient quality, the paucity of research in many settings means that analysts often follow the second option. We focus on this second option in the discussion that follows. We first discuss the estimates from high-income countries often used as reference values, then discuss the adjustments for income differences used to extrapolate to lower-income countries.

The starting point for extrapolation is often either values recommended for application by OECD member countries or for use in U.S. regulatory analyses. In both cases, the values are based on substantial review of the literature. They differ significantly, however, in terms of both absolute amount and their relationship to income.<sup>35</sup>

- For the OECD as a whole, the recommended central VSL estimate is \$3 million (2005 U.S. dollars) (OECD 2012). The ratio of this estimate to gross national income (GNI) per capita for OECD countries in the same year is 98.
- In the U.S., recommended central VSL estimates are generally between \$9 million and \$10 million if updated to the same year (2015 U.S. dollars) (U.S. Environmental Protection Agency 2010, U.S.

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<sup>35</sup> Throughout this discussion, we estimate income using gross national income (GNI) per capita expressed in international dollars, based on purchasing power parity, unless otherwise noted. Although many different income measures could be used (see Hammitt 2017 for more discussion), we rely on GNI per capita because consistently derived estimates are available and easily accessible for a large number of countries and because it is a broader measure than GDP per capita. As discussed in Chapter 3, we rely on purchasing power parity because it provides a better estimate of the resources available to those in the countries of concern than market exchange rates. All GNI per capita estimates in this chapter are taken from World Bank data (<https://data.worldbank.org/indicator/NY.GNP.PCAP.PP.CD?locations=US>).

Department of Transportation 2016, U.S. Department of Health and Human Services 2016). Comparing these estimates (without updating) to GNI per capita for the same year as the original estimate results in a VSL to GNI per capita ratio ranging from 156 to 166.<sup>36</sup>

The substantial difference between the OECD and U.S. ratios is attributable largely to the use of divergent approaches to develop these estimates; it is not solely due to differences in the incomes and preferences of these populations. The OECD estimate is derived from a meta-analysis of stated-preference studies, while the U.S. estimates are based on qualitative literature reviews and rely largely on revealed-preference studies of the trade-offs between wages and job-related risks. Perhaps most importantly, the OECD and U.S. estimates rely on different criteria to select studies for inclusion. These recommended values are periodically updated to reflect the results of new research.

Because VSL is derived from estimates of individuals' willingness to exchange their own income for small changes in their own mortality risk, these values are likely to be smaller for poorer than for wealthier individuals, given the need to conserve money for purchasing other necessities.

Because these values represent the trade-off between spending on mortality risk reductions and on other things, it would be nonsensical to expect that the values would be the same for individuals with substantially different income levels. For example, a \$9 million VSL implies that the average U.S. resident is willing to pay \$900 for a 1 in 10,000 mortality risk change, or slightly less than 1.6 percent of U.S. GNI per capita, which was \$57,900 in 2015. In a lower-income country, where GNI per capita may be substantially smaller, it seems implausible or impossible that the average individual would be willing to spend \$900 on the same risk reduction, given other more important needs. Overall, individual WTP per unit of risk reduction (and hence VSL) is expected to decrease as income decreases.

To extrapolate values across countries, analysts select an estimate (or estimates) of the degree of change in the VSL associated with a change in income; i.e., the income elasticity of VSL. Although comparisons among high-income populations often find that differences in the VSL are less than proportional to income (an income elasticity of less than one), comparisons between populations with large income differences often find that VSL is more than proportional to income (an income elasticity of greater than one). An income elasticity greater than one implies that the ratio of VSL to GNI per capita is smaller in lower- than in higher-income populations. This seems reasonable given that lower-income individuals must devote a larger share of their incomes to more-necessary or urgent expenses.

Adjusting a reference VSL for income differences requires an income estimate for the population to which the reference VSL applies, an income estimate for the target population, and an estimate of the

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<sup>36</sup> As discussed later, these U.S. estimates are very similar to the recommendation in a series of studies by Viscusi and Masterman; i.e., a reference value of \$9.6 million based on their meta-analysis of U.S. wage-risk studies.

rate at which VSL changes as income changes; i.e., the average elasticity over the relevant income range.<sup>37</sup> The formula is:

$$VSL_{target} = VSL_{reference} * (Income_{target} / Income_{reference})^{elasticity}$$

(equation 4.1)

The same equation can be used to extrapolate these values over time. In this case, the reference VSL and income level are for the starting year in the country of concern, and the target VSL and income level are for a future year in that country. Commonly, analysts assume that the same elasticities apply over time as across populations with differing incomes at the same point in time.

The results of extrapolating VSL estimates across countries with substantially different income levels are highly sensitive to the elasticity estimate, as illustrated by Table 4.1. To construct the table, we began with the U.S. Department of Health and Human Services (USDHHS) VSL of \$9.4 million and extrapolate to the values for an income level of \$1,025, using the associated U.S. GNI per capita estimate (\$57,900) and different elasticities. We select \$1,025 as the target income level because it represents the dividing line used by the World Bank to distinguish between low- and middle-income countries for the same year.<sup>38</sup>

**Table 4.1: Effect of Income Elasticity<sup>a</sup>**

	Extrapolated VSL for income = \$1,025 <sup>b</sup>	Ratio of VSL to income = \$1,025	WTP for 1 in 10,000 risk change	WTP as a percent of income = \$1,025
<b>Elasticity = 0</b>	\$9.4 million	9,200	\$940	92%
<b>Elasticity = 0.5</b>	\$1.3 million	1,200	\$130	12%
<b>Elasticity = 1.0</b>	\$170,000	160	\$17	1.6% <sup>c</sup>
<b>Elasticity = 1.5</b>	\$22,000	22	\$2.20	0.2%
<b>Elasticity = 2.0</b>	\$2,900 <sup>d</sup>	2.9	\$0.29	0.03%

Notes:

a. Estimates are for illustration only; see text for more discussion. Results rounded to two significant digits.  
b. Extrapolated from a U.S. VSL of \$9.4 million and U.S. GNI per capita of \$57,900 (2015 dollars)  
c. An income elasticity of 1.0 means the ratio is constant; e.g., the starting point (U.S. VSL = \$9.4 million) yields a WTP estimate of \$940 for a 1 in 10,000 risk change, which is also 1.6 percent of U.S. GNI per capita.  
d. This estimate appears implausibly low, given that it seems reasonable to expect that VSL will exceed the present value of future earnings and that the life expectancy of an average-aged adult would exceed 20 years. In such cases, the present value of future earnings should be used as a lower bound estimate of the VSL, as discussed in the text.

Table 4.1 indicates that a change in income elasticity can change the estimated VSL for the target country by orders of magnitude. Similarly, the final two columns show that the WTP estimates that

<sup>37</sup> At times it is convenient to work with ratios of VSL to income rather than VSL itself. Derived from equation 4.1, the relationship is:  $(VSL_{target} / Income_{target}) = (VSL_{reference} / Income_{reference}) * (Income_{target} / Income_{reference})^{(elasticity - 1)}$ .

<sup>38</sup> The World Bank uses exchange rates calculated using its Atlas method to convert currencies when categorizing countries by income level, rather than purchasing power parity.

underlie the VSL estimates will vary substantially as a proportion of income in the target country depending on the assumed elasticity.

Note that larger elasticities may lead to VSL estimates that appear low in comparison to income. It seems plausible to assume that VSL will exceed the present value of future earnings, given that VSL encompasses the intrinsic value of living longer in addition to the effects of survival on production and consumption. If we assume that an adult of average age has a life expectancy of at least 20 years in lower-income countries, then we would expect the VSL would be at least 20 times GNI per capita, or more than \$20,500 in the example (assuming future income is \$1,025 per year and is not discounted).

Robinson, Hammitt, and O’Keeffe (2018, 2019a) review the VSL literature. They find that recent recommendations seem to be coalescing around elasticities close to 1.0 (OECD 2016, World Bank and IHME 2016, Viscusi and Masterman 2017a, 2017b, Masterman and Viscusi 2018). These recommendations generally include elasticities around 0.8 for extrapolating across high-income countries and between 1.0 and 1.2 for lower-income countries. However, these estimates rely on different reference VSLs as well as different income measures, which substantially influence the resulting values.<sup>39</sup>

The OECD and the World Bank studies start with the OECD estimate referenced earlier, while the series of studies by Viscusi and Masterman instead start with a much larger U.S. VSL based on their meta-analysis of wage-risk estimates (\$9.6 million), which is very close to the estimates currently used by U.S. regulatory agencies.<sup>40</sup> In addition, these studies vary in how they measure income and whether they use purchasing power parity or market exchange rates to convert values across currencies. Rounding to two significant digits, assuming an income elasticity of 1.0, and using GNI per capita based on purchasing power parity to estimate income, the ratio of VSL-to-income would be 100 if we rely on the OECD estimate and 160 if we rely on the U.S. estimate from USDHHS (2016). However, these estimates primarily reflect evidence from high- and middle-income countries; little information is available on the values for low-income countries.

To supplement this work, Robinson, Hammitt, and O’Keeffe (2018, 2019a) completed a criteria-driven review of studies conducted in low- and middle-income countries. The review included studies conducted in countries identified as low- or middle-income in any one of the past 20 years; a total of 172 countries. They found 17 stated-preference studies (including 18 surveys) and nine wage-risk studies that met their selection criteria. These 26 studies were conducted in 15 countries, all of which are now middle- or high-income, representing the preferences of only a small fraction of the population residing in countries that are currently in the low- or middle-income category.

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<sup>39</sup> These analyses typically compare mean values of VSL and income across studies. Analysis of how mean values differ across populations (so-called “ecological regression”) may not accurately represent how VSL varies with income between individuals, which is the relevant concept.

<sup>40</sup> The income elasticity implied by the difference between the U.S. and OECD value is about 2.2, well above the elasticities found in the literature for high-income countries. This result suggests that, as discussed earlier, the differing values result in part from the differing approaches used to develop the estimates.

That review raises questions about the quality of several studies, suggesting that the results are highly uncertain. In addition, many of the studies cover populations whose income differs significantly from the national average, raising concerns about using them to estimate population-average values. The authors examine the income elasticity needed to extrapolate from the USDHHS VSL of \$9.4 million to the results from a subset of these studies and find an implied income elasticity with a mean of 1.5 and a median of 1.4. Although extrapolating from these studies has numerous limitations, these elasticities seem reasonable, given that we expect WTP for small changes in mortality risk will decline as income decreases.

It is difficult, if not impossible, to improve these estimates or validate these results without more high-quality research from low- and middle-income countries, which can be compared to the results of extrapolating from an estimate for a high-income country using alternative elasticities. More work is also needed to better understand how factors other than income affect these values.

#### 4.3 Adjustments for Age and Life Expectancy

The estimates discussed above are population-average values for adults. Because the number of life years remaining for younger or older individuals may be much larger or smaller, respectively, intuition suggests that different values may be applicable. Research conducted largely in high-income countries suggests that values for children may exceed the average for adults by perhaps as much as a factor of two; values for working age adults may follow an inverse “U” pattern that peaks in middle-age; and values at older ages may remain constant or decrease (see Robinson, Hammitt, and O’Keeffe 2018 and Robinson et al. 2019b for more discussion). However, the results across studies are inconsistent and raise questions about the robustness of these findings. For low- and middle-income countries, little empirical research is available and it is unclear whether the same patterns are likely to hold.

Little is known about how the value of mortality risk reduction varies by age or life expectancy in low- and middle-income countries. A constant VS LY, derived from the VSL, provides a rough proxy for estimating these effects when a policy disproportionately affects the very young or the very old.

In applied work, one frequently-used simplifying assumption is that the value of mortality risk reduction increases with life expectancy; decreasing with age. To implement this approach, often a constant VS LY is used. Although VS LY could be estimated through empirical work, few such studies are available. VS LY is often instead calculated by dividing a VSL estimate by the life expectancy of an individual at the average age of those studied.<sup>41</sup> This VS LY is then multiplied by the change in life expectancy associated with the policy to estimate the value of mortality risk reductions for individuals in different age groups.

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<sup>41</sup> When valuing mortality risk reductions, individuals presumably take into account the likely decline in health status that will occur as they age. Deriving a constant VS LY from the VSL essentially averages health status over future life years. In contrast, when QALYs are applied to changes in longevity, they may be adjusted for expected health status at each year of age; i.e., a value less than 1.0 QALY may be assigned to future life years. When DALYs are applied, the estimates are not adjusted for health status; i.e., a value of 1.0 DALY is used for each year of age.

In these calculations, future life years are often discounted applying the same rate as used for money values. However, as discussed in Chapter 3, it is unclear whether using the same rate is appropriate. Individuals may discount their own life years at a smaller rate; in addition, future life years count less because the probability of remaining alive decreases with age. Discounting also flattens the relationship between the value of reducing risk and age, making it more similar to the alternative of using the same VSL for all ages. More generally, regardless of the discounting approach, assuming VS LY is constant provides a rough proxy for the effects of age and life expectancy, but is not supported by theory or the available empirical research.

For individuals of average age, applying this VS LY approach will lead to the same result as applying the population-average VSL. For younger individuals the result will be greater and for older individuals the result would be smaller. We illustrate this calculation and the relationship between VS LY and VSL estimates in Figure 4.2, assuming future life years are not discounted. Ideally, analysts would use a life table in these calculations, that indicates the likelihood of surviving each year of age conditional upon reaching that age for the population affected by the policy.

**Figure 4.2: Example of VS LY Calculation and Application**

Assume:

- Population-average VSL = \$900,000.
- Life expectancy of an adult of average age = 30 years

Then VS LY = \$30,000 (= \$900,000/30), assuming future life years are not discounted.

If this VS LY is used for valuation, and:

- the individual is an adult of average age with 30 years of life remaining, then the equivalent VSL is \$900,000 (30 \* \$30,000).
- the individual is younger than average with 50 years of life remaining, then the equivalent VSL is \$1,500,000 (50 \* \$30,000).
- the individual is older than average with 5 years of life remaining, then the VSL is \$150,000 (5 \* \$30,000).

As discussed earlier, a VSL of \$900,000 is equivalent to individual WTP of \$90 for a 1 in 10,000 risk change. Note that the increase in life expectancy is approximately equal to the risk reduction multiplied by current life expectancy. For average-age adults, it is 0.003 years (= 30 years \* 1/10,000) and the value is \$90 per person (= \$30,000 \* 0.003 years). If the policy only affects younger people, with a life expectancy of 50 years, the increase in life expectancy is 0.005 years (= 50 years \* 1/10,000) and the value is \$150 per person (= \$30,000 \* 0.005 years). If the policy only affects older people, with a life expectancy of 5 years, the increase in life expectancy is 0.0005 years (= 5 years \* 1/10,000) and the value is \$15 (= \$30,000 \* 0.0005 years).

Analyses conducted in low- and middle-income countries must at times also address deaths around the time of birth, which raises difficult normative questions as well as empirical issues. We know very little about parental WTP to reduce mortality risk to a fetus or a newborn. One option is to apply the VSL and



VSLY estimates described above to deaths that occur at or immediately subsequent to birth (applying the VSLY estimate to life expectancy at age zero), and to value deaths that occur prior to birth at zero. Additional sensitivity analysis is likely to be desirable that tests the effects of assigning positive values to deaths prior to birth.

#### 4.4 Summary and Recommendations

Ideally, the value of mortality risk reductions in low- and middle-income countries would be derived from multiple high-quality studies of the population affected by the policy. Any individual study will have strengths and limitations and these values will likely vary across countries depending on characteristics of the society as well as the individuals affected and the risk. However, we expect extrapolation from studies of other populations will continue to be necessary in the near-term, given the paucity of studies conducted in these countries.

Analysts addressing policies to be implemented in high-income countries will often have sufficient studies of adequate quality to develop estimates appropriate for that context; the recommendations that follow are intended for application in low- and middle-income countries. These recommendations focus on population-average values for each country. If the income level of individuals affected by the policy differs significantly from the national average, analysts may wish to adjust the values to reflect the income difference.

In the near-term, to ease comparison with the findings of other BCAs as well as to examine related uncertainties, our recommendations for estimating the value of mortality risk reductions in low- and middle-income countries include selecting a preferred estimate and conducting a standardized sensitivity analysis using common defaults. Such sensitivity analysis is especially important when these values substantially affect the results, given that the estimates may vary by an order of magnitude depending on the assumptions and approach, particularly for very low-income countries. We also recommend conducting sensitivity analysis using VSLY estimates if the policy disproportionately affects the very young or the very old.

- **Recommendation 4(a): Context-Specific Values**
  - i. ***The value featured as the preferred estimate by the analyst should reflect the decision-making context, taking into account the characteristics of the individuals affected by the policy and of the risk that the policy addresses.*** Ideally, these values should be derived from a criteria-driven review of the WTP literature, that identifies high-quality studies suitable for the context.<sup>42,43</sup> In some cases, analysts may find it possible to conduct new valuation research that addresses the

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<sup>42</sup> Chapter 2 provides an overview of the framework for conducting benefit transfers.

<sup>43</sup> While the Robinson, Hammitt, and O’Keeffe (2018, 2019a) review provides a useful starting point, analysts should search for newer studies and should tailor the criteria they apply to the policy context. Additional information on best practices is provided by Johnston et al. (2017) for stated preference studies; Viscusi (2013) identifies issues that may arise in conducting wage-risk studies. Neither source focuses specifically on estimating VSL in low- or middle-income countries. Analysts will need to exercise judgment in adapting the recommendations for application in the contexts of concern.

particular policy context rather than relying solely on previously completed studies. However, because any individual study will have advantages and drawbacks, it is useful to compare the result of new research to the results from other studies. Alternatively, analysts may wish to rely on the approaches discussed below as defaults.

- **Recommendation 4(b): Population-Average Values**

- i. ***The analysis should include a standardized sensitivity analysis to facilitate comparison to other studies and to explore the effects of uncertainties.*** The sensitivity analysis should follow the current practice of extrapolating a country-level population-average VSL estimate from the substantial research conducted in high-income countries, using GNI per capita measured using purchasing power parity to estimate income and an assumed income elasticity.

The sensitivity analysis should use the following three estimates.

- i.a) *VSL extrapolated from a U.S. estimate to the target country using an income elasticity of 1.5.* The starting point should be VSL-to-GNI per capita ratio of 160, based on a U.S. VSL of \$9.4 million and U.S. GNI per capita of \$57,900. If this approach yields a target country value of less than 20 times GNI per capita, then 20 times GNI per capita should be used instead given the expectation that VSL will exceed likely future income.
- i.b) *VSL = 100 \* GNI per capita in the target country.* This calculation applies the OECD ratio to all countries, which is equivalent to using that ratio as the starting point and assuming income elasticity is 1.0.
- i.c) *VSL = 160 \* GNI per capita in the target country.* This calculation applies the U.S. ratio to all countries, which is equivalent to using that ratio as the starting point and assuming income elasticity is 1.0.

We illustrate the results in Table 4.2, which summarizes the ratio of VSL to GNI per capita using these alternative approaches. In this example, we use six income levels that span the range of income levels found in low- and middle-income countries when expressed as GNI per capita based on purchasing power parity. As expected, for low-income countries, the estimates using an elasticity of 1.5 are much smaller than the estimates using the other approaches; for middle-income countries, the range is narrower. Estimates using each of these three approaches for all countries categorized as low- or middle-income (based on 2015 GNI per capita) are provided in Appendix B.

**Table 4.2: Examples of Extrapolated VSL Estimates Using Alternative Approaches**

Approach	GNI per Capita (2015 international dollars)					
	\$1,000	\$5,000	\$10,000	\$15,000	\$20,000	\$25,000
a) Reference ratio=160 Elasticity=1.5	\$0.021 million (21*GNI per capita)	\$0.24 million (48*GNI per capita)	\$0.67 million (67*GNI per capita)	\$1.2 million (83*GNI per capita)	\$1.9 million (95*GNI per capita)	\$2.7 million (110*GNI per capita)
b) Reference ratio=100 Elasticity=1.0	\$0.10 million (100*GNI per capita)	\$0.50 million (100*GNI per capita)	\$1.0 million (100*GNI per capita)	\$1.5 million (100*GNI per capita)	\$2.0 million (100*GNI per capita)	\$2.5 million (100*GNI per capita)
c) Reference ratio=160 Elasticity=1.0	\$0.16 million (160*GNI per capita)	\$0.80 million (160*GNI per capita)	\$1.6 million (160*GNI per capita)	\$2.4 million (160*GNI per capita)	\$3.2 million (160*GNI per capita)	\$4.0 million (160*GNI per capita)

Note: All results rounded to two significant digits.

Option (i.a) is generally the preferred default, because it addresses concerns about the resources available for spending on mortality risk reductions in low- and middle-income countries. It seems reasonable to expect that the proportion of income devoted to attaining these small risk reductions will decrease as income decreases, rather than remain constant. Options (i.b) and (i.c) are designed to align the results with the ranges applied in other research and explore related uncertainties; however, the resulting estimates appear high for lower-income countries where resources are significantly constrained.

- ii. **Values should be adjusted for expected real income growth in the target country.** It often requires several years for policy impacts to fully manifest. Analysts should project the change in real income (measured as GNI per capita) that occurs over this time period and adjust the VSL estimates accordingly using the approaches above.<sup>44</sup>

- **Recommendation 4.3: Age and Life Expectancy Adjustments**

- i. **If the policy disproportionately affects the very young or the very old, conduct sensitivity analyses using VSLY estimates.** In such cases, analysts should derive a constant VSLY from one or more of the VSL estimates discussed above; i.e., the context-specific estimates (if any) and the three estimates that result from the standardized sensitivity analysis. Note that if the mean age of the individuals affected is the same as the mean age used in deriving VSLY from VSL, the results of applying each approach should be similar and this sensitivity analysis is not needed.

<sup>44</sup> Long-term growth rates may be found in the International Monetary Fund's World Economic Outlook reports, available at <https://www.imf.org/en/publications/weo>.

This constant VSLY should be calculated by first estimating the population-average VSL for the country affected by the policy, then dividing that VSL by undiscounted future life expectancy at the average age of the adult population in that country.<sup>45</sup> In this calculation, “adults” would ideally be defined by the age range during which individuals are most likely to participate in the labor force, for consistency with the age ranges often included in the underlying VSL research. However, due to the difficulties inherent in defining this average age in some countries and the desire to promote consistency, analysts may wish to rely on the age that is equivalent to one-half of life expectancy at birth as a rough proxy. The constant VSLY that results should then be multiplied by the change in future life expectancy for those affected by the policy.

- ii. ***If the analysis addresses deaths around the age of birth, additional sensitivity analysis may be desirable.*** While the VSL and VSLY estimates described under the above recommendations can be used, analysts may wish to also explore the impact of assigning positive values to mortality risk reductions that occur prior to birth.

These recommendations should be periodically revisited and revised to reflect the results of new research. They focus on the effects of income and life expectancy and do not address other differences between the risks and populations studied and the risks and populations addressed by the analysis due to gaps and inconsistencies in the available research. These other differences should also be explored both qualitatively and quantitatively. Analysts should highlight the implications for decision-making; i.e., the extent to which the uncertainties affect whether a policy has positive net benefits or the ranking of alternative policies.

Over the long term, more research is needed that explicitly addresses the value of mortality risk reductions in low- and middle-income countries. Such additional research will help analysts, decision-makers, and other stakeholders better understand the preferences of those affected, which can aid in policy implementation as well as evaluation. It also moves away from focusing largely on the effects of income differences and encourages greater attention to other sources of variation such as differences in cultural norms and other context-specific factors.

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<sup>45</sup> Not discounting reflects the expectation that individuals may discount future life years at a rate smaller than the rate used to discount money; it also increases the difference between the VSL-based benefit estimates and the VSLY-based benefits estimates for sensitivity analysis. This recommendation is explicitly designed for use in uncertainty analysis; these guidelines do not address the use of VSLY estimates for other purposes such as deriving cost-effectiveness thresholds.

# Chapter 5. Valuing Nonfatal Health Risk Reductions

The conceptual framework and general approach for valuing nonfatal health risk reductions is the same as for valuing mortality risk reductions, as introduced in Chapters 1 and 2 and discussed in more detail in Chapter 4. The major challenge when valuing nonfatal risks is that relatively few WTP studies have been completed even in high-income countries, regardless of whether the risks involve illness, injury, or another form of disability.

In this chapter, we explore how to best value nonfatal risk changes given the limitations of the research available. Again, we focus on values applicable when assessing policies to be implemented in low- or middle-income countries. More detailed information on the issues discussed in this chapter, including additional references, is available in Robinson and Hammitt (2018).

We first briefly review the conceptual framework and the approaches for estimating individual WTP. We then discuss measures that can be used to approximate WTP when suitable estimates of adequate quality are not available. These proxies include estimates of averted costs (often referred to as the cost of illness, COI), alone or in combination with estimates of the change in QALYs or DALYs valued in monetary terms. We then summarize our findings and recommendations.

Because of the diversity of the health effects likely to be considered and the gaps in the research literature, in this chapter we discuss concepts and criteria that analysts can apply in developing estimates, rather than recommending specific values.

## 5.1 Conceptual Framework

The basic concepts that underlie valuation of nonfatal risk reductions are the same as for mortality risk reductions. The starting point is typically an estimate of the change in the likelihood of illness, injury, or other disability in a defined time period for those individuals affected by the policy, which can be aggregated to calculate the expected number of statistical cases the policy averts. The term “statistical” is again used to emphasize that the number and identities of the affected individuals is unknowable in advance (and usually in retrospect); most policies reduce the risk incurred by members of the affected population by a small amount rather than preventing identifiable cases with certainty. For example, if a policy decreases the risk of a specific illness by 1 in 10,000 in a given year for each of 10,000 individuals, it prevents one statistical case of that illness ( $10,000 * 1/10,000 = 1$ ).

As is the value of mortality risk reductions, the value of nonfatal risk reductions is based on individuals’ willingness to trade spending on other goods and services for reductions in their own risks. Presumably, it encompasses both the pecuniary and non-pecuniary consequences of the health effect. These values are likely to vary across individuals and also across types of health risks. For example, a health effect that occurs when one is very young may be valued differently than the same effect if it occurs when one

is middle-aged or elderly; the value of a chronic condition with lifelong effects is likely to be quite different from the value of an acute condition with relatively short-lived effects. These values will also vary due to other factors, such as income and characteristics of the society including its cultural mores and the quality and accessibility of the health care system.

One issue is whether individual WTP adequately accounts for the value of the risk reduction, given that nonfatal health effects often impose significant costs on others.<sup>46</sup> For example, if individual WTP for a nonfatal risk reduction of 1 in 10,000 is \$3, then the private component of the value per statistical case (VSC) is \$30,000 (= \$3 ÷ (1/10,000)). If the health effect imposes costs on other parties, these costs should be added to private WTP and will increase the VSC. This may be the case if the government or private insurers bear some of the medical costs, or if family or friends care for the individual rather than pursuing their preferred activities.

Ideally, the private component (borne by the affected individual and his or her household) would be derived from studies of individual WTP for the nonfatal health risk reduction, using stated- or revealed-preference methods. However, typically analysts rely on existing valuation studies, using the benefit transfer framework introduced in Chapter 2.

The logical starting place is previously-completed literature reviews. We are not aware of a recent, comprehensive survey of the global valuation literature on nonfatal risks. Some resources include Van Houtven et al. (2006), who focus on acute effects; Hunt and Ferguson (2010) and Hunt et al. (2016), who focus on respiratory and cardiovascular conditions associated with air pollution; and European Chemicals Agency (2016), which focuses on effects associated with chemical exposures, including skin sensitization, kidney failure and kidney disease, fertility and developmental toxicity, and cancer. For effects on children, Gerking and Dickie (2013) and Alberini et al. (2010) review related studies. For injuries, most WTP studies bundle a range of injuries into a few categories. For example, Viscusi and Aldy (2003) identify 40 wage-risk studies globally that define the nonfatal risk variable as either the overall nonfatal injury rate, the rate for injuries severe enough to result in a lost workday, or the rate of lost workdays. Many of these reviews are relatively old and do not focus on values directly applicable to low- and middle-income countries.

Estimates of individual WTP ideally would be used to value nonfatal health risk reductions. However, given the number and diversity of possible illnesses and injuries, analysts will often find that relatively few studies are available for the health effect of concern, even in high-income countries.

While guidance on conducting benefit transfers is provided in several texts and articles, it is often focused on high-income countries. Analysts will need to adapt this guidance to reflect the policy context and tailor it to reflect the importance of the estimates to the overall results and the time and resources

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<sup>46</sup> Mortality risks also impose costs on others and these costs should be added to the VSL estimates discussed in Chapter 4 if significant. These costs are often ignored in the case of mortality risk reductions, however, for two interrelated reasons. The first is that they are relatively small in comparison to the sizable values individuals place on reducing mortality risks and hence not likely to noticeably influence the analytic conclusions. The second is that because everyone dies eventually, reducing mortality risks delays these costs (and perhaps changes them if death results from a different cause) rather than eliminating them.

available. Useful references include Söderqvist and Soutukorva (2006), Freeman et al. (2014), and Johnston et al. (2015). Because benefit transfer requires significant judgment on the part of the analyst, careful documentation of the approach and discussion of its limitations is essential.

When conducting these transfers, analysts may need to adjust an estimate from a high-income country to a lower-income setting, using an estimate of income elasticity as discussed in the prior chapter. The relationship between WTP and income is not as well-studied for nonfatal risk reductions as for mortality risk reductions. As a default, analysts may wish to assume that WTP changes in proportion to income; i.e., an income elasticity of 1.0.<sup>47</sup> An elasticity of 1.0 means that the ratio of the value of the risk reduction to income is constant across income levels.

When WTP estimates are used for valuation, averted costs can be added to these estimates to account more completely for the impacts of the risk reductions on social welfare, as long as these costs are not included elsewhere in the analysis.<sup>48</sup> As discussed in the subsequent section, these costs may include those incurred by third parties; for example, costs associated with medical treatment covered by government programs, private insurance, or donor organizations and with caregiving provided outside of the health care system (e.g., by family and friends).<sup>49</sup>

We expect that, in many cases analysts will not be able to identify a high-quality WTP study that addresses a reasonably similar risk and population, and will need to rely on proxy measures to value nonfatal risk reductions. We focus on these proxies in the remainder of this chapter.

## 5.2 Methods for Approximating Individual Willingness to Pay

When WTP studies of adequate quality are not available for valuing nonfatal risk reductions, analysts frequently rely on two approaches either alone or in combination. The first involves applying estimates of averted costs, often referred to as the direct and indirect cost of illness (COI). Such estimates are incomplete measures of value because they do not address pain and suffering and other quality of life impacts. To address these nonpecuniary effects, analysts at times estimate the monetary value of the change in QALYs or DALYs associated with the risk reduction. We discuss the application of each approach below.

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<sup>47</sup> The formula is:  $VSC_{target} = VSC_{reference} * (Income_{target} / Income_{reference})^{elasticity}$ .

<sup>48</sup> This approach requires distinguishing between the types of medical costs included in the calculation of costs and benefits. For example, for a policy that provides vaccinations, the costs associated with delivering the vaccine would be included in the cost component of the analysis, and the cost-savings associated with the resulting reduction in disease incidence would be included in the benefit component.

<sup>49</sup> The extent to which averted costs are included in a particular WTP estimate will depend on the design of the study. For example, respondents to a stated-preference survey may be instructed to include or exclude certain impacts, such as the effects of illness on their earnings. In a revealed-preference study, researchers may statistically control for some types of costs.

### 5.2.1 Averted Costs

Averted costs refer to changes in the real resource costs associated with incurred cases of illness, injuries, or other conditions. Such estimates are often used to compare the costs of different health conditions or of alternative treatments for a particular condition. COI estimates typically include direct medical costs and indirect productivity losses. We use the term “averted costs” to emphasize that, in the context of benefit valuation, we are generally interested in decreases in these costs. In addition, costs other than those associated with medical care and productivity may be included if they are affected by the policy. Such costs may relate, for example, to expenditures on transportation and lodging while seeking medical care or on processing reimbursement claims, or to the reallocation of leisure time.

Averted costs include the direct costs associated with medical treatment and the indirect costs associated with lost productivity, and can be used as a proxy when estimates of WTP are unavailable.

Direct medical costs typically include expenditures for services from physicians and other health care providers, medication, hospital stays, rehabilitation, and other treatment-related activities. Guidance on estimating these costs in low- and middle-income countries is provided in Vassall et al. (2017). Indirect costs associated with lost productivity may stem from absence from work or from decreased productivity while at work, and may include other costs such as those associated with idling assets or training replacement workers. Productivity losses may also include decreases in unpaid work, such as household services, agricultural labor for household consumption, or volunteer efforts. While losses in leisure time are not normally included in COI studies, they should be considered in BCA. Those affected are likely to experience a welfare gain if the policy allows them to reallocate time from relatively unpleasant activities (such as caring for an ill relative) to more pleasant or productive activities (such as paid or unpaid work or recreation). Chapter 5 discusses the value of changes in time use in more detail.

Averted costs may accrue to multiple parties: to an individual who would have become ill or injured in the absence of the policy, to his or her family or household, and to society at large. For example, costs may include medical expenses paid out-of-pocket by the ill individual, potentially affecting the resources available to his or her household, or by others such as the government, insurers, or donor organizations. In addition to productivity losses that accrue to the ill or injured individual, productivity losses may accrue to those who provide caregiving outside of the health care system; e.g., friends or family.<sup>50</sup>

As noted earlier, estimates of averted costs can be added to WTP estimates as long as care is taken to avoid double-counting, to more fully account for the effects of the health risk reduction on social welfare. In that case, costs incurred by the individual should be excluded if they are likely already included in the WTP estimate. Averted costs can be also used as a standalone proxy measure, when WTP estimates are not available, in which case costs incurred by the individual instead should be included.

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<sup>50</sup> Care provided by employees of the health care system is included in the medical cost component.



Conceptually, we expect that averted costs borne by the individual will understate individual WTP, because WTP includes effects on wellbeing in addition to the costs an individual incurs. Difficulties in measurement may, however, cause an individual's estimated averted costs to be larger or smaller than his or her WTP. Measurement is complicated in part because prices are often not a good measure of opportunity costs; in many countries, health care and labor markets are significantly distorted.

In addition, the data available are limited. Ideally the averted cost estimates would reflect marginal costs per incident case, but often only estimates of average annual costs are available. The allocation of these costs across the individual, his or her family or household, and third parties varies significantly across individuals and countries and may be difficult to estimate. For lost productivity, wage rates are often used to estimate values, but whether they are equivalent to the associated opportunity costs is uncertain. The valuation of losses in unpaid productive time, such as that used for household tasks, raises additional challenges. Issues related to valuing changes in time use are discussed in more detail in Chapter 6.

### 5.2.2 Monetized QALYs and DALYs

Another option is to rely on monetized QALYs or DALYs. These measures differ in concept and application, but both translate the impact of nonfatal health effects into a life year measure, so that the years of life lived in different health states or lost to premature fatality can be combined into a single indicator. Such estimates are relatively plentiful and easily accessible, addressing a wide range of health conditions.

QALYs and DALYs are nonmonetary measures that integrate the duration and severity of health conditions. They reflect preferences across different health states rather than an individual's willingness to exchange income for reductions in risks of differing types.

Our concern in this chapter is with the use of these measures to estimate individual WTP for nonfatal risk reductions. We first provide a brief overview of the construction of QALYs and DALYs, referencing other sources for more information. We then describe their monetary valuation. Both QALYs and DALYs can be used to address fatal as well as nonfatal effects; fatal effects are represented by years of life lost or gained. In the discussion that follows, we are concerned only with the use of these measures for nonfatal effects.

#### 5.2.2.1 Estimating QALYs and DALYs

The QALY is a nonmonetary measure that integrates the duration and severity of various health conditions. QALYs are widely used to rank and prioritize public health programs, analyze the cost-effectiveness of health policy and medical treatment decisions, and compare health status across individuals or population groups. In these contexts, QALYs are generally not assigned a monetary value, but monetization is needed to apply these estimates in BCA.<sup>51</sup>

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<sup>51</sup> Valuation is implicit in any decision that affects spending on health. As discussed in Chapter 1, in CEA these values may be represented by monetary thresholds that are compared to the cost-effectiveness ratio to determine whether an intervention may be worth implementing.

QALYs are derived by multiplying the amount of time an individual spends in a health state by a measure of the associated health-related quality of life (HRQL). HRQL is measured using a scale anchored at zero and one, where one corresponds to full health and zero corresponds to a state that is as bad as dead (values cannot be greater than one but may be less than zero for states judged to be worse than dead). Once HRQL is determined for a particular health state, it is then multiplied by the duration of that state to estimate the associated QALYs.<sup>52</sup>

HRQL can be estimated directly or indirectly. Direct methods include the standard gamble, time tradeoff, and visual analog scale, administered in individual interviews or surveys. Indirect methods typically apply one of several generic HRQL indices, examples of which include the EQ-5D, the Health Utilities Index (HUI), and the Quality of Well-Being (QWB) scale. Each employs a classification system with several dimensions to describe health as well as a scoring system based on population surveys to estimate the associated HRQL. The resulting HRQL estimates vary depending on the approach used. Each has advantages and limitations, which should be discussed in the context of a particular analysis along with the associated uncertainties.

QALYs are not entirely consistent with the conceptual framework for valuation in BCA, which focuses on measuring a broader conception of welfare rather than solely health. Their construction is based on the assumption that how individuals value health states is independent of the duration of the state, the age at which it is experienced, the individual's remaining life expectancy, and his or her wealth and income.

The DALY is a similar measure that is commonly used in global health and is often applied when estimating the burden of disease and the cost-effectiveness of health-related interventions.<sup>53</sup> DALYs use a scale that inverts the QALY scale. They are framed as the loss from full health associated with disability, rather than as the gain associated with improved health. For nonfatal effects, the disability is assigned a value between zero (for full health) and one (equivalent to dead). For example, a year with a health condition assigned a disability weight of 0.2 is equivalent to 80 percent of a year in full health. In contrast, for QALYs, a year with a condition equivalent to 80 percent of a year in full health would be represented by an HRQL of 0.8. The disability weight is multiplied by the duration of the condition to calculate years lived with disability (YLDs).

The methods for estimating DALYs rely on a set of standardized weights that were originally derived from judgments by medical experts and are now derived from population surveys. The discounting method used, the weighting of different age groups, and the assumptions regarding life expectancy have

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<sup>52</sup> For more information on QALYs, including discussion of criteria to be considered in selecting among the available estimation methods and estimates, see Institute of Medicine (2006), Drummond et al. (2015) and Neumann et al. (2016a). A comprehensive database of cost per QALY studies is available in the Cost-Effectiveness Analysis Registry maintained by the Center for Evaluation of Value and Risk in Health at Tufts Medical Center ([www.cearegistry.org](http://www.cearegistry.org)).

<sup>53</sup> A comprehensive database of cost per DALY studies is available in the Global Health Cost-Effectiveness Analysis Registry maintained by the Center for Evaluation of Value and Risk in Health at Tufts Medical Center (<http://healthconomics.tuftsmedicalcenter.org/ghcearegistry/>); see Neumann et al. (2016b) for more discussion.

also evolved over time and vary across analyses. Recent weights are provided in Salomon et al. (2015). These weights are based on surveys that ask respondents to consider two hypothetical individuals with different health states, and identify which individual they deem healthier. Analysts relying on DALY estimates should be clear about the source of the disability weights and about the assumptions used in their analysis.

There has been some debate over whether DALYs are intended to measure health or to measure welfare more generally. In recent iterations of the DALY weights, the researchers have been clear that the intent is to measure health alone (Salomon et al. 2012). Thus DALYs are also not entirely consistent with the BCA framework, which focuses on a broader conception of welfare.

#### 5.2.2.2 Valuing QALYs and DALYs

The monetary value of a QALY or a DALY is often based on a VSLY estimate, derived from a VSL estimate using an approach such as that discussed in Chapter 4. This VSLY is then multiplied by the change in QALYs or DALYs to estimate the value of the risk reduction.<sup>54</sup> Using VSLY estimates to value QALYs or DALYs is based on several simplifying assumptions. The first is that VSLY is constant; both theory and empirical research suggest this is not the case as discussed in Chapter 4.

Additional assumptions are that the value of a QALY or DALY is both constant and equivalent to this VSLY. An increasing body of scholarship as well as theory suggests that this assumption also does not hold. For example, several studies suggest that individual WTP per QALY depends on the severity and duration of the health condition as well as other factors. Simple economic models suggest that marginal and

average WTP per QALY should decrease with the magnitude of the QALY gain, but provide little guidance about the magnitude of the decrease. To date, such valuation work focuses largely on QALYs and does not address DALYs, although the latter are more often used in global health.

Although not well-supported by theory or empirical evidence, the value per QALY or DALY is usually estimated as equivalent to a constant VSLY. While some researchers have explored functions that may better estimate these values, more work is needed. In the near-term, applying a constant VSLY to value QALYs or DALYs provides a useful proxy but should be accompanied by discussion of associated uncertainties.

Unfortunately, the literature on WTP per QALY (or DALY) is not yet well-enough developed to support the use of a valuation function in low- and middle-income countries. Rather than assuming that the value of a QALY or DALY is a constant, such an approach would adjust the value to reflect the characteristics of the health effect, such as its severity and duration, and the characteristics of those affected. In the interim, valuation using a constant value per QALY or DALY appears to be the most feasible and reasonable approach.

Determining the extent to which estimates of averted costs should be added to monetized QALY or DALY estimates raises several complicated issues that are not easily resolved. Given these uncertainties,

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<sup>54</sup> For example, if VSLY calculated for that country is \$20,000, and the QALY gain associated with the risk reduction is 0.3 QALYs, then the monetary value would be \$6,000 ( $\$20,000 * 0.3$ ).

analysts may wish to assume that monetized QALY or DALY estimates include direct and indirect costs borne by the individual but not by third parties. Hence third-party costs may be added, including the opportunity costs associated with caregiving provided outside of the health care system. The treatment of costs incurred by the household or family members is more uncertain; analysts may wish to examine the effects of including or excluding these costs on their results if the costs are significant.

### 5.3 Summary and Recommendations

Ideally, the private value of changes in nonfatal risks would be derived from estimates of individual WTP, that indicate the extent to which those affected by the policy are willing to exchange income for a reduction in their own risks. Averted costs not included in the WTP estimate, particularly those incurred by third parties, should be added. However, because primary valuation research is lacking for many nonfatal risks, analysts often apply other measures to approximate these private values. Such proxy measures include estimates of averted costs and monetized QALYs and DALYs.

In the near-term, we recommend that analysts begin by searching the literature to determine whether reasonably high quality, suitable estimates of WTP are available. If not, they should apply estimates of averted costs borne by the individual and by others, recognizing that these costs may understate the value of the risk reduction. Monetized DALYs or QALYs should be used in sensitivity analysis, especially if including these estimates could significantly affect the analytic conclusions.

More specifically, analysts should proceed as follows.

- **Recommendation 5(a): Willingness to Pay Estimates**
  - i. ***Rely on WTP estimates, if suitable estimates of adequate quality are available for the nonfatal health effects of concern.*** These estimates should be derived from a criteria-driven review of the WTP literature, applying the benefit transfer framework described in Chapter 2.
  - ii. ***Add estimates of averted costs not otherwise included in the analysis.*** Costs averted by the nonfatal risk reduction should be added, especially if they are expected to be significant, as long as they are not included in the WTP estimate or elsewhere in the analysis. These additional costs are likely to include medical costs paid by third parties, such as government programs, private insurance, or donor organizations. They are also likely to include the opportunity costs of caregiver time, when such caregiving is provided by household members or friends outside of the formal health care system. Often costs borne by the individual are included in the WTP estimate, in which case they should not be added.
- **Recommendation 5(b): Proxy Measures**
  - i. ***When WTP estimates are not available, use averted costs as a proxy measure.*** Sum the costs incurred by the individual, the household and family members, and third parties, recognizing that this sum is expected to understate the value of the risk reduction. Costs incurred by the individual should include out-of-pocket medical expenditures and productivity losses as well as other costs if significant.

- ii. **Conduct sensitivity analysis using monetized estimates of the change in QALYs or DALYs.** In cases where WTP estimates are not available and averted costs are used to estimate the value of nonfatal risk reductions, sensitivity analysis should be conducted that replaces the estimates of costs incurred by the individual with estimates of monetized QALYs or DALYs. Such analysis may not be necessary if increasing the estimates of the value of nonfatal risk reductions is unlikely to affect the analytic conclusions; e.g., if nonfatal risk reductions represent an insignificant share of total benefits or if the rankings of the policy options are not likely to be altered.

These values should be developed as follows:

- a) *Estimate the change in QALYs or DALYs attributable to nonfatal risk reductions associated with the policy:* The selection of a QALY or DALY measure should take into account the benefit transfer considerations noted in the WTP discussion above, including both the quality and applicability of the available estimates. Only the change in health or disability should be included in these estimates; changes in longevity should be valued using the approaches described in Chapter 4.
- b) *Estimate the monetary value:* In the near-term, the monetary value per QALY or DALY should be derived from the approaches described in Chapter 4 for estimating a constant VSLY.

These recommendations can be implemented based on the research now available, but may provide only rough proxies for the value of nonfatal risk reductions in low- and middle-income countries. The uncertainties associated with these estimates and their implications should be discussed along with the results. Over the longer term, more research on individual WTP for nonfatal risk reductions is needed. In addition, additional work on developing a valuation function that better represents individuals' WTP for changes in QALYs or DALYs would be very useful, since QALY and DALY estimates are relatively plentiful.

# Chapter 6. Valuing Changes in Time Use

How individuals use their time, regardless of whether it involves paid or unpaid work or leisure, is often affected by policies that aim to improve health and development in low- and middle-income countries. Such changes may be categorized as either a cost or a benefit, depending on whether the change in time use contributes to implementation of a policy (a cost) or is among its outcomes (a benefit), as discussed in Chapter 2.

In this chapter, we focus primarily on valuing small changes in daily activities, rather than on major changes over one's lifetime, although the same general principles apply. We first introduce the conceptual framework, then briefly discuss the valuation of changes in paid work. We next describe the valuation of changes in unpaid time use in more detail, based on the literature review in Whittington and Cook (2019). The concluding section summarizes the discussion and describes the resulting recommendations.

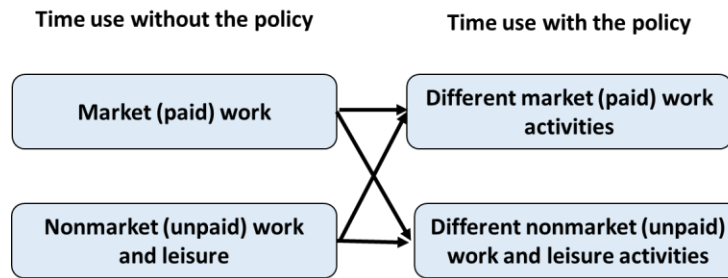
## 6.1 Conceptual Framework

As discussed in Chapters 1 and 2, BCA requires comparing conditions without the policy to conditions with the policy. For time use, this comparison involves determining how individuals are likely to spend their time under each scenario. The policy may lead to a shift across paid work tasks, across unpaid activities, or between paid and unpaid activities.

These changes are often described as “marginal” when they involve a small shift in time use. For example, a vaccination program may require that individuals travel to a health care center, decreasing the time available for other activities. A program providing cleaner water could either increase or decrease the time required to travel to the water source. However, the changes associated with some policies may be much larger. For example, an education program may increase the extent to which individuals engage in paid work throughout their lifetime as well as their ability to attain higher paying jobs.

Figure 6.1 illustrates the major categories of changes in time use, including market (paid) work time and nonmarket (unpaid) time. We consolidate household tasks, unpaid work outside of the household, and leisure activities into the latter category, in part for ease of exposition and in part because analysts are often unable to identify the specific nonmarket activity affected by the policy. For paid work, it is often easier to identify the specific activities involved. In either case, the value of the change in time use requires comparing the value of the activities without and with the policy to estimate the net effect.

**Figure 6.1: Changes in Time Use**



In many cases analysts assume the share of time used for market or nonmarket activities is fixed, essentially ignoring the diagonal arrows in Figure 6.1. In other words, they assume that any change in market work attributable to the policy displaces other market work time, and any change in nonmarket time use displaces other nonmarket activities. Policies that change the allocation of time across these two major categories often have additional effects on welfare that must also be taken into account, especially if they increase or decrease the likelihood that the affected individuals will engage in paid work.

As discussed in Chapter 1, the conceptual framework for valuation includes two interrelated assumptions. The first is that each individual is the best or most legitimate judge of his or her own welfare, which means that values should be based on the preferences of the individuals affected by the policy. The second is that the value of a resource can be based on the value of its best alternative use; i.e., its opportunity cost.

When applied to changes in time use, this framework assumes that individuals allocate their time to those activities that produce the greatest utility subject to their budget and other constraints. Time is a direct source of utility or disutility, in that its consumption or use can be pleasant or unpleasant. Time is also an input into the production of utility, because its allocation often involves intermediate activities that are instrumental to pursuing other goals. For example, an individual may devote time to earning income which can be used to purchase other goods and services, or to traveling to a workplace or health care facility so as to engage in activities at that site. The value of time is associated with its scarcity; using time for one purpose means the same block of time cannot be invested in another activity.

The standard economic model that underlies BCA assumes that, among the jobs available to them, workers chose the job that maximizes their own utility, given both the income it provides and its other attributes. The model furthermore assumes that workers' pay reflects the value of their output at the margin. Presumably, goods or services will not be produced unless the price received by the producer covers the cost to the producer, and the producer will not pay an employee more than that individual is worth to the organization. Typically, the cost of labor to the employer is larger than the amount received by the worker due to taxes and other costs. Thus the standard model suggests that the value of

paid work time is best estimated by its cost to the employer, since it approximates the value of the production that results.<sup>55</sup>

The standard model also assumes that individuals will allocate time between paid work and other activities so that, at the margin, the value of the compensation they receive is equal to the value of the uncompensated activity forgone. In other words, the value of nonmarket time is at minimum equal to the amount the individual would receive for paid work. This relationship is often described as the labor-leisure trade-off. This value may be less than the cost of labor to the employer, since as noted above what the employee earns likely excludes some costs the employer pays. However, in economies with high unemployment, a worker may face few or no options for paid work and labor market compensation may not appropriately measure the opportunity cost of his or her time. Similarly, those who do not engage in market work for other reasons, such as their age or impaired health, are unable to make this trade-off.

Ideally, the value placed on changes in time use would reflect the preferences of those affected by the policy. In some cases, the policy may provide market or nonmarket opportunities that are not otherwise available and that are preferred to the activities undertaken in the absence of the policy. In other cases, the policy may require that the individual spend time on activities (such as walking further or waiting in line) that are less desirable than what they would otherwise be doing. Given the complexities of these comparisons (illustrated in Figure 6.1), analysts often rely on simple assumptions for valuation. Changes in paid work time are generally valued using market compensation rates, while changes in nonmarket time are generally valued at a fraction of the wage rate derived from available research. We discuss these approaches in more detail below.

Note that the value of changes in time use that result solely from changes in the risk of mortality or of nonfatal health effects should not be added to the values discussed in Chapters 4 and 5. Mortality risk reductions increase life expectancy, lengthening the time period over which an individual can earn income, consume goods and services, and enjoy other activities. If these changes in time use are fully attributable to the effects of living longer, then their value is likely included in the value placed on mortality risk reductions (i.e., the VSL) and should not be added (see Hammitt 2017 for more discussion).<sup>56</sup> However, if a policy jointly extends life expectancy and increases earnings, for example by increasing educational attainment, then the increase in earnings should also be included as discussed in Chapter 4.

For nonfatal effects, the relationship between the value of the health impact and the value of time is complicated by the frequent need to use proxy measures. If WTP estimates are available, then the value

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<sup>55</sup> This section presents a simple, basic version of the standard model that focuses on the attributes most important to the discussion of empirical estimates that follows. The economics literature includes substantially more complex discussions of the conceptual issues noted here, including deviations from these assumptions.

<sup>56</sup> If the VSL is derived from studies that explicitly exclude the effects on earnings, this condition would not hold. For example, respondents to a stated preference survey could be instructed to ignore the change in income when responding to WTP questions.



of the time an individual would spend in nonmarket activities is likely included but the treatment of paid work may depend on the study design. Analysts will need to review the underlying research to determine whether the expected change in earnings can be added to the WTP estimate without double-counting. If estimates of averted costs are instead used as proxies, then the approaches discussed in this chapter can be used to estimate the value of the associated change in time use. In either case, the value of time that family members and friends would otherwise spend in caring for the affected individual may be added. These issues are discussed in more detail in Chapter 5.

## 6.2 Valuing Market Work Time

Compensation data are typically used to value market work time, including wages, taxes, benefits, and other indirect costs incurred by the employer. These costs reflect the full opportunity cost associated with the individual's labor.<sup>57</sup>

Changes in market time use should be valued based on the cost to the employer, which includes payment of taxes, benefits, and other costs in addition to the wages received by the employee.

In low- and middle-income countries, the data available to estimate these values varies significantly across countries as well as across subsets of the population. In some cases, the country may systematically collect data on wages and other costs, and provide disaggregated estimates by industry and occupation as well as by geographic region and other attributes such as age and gender. In other cases, analysts may need to estimate values based on more limited data. One useful resource is the Living Standards Measurement Study (LSMS), which provides household survey data from collaborations between the World Bank and national statistical offices.<sup>58</sup>

Although representative national surveys are becoming more accessible in many low- and middle-income countries, they remain scarce in many locations. Analysts may instead need to conduct primary research on local wage rates and employer costs to value market time. Although it may be tempting to convert estimates of the labor share of annual GDP or GNI per capita into an hourly estimate (by dividing by the national average hours worked annually), this approach is not likely to provide a close approximation of the average wage rate in a specific location.

## 6.3 Valuing Nonmarket Time

For unpaid work and leisure, valuation is more challenging because there is no directly observable market price for time spent in these activities.<sup>59</sup> Such activities are diverse and have varying attributes,

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<sup>57</sup> More information on valuing paid work within the health care sector is provided in the iDSI Reference Case (NICE International 2014, Wilkinson et al. 2016) and the Global Health Cost Consortium guidance on health services costing (Vassall et al. 2017).

<sup>58</sup> See <http://surveys.worldbank.org/>.

<sup>59</sup> In some types of analysis, the value of unpaid work time is estimated based on the cost of paying a replacement worker. This approach does not address the associated opportunity costs. If an individual voluntarily elects to undertake unpaid labor, he or she is not necessarily forgoing a job involving similar activities. For example, if a highly paid individual chooses to stay home to care for a child, his or her opportunity cost (i.e., forgone market wages) may well exceed the cost of hiring a childcare worker. Alternatively, some individuals engage in essential nonmarket work because the cost of hiring a replacement worker exceeds the amount he or she could earn in the market. These individuals presumably value the nonmarket work time at minimum at their own market wage rate.

both pleasant and unpleasant, and hence are likely to be valued differently. For example, nonmarket time may include relatively enjoyable activities such as conversing with friends as well as less enjoyable activities such as housework and farming. Ideally, these values would be estimated based on data from the population affected by the policy, that directly address the change in time use attributable to that policy.<sup>60</sup> Typically, such data are not available and the analyst must apply the value transfer framework introduced in Chapter 2.

Whittington and Cook (2019) review the literature on the value of time in low- and middle-income countries. They note that different values are likely to be appropriate for different types of time use. For example, researchers in the transportation sector have long recognized that differing values should be used for time spent traveling, depending on factors such as transport speed, wait time, and predictability. These values are also likely vary among individuals even for the same activities. For example, one person may find waiting in line boring while another may enjoy talking to others in the queue.

As noted earlier, in high-income countries analysts often assume that the value of nonmarket time is at minimum equal to the after-tax wage rate, since that is the amount that an individual could earn by instead engaging in paid work. In low- and middle-income countries, people more commonly work outside the formal sector and data on the compensation they might earn by working in the formal sector is generally not an appropriate measure of value. Instead, nonmarket valuation methods, including both revealed- and stated-preference studies, are used to estimate the value of changes in nonmarket time use.

Much of the available research addresses the value of travel time. In high-income countries, economists suggest that a reasonable estimate of the value of travel time savings is 50 percent of an individual's after-tax wages, based on review of the available research (von Wartburg and Waters 2004, Boardman et al. 2018). These estimates presumably reflect both the pleasant and unpleasant aspects of the travel time, leading to values that are lower than the amount the individual could receive from working.

In the absence of research on the value those affected by the policy place on a change in nonmarket time use, the available evidence suggests that 50 percent of the after-tax wage rate may be a reasonable central estimate, with a range of 25 percent and 75 percent of the after-tax wage rate.

There are relatively few empirical studies of the value of nonmarket time in low- and middle-income countries.

Whittington and Cook (2019) review 11 revealed- or stated-preference studies conducted in these countries, of which nine focus on travel time. Nine report mean estimates that are within the range of 25 percent to 75 percent of some measure of household income or wage rates. Although this literature is limited, it suggests that the recommendations for high-income countries may be an appropriate

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In general, the replacement cost approach is incompatible with the conceptual framework for BCA, which focuses on opportunity costs.

<sup>60</sup> Whittington and Cook (2019) provide examples of approaches for conducting revealed-preference research and a guide to implementing stated-preference studies for estimating these context-specific values.

starting point for valuing changes in nonmarket time use in low- or middle-income countries. In other words, as a first approximation, this value can be estimated at 50 percent of the average after-tax wage rate. To estimate the after-tax wage rate, analysts can rely on the same sources as discussed in Section 6.2, but will need to adjust the values to net out taxes or other payments not received by the worker.

Although Boardman et al. (2018) recommend assigning higher values to avoiding more unpleasant uses of time (walking or waiting) in high-income countries, Whittington and Cook (2019) note that the studies they review do not provide insights into these differentials for low- and middle-income countries. Thus they recommend applying 50 percent of after-tax wages to all types of nonmarket time use in these settings. They also suggest that analysts undertake a sensitivity analysis to determine the implications of instead assigning values between 25 percent and 75 percent of the after-tax wage rate. An example of this approach from Whittington and Cook (2019) is provided in Figure 6.1.

**Figure 6.1: Example of Valuing Changes in Nonmarket Time Use**

Assume a project would provide a Kenyan community with piped water connections in their compound. Previous research suggests that the median household spends 2.35 hours per day collecting water during the dry season. If the project reduces this collection time to zero, the local unskilled wage rate is 35 Kenyan shillings (Ksh) per hour, and the default value of time is 50 percent of this wage rate, then the project would yield time-savings benefits of 41 Ksh per person per day or 1,230 Ksh per month. The sensitivity analysis would yield values from 620 Ksh per month (25% of unskilled wages) to 1,850 Ksh per month (75% of unskilled wages).

Source: Whittington and Cook (2019)

This approach raises difficult questions when the change in time use affects young children or others outside of the labor force.<sup>61</sup> Unfortunately, the available studies do not report values separately for children and adults, suggesting that the same values should be applied to individuals of all ages in the absence of additional research. Whittington and Cook recommend valuing changes in time use for children younger than school-age at zero, as they are unlikely to perform work that would be performed by an adult.

#### **6.4 Summary and Recommendations**

Ideally, the value of changes in time use would be estimated using data that address the population affected by the policy and the specific types of activities it affects. For market work time, compensation for similar individuals in similar occupations generally provides a reasonable estimate of these values. For nonmarket work and leisure, data from nonmarket valuation studies are typically needed for valuation. In the absence of studies relevant to the particular policy context, previous work provides a range of values that can be applied to estimate these values.

We recommend that analysts proceed as follows.

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<sup>61</sup> Changes in time use can also have other consequences; for example, decreasing the amount of time children spend collecting water or firewood may increase their educational attainment. These other consequences should be included in the analysis if significant.

- **Recommendation 6(a): Market Work Time**
  - i. ***Changes in market work time should be valued based on compensation data for the population of concern.*** These estimates should be derived from the best available data on the likely earnings of the individuals affected by the policy, in the same or similar occupations. When the costs to employers include taxes, expenditures on fringe benefits, or other costs in addition to the compensation received by the employee, these additional costs should be included in the estimates.
  
- **Recommendation 6(b): Nonmarket Work and Leisure Time**
  - i. ***Changes in nonmarket work and leisure time should be valued based on WTP estimates, if suitable estimates of adequate quality are available.*** These estimates should be derived from a criteria-driven review of the WTP literature, applying the value transfer framework described in Chapter 2.
  - ii. ***If suitable WTP estimates are not available, the analysis should use standard default values and conduct sensitivity analysis.*** This analysis should apply 50 percent of after-tax wages as a central estimate, with sensitivity analysis using values of 25 percent and 75 percent of the after-tax wage rate.

These recommendations can be implemented based on the research now available. In some cases, it may be possible to conduct new revealed- or stated-preference studies to provide context-specific estimates for changes in nonmarket activities. Over the longer term, developing a larger database of these estimates will allow refinement of these recommendations and better tailoring to the individuals and activities affected by the policy.

# Chapter 7. Assessing the Distribution of the Impacts

As introduced in Chapters 1 and 2, conventionally BCA focuses on economic efficiency, summing a policy's costs and benefits to estimate its net effects. There is widespread agreement, however, that information on how the impacts are distributed across individuals is also needed to support sound decisions. The iDSI Reference Case, which these guidelines supplement, emphasizes the importance of such information (see Appendix A).

This chapter summarizes and builds on the review provided in Robinson, Hammitt, and Adler (2018). That paper notes that little attention is paid to assessing distribution despite concerns about the distributional effects of policies. The goal of this chapter is thus relatively simple: to encourage analysts to provide information on the distribution of both costs and benefits in addition to assessing the overall impacts of the policy. We explore related concepts, discuss approaches for describing how impacts are distributed, and summarize our conclusions and recommendations.

## 7.1 Conceptual Framework

Decision-makers and other stakeholders often want to know who might be harmed by a policy, who might be helped, and by how much. Will the benefits primarily affect the disadvantaged while the costs primarily affect the advantaged? Or vice-versa? Or do both the benefits and costs accrue to the same group? What is the relative magnitude of the impacts? The answers to these types of questions can aid in choosing among policy options and also in tailoring policies to better address distributional concerns.

To respond to these questions, analysts must first identify the types of individuals and impacts of concern. Individuals of concern may be defined by attributes such as income, gender, health status, geographic location, educational attainment, and so forth.<sup>62</sup> Similarly, impacts of concern may relate to changes in income, health, longevity, education, environmental conditions, and other contributors to wellbeing. Considering these impacts throughout the analytic process will aid decision-makers in determining whether and how the policy options should be adjusted to address any related concerns.

In the discussion that follows, we focus on changes in income and in health and longevity that accrue to members of different income groups. While this focus reflects the impacts and groups that are often of greatest concern, it is largely for ease of exposition. We recognize that analysts, decision-makers, and other stakeholders are likely to wish to address other impacts and groupings that are important in the particular policy context.

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<sup>62</sup> This question is closely related to the issue of standing (or perspective); i.e., determining whose preferences are counted, as discussed in Chapter 2. However, in determining standing, the analyst is concerned with delineating the total population to be addressed, whereas in assessing distribution, the analyst is concerned with defining subgroups across that population.

Our reviews of the literature suggest that, when distributional analysis is undertaken, analysts tend to focus on a subset of impacts or a subset of the population. For example, they often address the distribution of health improvements without addressing the degree to which they are offset by the distribution of costs. Another example is that analysts frequently focus on impacts on those who are impoverished, rather than across all income groups.

Such narrow focus is problematic. Any dividing line raises difficult questions about the rationale both for choosing that threshold and for ignoring other impacts. For example, focusing on those living below the poverty line disregards the impacts on those who are only slightly above it. Arguments about defining the threshold can also divert attention and analytic effort away from more fundamental and important tasks related to estimating and evaluating the distribution.

Considering only a subset of the population (such as the poor) or only a subset of the impacts (such as changes in health risks) also ignores implications of the overall distribution of impacts for policy design and decision-making. For example, a policy redesign that shifts costs from the wealthiest to middle-income groups may be less desirable than the opposite, even if in both cases the poor receive the majority of the benefits.

Information on the full distribution of the net impacts – both positive and negative – is needed to support sound decision-making. This information allows decision-makers and others to weigh the extent to which benefits and costs are counterbalancing for each group as well as the overall distribution of both costs and benefits across groups. The distributional analysis can make the trade-offs between economic efficiency and distributional concerns explicit.<sup>63</sup>

To support sound decision-making, the analysis should consider the distribution of both costs and benefits throughout the population. Focusing solely on a subset of impacts (health benefits but not costs) or a subgroup of the population (the very poor rather than the full income distribution) does not provide adequate information to support policy evaluation, design, and implementation.

As discussed in Chapter 1, the conventional normative basis for using BCA in decision-making is based on the Kaldor-Hicks potential compensation test: a policy is desirable if those who benefit could compensate those who are harmed. Proponents of this view may argue that concerns about distribution can be more efficiently addressed through the tax and income support system, rather than through programs focused on other goals such as improving health. However, constantly tweaking the tax and income support system to compensate for inequities introduced by other policies is clearly impossible. As a result, decision-makers and other stakeholders generally desire information on distribution that can be considered along with information on the overall benefits and costs. For example, they may choose an economically-efficient policy that maximizes net benefits, perhaps

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<sup>63</sup> Within the CEA framework, methods for extended cost-effectiveness analysis (ECEA) have been developed by Verguet, Laxminarayan, and Jamison (2015) to systematically estimate the full distribution of the health impacts, financial risk protection, and expenditures associated with an intervention. These approaches could be modified to address these impacts within the BCA framework.

addressing distributional concerns through other policies, or may choose a less efficient option to ameliorate distributional impacts or achieve other policy goals.

Concerns about distribution generally reflect interest in both the equality and the equity of the outcomes. Equality describes the distribution of a quantity (such as health or income) across individuals or groups. Equity involves judging the extent to which the distribution is fair or just. Typically, analysts focus on describing how impacts are distributed, leaving it up to the decision-maker to determine whether that distribution is equitable.

Two normative frameworks are frequently referenced in this context. As introduced in Chapter 1, the first is utilitarianism, which typically assumes that an incremental dollar received by a poor person yields a greater increase in wellbeing than the same amount received by a rich person. Prioritarianism is similar but counts changes in the utility of individuals who are worse off as more important than comparable changes to individuals who are better off. It goes beyond utilitarianism by weighting improvements in wellbeing differently across the population. Prioritarianism seems consistent with many people's intuition about what might be just or fair.

Utilitarian and prioritarian evaluations can be undertaken directly or approximated using weighted BCA. Direct evaluation requires developing or selecting a utility function that summarizes individuals' wellbeing (as a function of consumption, health, and other relevant characteristics) in a way that is interpersonally comparable; i.e., the measure describes which of two people has higher wellbeing and which one gains more wellbeing from a specified change in policy. For the utilitarian evaluation, one simply adds the wellbeing measures resulting from these utility functions across individuals. The prioritarian evaluation also requires specification of a transformation function that quantifies how much social welfare is improved by increasing wellbeing of people at different levels.

Regardless of the normative framework, data on both the costs and benefits that accrue to each population subgroup are needed. Otherwise, a function that evaluates or weights the distribution of the impacts cannot be applied.

Alternatively, utilitarian and prioritarian evaluations can be approximated by weighting individuals' costs and benefits and summing them across the affected population. For the utilitarian evaluation, the weights account for the difference in the marginal utility of an increase in wealth; for the prioritarian evaluation, the weights account for this difference plus the difference in social value associated with improving wellbeing of different individuals. For either utilitarianism or prioritarianism to be widely used, more work is needed on how to define wellbeing measures that can be compared across individuals and how to weight alternative allocations.

To implement these or any other normative framework, descriptive information on how both costs and benefits are distributed is needed. A function that evaluates or weights impacts accruing to members of different population subgroups cannot be applied without this basic information.

In the discussion that follows, we focus on supplying this descriptive information for two reasons. First, BCAs rarely include this information; encouraging greater reporting is an important initial step in moving towards greater consideration of distribution. Second, developing and applying weights requires substantial additional work given the complexities of the issues. These include the lack of consensus on the appropriate normative framework and on how it can be best implemented in the context addressed by these guidelines; i.e., health and development policies implemented in low- and middle-income countries. We return to this need for more work in the concluding section of this chapter.

## 7.2 Methods for Describing Distribution

Typically, when conducting BCA, the analysis of total costs and total benefits provides the starting point for the distributional analysis. In the sections that follow, we first provide a general overview of the steps involved in estimating the distribution of the costs and benefits, focusing on the distribution of health and longevity and disposable income across individuals in different income groups. We then briefly discuss some options for describing the equality of their distribution.

When calculating net benefits, transfer payments are frequently ignored, but they must be included in distributional analysis. Transfers are monetary payments between persons or groups that do not affect the total resources available to society but that do affect the allocation.

Our goal is to introduce the issues and options. The detailed approach will vary significantly depending on the decision-making context, the nature of the policy, the characteristics of its benefits and costs, the population groups of interest, and the data and other analytic resources available.<sup>64</sup> These issues are discussed in more detail in Robinson, Hammitt, and Adler (2018), which also provides additional references.

In Chapter 2 we define “costs” as the inputs or investments needed to implement and operate the policy. We then define benefits as the outputs or outcomes of the policy; i.e., the changes in welfare such as reduced risk of death, illness, or injury. Transfer payments need not be included in BCA but must be considered in distributional analysis. Transfers are monetary payments between persons or groups that do not affect the total resources available to society. The transfer itself is a benefit to recipients and a cost to payers, with zero net effect. For example, taxes and fees are usually transfer payments, and should be included in any distributional analysis.<sup>65,66</sup>

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<sup>64</sup> We focus here on the initial consequences. The screening analysis discussed in Chapter 2 should address the extent to which subsequent consequences should be assessed. For example, increased wealth is likely to affect future health (e.g., by allowing the individual to live in a safer environment and pay for medical care).

<sup>65</sup> While the transfers themselves are often ignored in BCA, they may lead to behavioral changes that significantly affect resource allocation and the calculation of total costs and benefits. Any such changes should be included in the analysis. In addition, the analysis should include the resource costs of implementing the transfers, such as administrative costs and deadweight losses.

<sup>66</sup> Skinner et al. (2019) provide an example of supplementing BCA with distributional analysis when assessing the financial risk protection provided by health insurance.

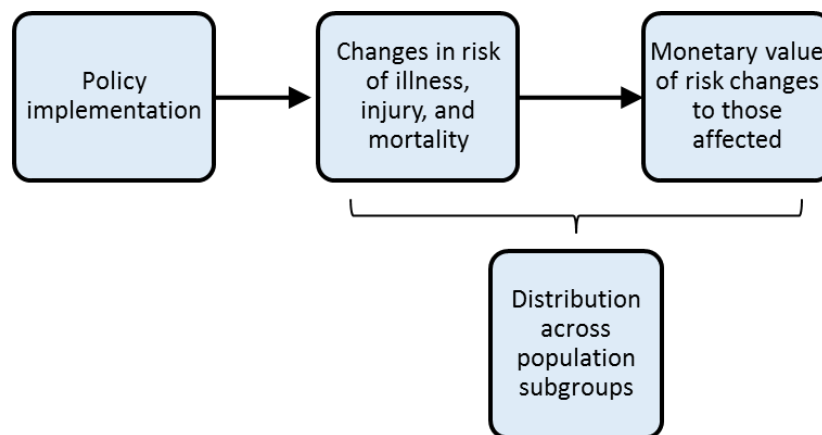


### 7.2.1 Estimating the Distribution of Benefits

In the case of health and longevity as well as other policy outcomes, there are several options for measuring the effects on individuals with different attributes, such as income levels. Analysts can count the number of statistical cases averted; use integrated nonmonetary measures such as QALYs or DALYs; and apply estimates of WTP for the risk changes. At minimum, distributional analysis of health-related policies should provide estimates of the number of averted cases of deaths, illnesses, or injuries across the members of groups of concern, and of the monetary value of these cases for each group. Similarly, the distribution of both changes in incidence and values should be reported for non-health benefits.

This process is illustrated in Figure 7.1 for health outcomes and discussed below. As is the case for other analytic components, this process should be iterative. Preliminary results from screening analysis, based on easily accessible data and a reasonable range of assumptions, can be used to inform the policy development process in addition to informing decisions about future research and analytic steps.

**Figure 7.1: Distribution of Health Benefits**



The starting point for estimating this distribution is the benefit analysis. For example, if the impacts of concern are health and longevity as illustrated in Figure 7.1, that analysis will provide estimates of the change in the risk of mortality as well as nonfatal illnesses and injuries attributable to the policy – expressed as the number of statistical cases averted. The challenge is then to identify how these cases are allocated across members of the groups of concern, which will depend on the effectiveness of the policy in reducing risks faced by individuals in each group and may also depend on the baseline distribution of these risks. The research used to predict overall policy impacts (such as the risk assessment and disease modeling) may provide data on the distribution; otherwise, analysts may need to rely on other sources to develop assumptions and explore the implications of associated uncertainties. The underlying research is likely to also summarize or reference available data on populations that may be particularly sensitive or vulnerable to the risks as well as particularly responsive to the policy options under consideration.

The characteristics of the policy often aid in estimating this distribution. For example, if a vaccination program reduces the risks of tuberculosis, the vaccine is administered throughout the population, and the distribution of tuberculosis across different income or other groups is known, one possible default might be to assume the vaccine is equally effective across all members of the population.

Once the expected number of averted statistical cases is estimated, the next step is to estimate the monetary value of these risk reductions. For fatal and nonfatal risks respectively, these values are discussed in Chapters 4 and 5. Those chapters focus on population-average values, however. For distributional analysis, ideally analysts should adjust the values to reflect the preferences of individuals with differing characteristics. For example, the approaches for adjusting WTP to reflect income differences across countries, as described in those chapters, can also be applied to adjust for income differences within a country.

Due to widespread misunderstanding of the WTP concept among the general public, analysts are often reluctant to use different values for changes in risks that accrue to different segments of the population. However, relying on population averages likely overstates the values held by poorer individuals and understates the values held by wealthier individuals, making the distribution of benefits appear more progressive than it is and obscuring the extent to which individuals' benefits are greater or less than their costs. We recommend that analysts adjust the values to the extent possible to reflect the income and perhaps other characteristics of the individuals affected, and explain that these estimates are measuring the affected individuals' willingness to exchange their own income for changes in their own health or longevity. They are not the value that the government or the analyst places on averting certain death or illness or injury, nor are they a measure of moral worth. Without such adjustment, the results could be mistakenly interpreted as supporting a policy that does not align with the preferences of those affected.

### **7.2.2 Estimating the Distribution of Costs**

In the case of costs (and off-setting savings), analysts are typically interested in the monetary expenditures needed to implement the policy and the ultimate effect on the disposable income of the groups of concern.<sup>67</sup> If costs are borne directly by individuals, the main challenge is determining how the costs are distributed across those who belong to different groups – identified, for example, by income quintile. This assessment should take into account how this distribution is affected by consumer behavior. For example, if the price of a food is increased, some may substitute a cheaper alternative.<sup>68</sup>

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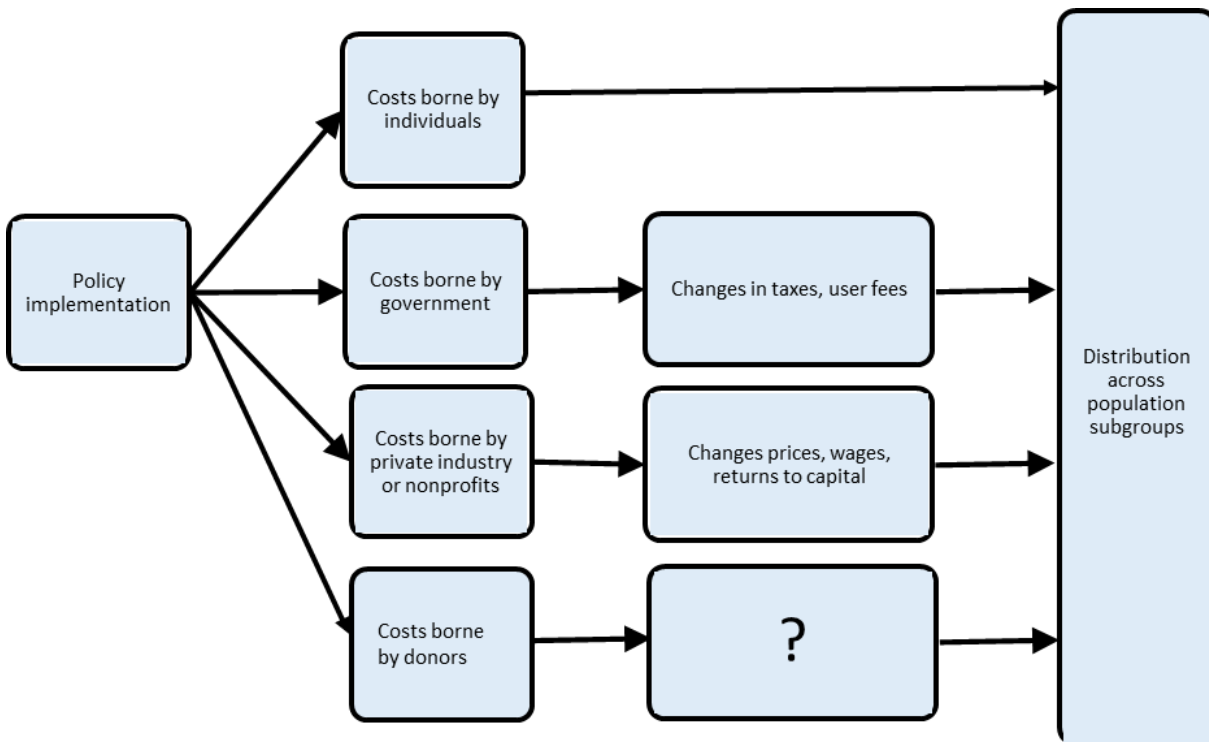
<sup>67</sup> There are many ways to define and measure income. For example, it can be defined at a particular point in time or over the individual's lifetime, and may include or exclude various types of payments (e.g., government subsidies as well as work-related earnings) and of wealth (e.g., investment income and real property). In general, more comprehensive measures are preferable to less comprehensive measures where feasible, so as to accurately reflect the resources available over time to the individuals affected by the policy.

<sup>68</sup> This type of substitution as well as other behavioral responses may affect benefits as well as costs, and should be taken into account throughout the analysis.

If costs are borne initially by the government, industry, donors, or other organizations, assessing the effects on individuals requires additional steps. For government programs, the analyst first needs to estimate how the costs translate into changes in taxes or user fees or are otherwise financed, then estimate the incidence of these taxes or fees. For programs operated by nonprofit or for-profit organizations, the analyst must determine how costs are allocated among owners, workers, and consumers. This allocation will be affected by how the costs translate into changes in unit prices (which have both income and substitution effects on consumer expenditures), in wages paid to employees, and in returns to capital that accrue to owners. Costs paid by external donors (e.g., aid from foreign governments or foundations) raise other issues. In the short-term, donor-financed costs may have little or no direct impact on the income or wealth of members of the target population. However, the donor agency may be interested in estimating how these costs would be distributed if the policy were instead funded using in-country resources.

Figure 7.2 illustrates this process, which again should be iterative. The initial results may have important implications for policy design as well as for decisions regarding how to best refine the analysis.

**Figure 7.2: Distribution of Costs**



The estimation of these effects is more complicated than can be covered by this short chapter; analysts should consult BCA texts (such as Boardman et al. 2018) for more information. In many cases, detailed assessment may not be feasible and analysts may use “what if” or bounding analysis to explore the possible consequences. Such analysis uses the available data to explore the effects under different

scenarios, as discussed in Chapter 8. For example, given what is known about the likely distribution of benefits, what would be the distribution of net benefits if all of the costs were allocated across members of the highest income group? Or only across members of the lowest income group? Or equally across members of all income groups?

### 7.2.3 Describing the Combined Distribution of Costs and Benefits

Once costs and benefits are estimated for members of each group of concern, they can be combined to determine the net effects. In this discussion, we assume these joint effects will be expressed as net benefits; benefit-cost ratios or internal rates of return could also be used. In addition to reporting the results for each group, analysts should explore the extent to which there is heterogeneity within the groups. For example, within an income quintile, some may be more vulnerable than others to a health hazard and may accrue a disproportionate share of the net benefits compared to others within the group.

At minimum, the results should be reported as a table, chart, or graphic that indicates the costs, benefits, and net benefits that accrue to individuals at different points in the distribution; e.g., to income quintiles. Table 7.1 provides a simple stylized example for a policy that only affects mortality risks in a society that consists of three income groups with an equal number of members, where many are relatively poor; i.e., the lowest income group includes a much narrower income range than the highest income group, although each group includes the same number of people. It assumes the cost per death averted is a constant (\$50,000) and that costs are distributed in proportion to deaths averted (for example, the program provides treatment for a fatal disease that is more prevalent at lower incomes and the costs are born by treated individuals). The value per expected death averted (i.e., the VSL) is estimated following the recommended default from Chapter 4 (base VSL-to-GNI per capita ratio = 160, income elasticity = 1.5), using the mid-point of each income range to estimate these values in international dollars. The example focuses on net benefits as the summary measure.

**Table 7.1. Distribution of Net Benefits** (stylized example; numbers provided only for illustration)

Income Range	Deaths Averted	VSL (value per death averted)	Benefits (deaths averted * VSL)	Costs	Net benefits (benefits minus costs)
\$0-\$3,000	10	\$39,000	\$390,000	\$500,000	(\$110,000)
\$3,001-\$10,000	5	\$350,000	\$1,750,000	\$250,000	\$1,500,000
\$10,001-\$30,000	3	\$1,900,000	\$5,700,000	\$150,000	\$5,550,000
Total	18	N/A	\$7,840,000	\$900,000	\$6,940,000

The table suggests that the net effect of the policy will be beneficial. However, although the poorest members of the population accrue a larger share of the risk reductions, they incur net costs.<sup>69</sup> These

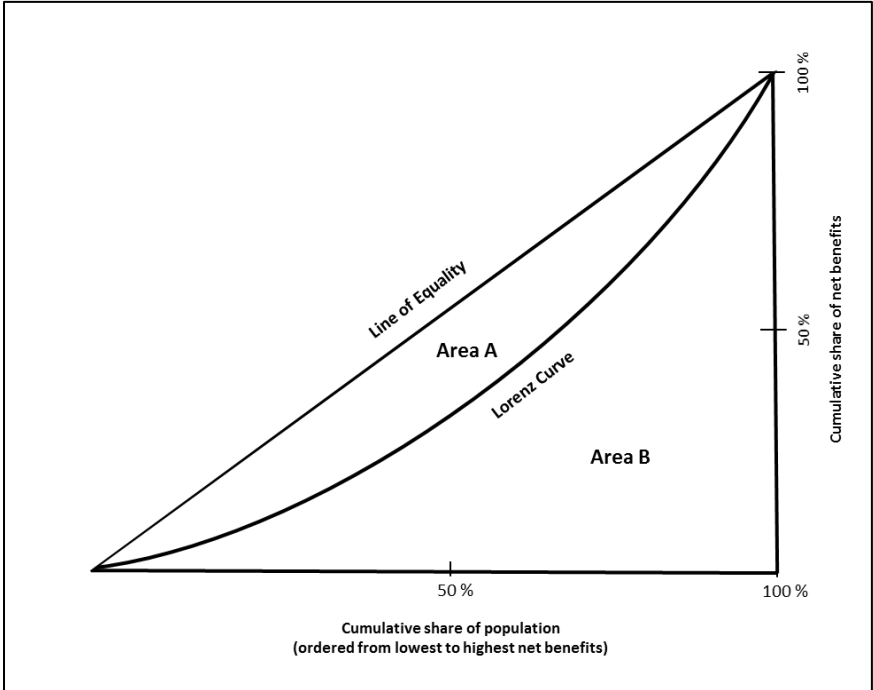
<sup>69</sup> Using the same VSL for all members of the population (\$610,000) erroneously implies that net benefits are positive for all income groups. The calculated benefits would be \$6,100,000, \$3,050,000, and \$1,830,000 for the low-, middle-, and high-income groups, respectively.

results thus raise concerns about whether costs to the poorest individuals should be reduced through subsidies or other measures, or whether a policy option that provides a greater share of the net benefits to the poor might be preferable.

The types of data displayed in this table are an essential starting point for any distributional analysis. However, while such a table describes how the costs and benefits are calculated and distributed, it does not measure the equality of the impacts. Standard inequality indices can be used to summarize the distribution and to compare across differing distributions. Several such measures are available, each of which has advantages and limitations. We provide an example of one commonly used measure below; analysts should review the references cited in Robinson, Hammitt, and Adler (2018) for more information on alternative measures and their advantages and limitations.

Figure 7.3 demonstrates the application of a Lorenz curve and the calculation of the Gini coefficient. A Lorenz curve shows the degree of inequality that exists in the distribution of a variable, such as the fraction of net benefits that accrue to each fraction of the population, represented as a cumulative distribution. The Gini coefficient is a numerical measure of the degree of inequality between the variables. When applied to a Lorenz curve, it is calculated by dividing Area A by the sum of Area A and Area B (because the sum of area A and area B is one-half, the Gini coefficient is equal to twice area A). It measures the departure from a uniform distribution and ranges from a value of zero to one, where zero represents perfect equality and one represents maximum inequality. A value of zero would result if each one percent of the population received one percent of the net benefits; a value of one would result if one individual received all the net benefits.

**Figure 7.3: Lorenz Curve and Gini Coefficient**



While the Gini coefficient is perhaps the most commonly used measure of equality, it is not without limitations. For example, a transfer between individuals will have differing effects on the Gini coefficient depending on their ranking within the distribution and the distribution's shape. In addition, it cannot be easily decomposed by subgroup and only considers a single dimension of inequality (net benefits in the example). Because this and other indices are mathematically complex, they can be challenging to communicate to a nontechnical audience. Clear discussion of the calculations and the implications of the results is needed.

Inequality indices provide useful information on the distribution of impacts. These indices are mathematically complex and each has advantages and limitations. Hence they should be accompanied by a clear discussion of their construction and interpretation.

Providing better information about the distribution does not solve the decision-making problem, however. These metrics do not provide a guide to determining whether the distributional effects are severe enough to warrant selection of a policy that is less efficient but provides a more desirable distribution. Decision-makers still need to decide how to measure and weigh the desirability of the distributional effects.

Distribution and efficiency can be more fully integrated by conducting weighted BCA, in which the costs and benefits accruing to different groups are multiplied by distributional weights that reflect estimates of society's preferences for distribution. Alternatively, policies can be evaluated using a social-welfare function to represent preferences for both the level and distribution of wellbeing.

Applying these more integrative approaches requires first agreeing on the normative framework (or frameworks) to be presented, then agreeing on how to implement the framework in terms of the mathematical formulation and parameter values. While uncertainty related to the appropriate framing could be represented by presenting the analytic results using multiple approaches, implementing these frameworks requires numerous complex decisions. Thus detailed guidance would be needed to facilitate implementation if such functions are to be routinely applied.

### 7.3 Summary and Recommendations

While there is widespread agreement that BCAs should be supplemented with information on how the impacts are distributed across individuals with different attributes (such as varying incomes), reviews of completed analyses suggest that such information is rarely provided. The reasons for this deficiency are unclear: perhaps analysts see this information as unimportant or unnecessary, lack the time and resources to conduct the assessment, need more methodological guidance, or are worried about what they might find.

Regardless, decision-makers and other stakeholders often express interest in this distribution, so that they can weigh the extent to which benefits and costs are counterbalancing for members of various population subgroups and determine the policy implications. To meet this need, analysts should at minimum include information on the distribution of both costs and benefits across groups defined by

income and other attributes of concern. The extent to which the analysis is quantitative or qualitative, as well as its level of detail, should be proportional to the importance of distributional issues. The results should be reported in a clearly labeled, separate section of the analysis, that discusses the available evidence and related uncertainties as well as the implications.

Ideally, both the BCA and the distributional assessment would be conducted concurrently with the policy development process, so that the preliminary results can be used to inform the options to be considered as well as future analytic steps.

Analysts should proceed as follows.

- **Recommendation 8(a): Individuals and Impacts of Concern**
  - i. **Identify the individuals and impacts of concern.** In consultation with decision-makers and other stakeholders, analysts should identify the characteristics of individuals and impacts of concern. At minimum, the distributional analysis should address the effects of the policy on the health, longevity, and income of members of different income groups, including the distribution of both cost and benefits. Analysts should consider whether other impacts and other groupings also should be addressed given the policy and decision-making context.
  - ii. **Determine the level of detail and degree of quantification.** The effort devoted to the distributional analysis should be proportionate to its importance for decision-making. “Importance” may depend on the likely magnitude of the distributional impacts and concerns about associated inequities; it may also depend on the need to respond to questions likely to be raised by decision-makers and others. The extent to which the analysis is quantitative or qualitative, as well as its level of detail, should also take into account the data, time, and resources available. Screening analysis that relies on easily accessible data is often useful in making these determinations.
  
- **Recommendation 8(b): Distributional Metrics**
  - i. **Describe the distribution of both benefits and costs across members of different population groups.** For each policy option assessed, analysts should report the results of the distributional analysis in text, tables, graphics, or other forms. These results should be reported as monetary values and in physical terms to the extent possible; e.g., as net benefits and as expected numbers of deaths, illnesses, and injuries averted. Measures of inequality, such as the Gini coefficient, may also be used; the advantages and limitations of the selected measure(s) should be discussed along with the results.

The findings from such analysis allow decision-makers and others to weigh distributional concerns along with other policy impacts and determine how to best address these concerns within a particular context. Over the long term, more work is needed to provide examples of how to assess the distribution of the impacts of different types of policies, develop recommendations on the application of specific inequality metrics, and consider options for distributional weighting using social-welfare functions.

# Chapter 8. Accounting for Uncertainty and Nonquantifiable Impacts

Any analysis involves uncertainties, including difficulties related to quantifying some potentially important effects. The challenge for the analyst is to determine how to best address these uncertainties to support decision-making. The goal is to ensure that decision-makers and other stakeholders comprehend the extent to which key uncertainties – in the data, models, and assumptions – affect the main analytic conclusions. The analysis should aid decision-makers in understanding the confidence they should have in the results and the likely direction and magnitude of any bias.

For example, if the best estimates suggest that benefits exceed costs for a policy, how likely is it that this conclusion would be reversed given uncertainty about the magnitudes of the quantified effects and the potential impact of nonquantified effects? Might these uncertainties affect the relative rankings of the policy options? Answering these questions requires quantifying impacts to the extent possible, identifying key uncertainties, and exploring them in both qualitative and quantitative terms.

This chapter provides a brief overview of related issues and methods. It is closely related to the discussion of screening analysis in Chapter 2, which discusses issues associated with determining the importance of particular impacts. More information is available in numerous texts and guidance documents, including Morgan and Henrion (1990), Drummond et al. (2015), and Boardman et al. (2018).

## 8.1 Uncertainty in Quantified Effects

The data and models used to estimate costs, benefits, and other impacts are inevitably limited, for example by the quality of the methods used to collect the data, the extent to which the data address the same population as the analysis, and the degree to which economic and other conditions may change between when the data were collected and when the policy is implemented. Projections of future economic growth are also uncertain. Any model, regardless of whether it involves simple formulae or complex computer simulations, requires making assumptions about the relationships between various parameter estimates, which may not be well-understood.

Uncertainty is different from variability; it reflects a lack of knowledge rather than the heterogeneity of the affected population or the policy impacts.

Uncertainty is a different concept than variability. Variability refers to heterogeneity; for example, differences in the ages of those affected by a policy. While variability can be described by statistical measures such as the standard deviation, it may be difficult to characterize precisely given that data may be available for only a small and perhaps non-representative sample of those affected or for a limited geographic area or time period. Variability is a characteristic of the real world which can be better understood but cannot be reduced through more research.



In contrast, uncertainty refers to lack of knowledge. For example, data on the relationship between exposure to a virus and the risk of mortality may be available for only a particular age group, and the analyst may be uncertain whether individuals of different ages would respond similarly to the exposure. Such uncertainty can be reduced by conducting additional research.

There are many options for addressing uncertainty in quantified effects when additional primary research is not possible or desirable due to time or resource constraints or other factors. Three approaches with increasing levels of complexity include qualitative discussion, numerical sensitivity analysis, and probabilistic analysis.

- **Qualitative discussion** is a necessary component of any analysis. It involves disclosing key assumptions and uncertainties and discussing their implications. This discussion should include both the likely direction of the potential bias (i.e., whether the assumption may lead to an under- or over-estimate of the impacts) and the likely magnitude of the effect (e.g., whether it is large or small).
- **Numerical sensitivity analysis** explores the effects of varying the values of key parameters. It should be used at minimum to explore whether uncertainty about key values or assumptions may substantially affect the analytic results. It can be conducted: (1) by changing one variable or assumption at a time; or (2) by varying several variables simultaneously. Specific recommendations for conducting sensitivity analysis of the parameter values discussed in these guidelines are included in the preceding chapters. In interpreting the results, analysts should keep in mind that it is extremely unlikely that all parameters will simultaneously be at their highest or lowest values. Thus the outcome of an analysis that uses lower (or upper) bound estimates for all or most parameters may be improbable.
- **Probabilistic analysis** relies on statistical distributions of parameter values. The results provide information about the spread (e.g., variance) of the likely impacts. To conduct a formal probabilistic analysis, analysts must estimate the joint distribution of the parameters, including any dependencies. Monte Carlo simulation techniques are typically applied, which involve taking a random draw from the joint distribution to produce a value for each parameter and using these values to calculate the outcome measure (e.g., net benefits). These steps are repeated many times to produce a distribution of the outcome measure and its expected value.

When there are gaps or inconsistencies in the empirical research, formal structured expert elicitation is a useful approach for quantifying the effects of uncertainty. Such elicitation is designed to avoid well-known heuristics and biases that can lead to poor judgment. While expert elicitation requires careful design and implementation, it is often informative when the above methods are not sufficient to quantify the impacts of important sources of uncertainty. More information on this method is provided in Morgan and Henrion (1990), Cooke (1991), and O'Hagan et al. (2006).

Regardless of the approach used to assess uncertainty, analysts should take care to avoid the appearance of false precision. Calculations should be performed without any intermediate rounding, but the results generally should be rounded for presentation to reflect the number of significant digits in the input data.

## 8.2 Characterizing Nonquantified Effects

Another challenge is addressing outcomes that cannot be quantified but may have important implications for decision-making. For example, available data may suggest that a disease affects the risk of both mortality and morbidity, but may not be adequate to estimate the change in some of these risks. Without quantification, it is difficult to appropriately balance the benefits associated with each policy option against its costs, or to determine the relative importance of these different types of benefits.

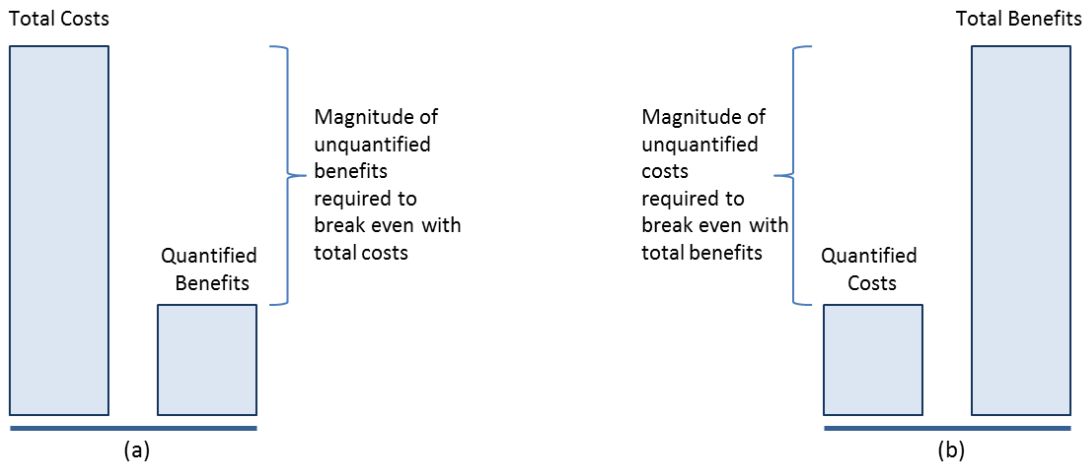
In some cases, the policy may lead to effects that are less tangible and more subject to normative judgment, such as impacts on dignity, equity, or privacy. While it may be difficult to quantify or value these changes, it may be possible to count the number of people affected or report other intermediate measures. However, care must be taken to not conflate intermediate measures with estimates of the benefits or costs of the policy; i.e., its impacts on wellbeing. For example, some policies increase the type or quality of information available and its dissemination, but research may be lacking on how recipients are likely to respond. Reporting the number of recipients may provide useful insights but is not a measure of the effects of the policy on individual or societal welfare.

Ignoring potentially important nonquantified effects may lead to poor decisions, but there is also a danger of overemphasizing them. In the absence of information, decision-makers and others may weight these effects in a manner consistent with their own (unarticulated and perhaps unconscious) beliefs, without sufficiently probing the rationale or the weighting. Clear presentation of the available evidence is needed to counterbalance this tendency.

Options for incorporating nonquantified effects into an analysis depend on the available data and include both quantitative and qualitative approaches. Approaches that involve some calculation include breakeven or bounding analysis. More qualitative approaches include the use of figures or graphics as well as text discussions.

- **Breakeven analysis**, sometimes referred to as threshold analysis, asks “how large would the nonquantified effect(s) have to be to bridge the gap between quantified benefits and costs?” Figure 8.1 provides an example of this concept. Part (a) shows the case where only some of the benefits can be quantified; part (b) illustrates the case where only some of the costs can be quantified. Breakeven analysis is most useful when some information is available on the potential magnitude of the impact, to provide a basis for judging whether the nonquantified effects can plausibly exceed the breakeven amount.

**Figure 8.1: Breakeven Analysis**



- **Bounding or “what-if” analysis** is similar to sensitivity analysis as described above, but typically involves wide ranges based on relatively little data or supporting evidence. Such analysis considers the extent to which benefits are likely to exceed costs based on lower- or upper-bound estimates of the magnitude of the nonquantified effects. It should be presented separately from any sensitivity analysis of the primary estimates of benefits and costs due to the high degree of speculation involved.

The treatment of nonquantified impacts should be tailored to the characteristics of the effect (such as whether it involves intangibles or normative values), the extent to which relevant data are available, and the importance of the effect for decision-making. These impacts should be clearly defined and distinguished from the quantified impacts to avoid the potential for double-counting.

### 8.3 Summary and Recommendations

All analytic results are uncertain to some degree, due to the characteristics of the available data and models and the difficulties of quantifying some potentially important effects. To ensure that decision-makers and other stakeholders appropriately account for these uncertainties, analysts should disclose all data sources and methods used and discuss their advantages and limitations, consistent with the iDSI Reference Case principles (see Appendix A).

- **Recommendation 8.1: Address Uncertainty**
  - i. ***Uncertainty in the results should be addressed both qualitatively and quantitatively.***

Analysts should quantify the impacts of the policy options to the greatest extent practical, and accompany these estimates with clear discussion of associated uncertainties. Sensitivity analysis and/or probabilistic analysis should be used to quantify the impact of uncertainties. The analytic approach and the parameter values to be addressed should be tailored to the magnitude of the impacts and the importance of the uncertainties in the decision-making process.

- **Recommendation 8.2: Address Nonquantified Effects**

- i. ***Nonquantified impacts should be clearly disclosed along with discussion of their potential implications.*** At minimum, analysts should list significant nonquantified effects and discuss them qualitatively. To the extent possible, the effects should be categorized or ranked in terms of their importance within the decision-making context, including their likely direction (e.g., whether they increase or decrease net benefits) and magnitude, and the implications for selecting among policy options. Where some data exist, but are not sufficient to reasonably quantify the effect, analysts should consider whether breakeven or bounding analysis will provide useful insights. Intermediate measures, such as the number of individuals affected, should be reported where available.

The goal of these analyses is to ensure that decision-makers and other stakeholders appropriately weight the analytic results and understand the likely direction and magnitude of any bias. For example, if all the important effects are quantified with a reasonable level of certainty, the decision-maker can be more confident of the findings than if important effects cannot be quantified and the results are highly uncertain. However, in the latter case, careful exploration of the nonquantified results and the uncertainties in the quantified estimates may suggest that benefits consistently exceed costs, or costs consistently exceed benefits, under any reasonable scenario. In such a case, the decision-maker may place more confidence in the results than would be the case without careful exploration of these issues.

# Chapter 9. Summarizing and Presenting the Results

Completed BCAs may be published in many forms, for example, as a stand-alone report or working paper, journal article, or book chapter. The presentation of the analytic approach and the findings will be dictated to some extent by the publication type as well as the intended audience. In this chapter, we briefly discuss some common elements that should be addressed regardless of the publication context. We begin by discussing the measures used to summarize the analytic results, including estimates of net benefits, benefit-cost ratios, and internal rates of return. We also provide a checklist that describes the essential questions that should be addressed in any analysis as well as a standard table for summarizing the results. Appendix A discusses additional reporting standards provided in the IDSI Reference Case.

The BCA should be clearly and comprehensively documented. Where the publication format limits the length of the text, supplemental material should be published online where it can be easily accessed by interested readers. The documentation must describe the problem the policy is designed to address, the options considered, the analytic approach, and the results, as well as the implications of uncertainties.

Without clear communication, the BCA will not meet its intended goal of informing related decisions. This communication should address two audiences. First, it should be written so that members of the lay public can understand the analysis and conclusions. Second, it should provide enough detail so that competent experts could ideally reconstruct the analysis, or at minimum explore the implications of changing key assumptions.

## 9.1 Summary Measures

After benefits and costs have been estimated, the final step is to compare them using a summary measure. In all cases, the present value of total benefits and of total costs should be reported, using a consistent categorization scheme as discussed in Chapter 2 and applying the discount rates discussed in Chapter 3. These totals can then be combined to estimate the present value of net benefits (benefits minus costs) and the benefit-cost ratio (benefits divided by costs).

As long as the distribution of benefits and costs over time is also reported, as recommended in Chapter 3, then the internal rate of return (IRR) can also be calculated. The IRR is the discount rate at which the present value of the net benefits is zero. It can be calculated by rearranging the terms used to calculate present values (see Figure 3.2 in Chapter 3) to solve for this rate. This calculation can be quite difficult; many calculators and spreadsheet programs include a function that allows users to more easily calculate the IRR.

Consistent categorization of impacts as benefits or costs is needed for total benefits, total costs, and benefit-cost ratios to be comparable across analyses. Benefit-cost ratios or IRRs may be useful in prioritizing spending across policies when resources are limited. Analysts will find it useful to also report net benefits to indicate the magnitude of the impacts, regardless of what summary measure is featured.

Regardless of the summary measure featured, a policy should not necessarily be implemented simply because its benefits exceed its costs, its benefit-cost ratio exceeds one, or its IRR is favorable. Comparison to other policies is necessary to identify the most efficient use of the resources. In addition, decision-makers will need to consider issues such as legal, political, and budgetary constraints as well as any distributional concerns.

Which summary measure is highlighted will depend in part on the context. If the primary goal is to explore alternative approaches for addressing a particular problem, then net benefits may be the preferred summary measure. For example, estimates of net benefits may be particularly useful when the government is considering what program to fund or which regulation to issue to address a clearly defined problem. If the primary goal is to determine how to best allocate limited resources across several policies, then the benefit-cost ratio may be informative. The IRR may be of interest when the appropriate discount rate is uncertain or where comparison to financial investments with monetary returns is desired. However, it is generally helpful to also report net benefits regardless of whether the benefit-cost ratio or IRR is highlighted in summarizing the findings, to encourage more comprehensive understanding of the implications.

Unlike net benefits, the benefit-cost ratio is sensitive to whether items are characterized as benefits or costs (that may be positive or negative). Benefit-cost ratios cannot be meaningfully compared unless impacts are consistently included in the same categories, as discussed in Chapter 2. If impacts categorized as costs in an analysis of one policy are counted as negative benefits in the analysis of another policy, the ratios of benefits to costs cannot be meaningfully compared.

Benefit-cost ratios do not indicate the magnitude of the welfare gains. For example, a policy with \$1,000 in benefits and \$100 in costs and a policy with \$1,000,000 in benefits and \$100,000 in costs both have a benefit-cost ratio of 10 to 1. However, the latter policy leads to substantially larger improvements in welfare. Similarly, if the costs of these policies occur in the current year and the benefits occur 10 years later, they have the same IRR (29 percent) but the second policy has the larger present value if the discount rate is smaller than this rate. Another example is a project with \$30,000 in benefits and \$10,000 in costs, which leads to higher net benefits but a smaller ratio than a project with \$10,000 in benefits and \$1,000 in costs. Net benefits are \$20,000 vs. \$9,000, but the benefit-cost ratios are 3 and 10 respectively. Accompanying reported ratios or rates of return with estimates of net benefits aids in ensuring a full understanding of the policy impacts.

Ratios can be very useful when considering the impact of investing the same amount in different policies (e.g., comparing the benefits across two policies that each cost \$10,000) or when considering whether to fund incremental increases in the size of a project (e.g., estimating the incremental benefits associated with an increase of \$1,000 in costs). They also aid in choosing a portfolio of policies to be funded out of a fixed budget. If the costs are the items paid out of that budget and all the other effects are included as benefits, then choosing the set of policies having the highest benefit-cost ratios maximizes the benefits that can be achieved.

The use of benefit-cost ratios may be particularly helpful in low- and middle-income countries where resources are significantly constrained, when the goal of the analysis is to determine how to best allocate these resources. If the tax base and borrowing power are very limited, the government has relatively little ability to fund programs. While funds from foundations or foreign aid may augment these resources and some policy goals may be achievable through regulation rather than direct government spending, in this case the government budget may be essentially fixed.

Care must be taken, however, to consider the relationship between the size of the investment and the benefit-cost ratio. For example, an education program serving 10,000 students may have a very different benefit-cost ratio than an education program serving 10 students due to economies of scale. One option is to begin by examining the benefit-cost ratios for a range of policies to identify those that may be most welfare-enhancing. This subset of policies can then be refined in terms of scale, scope, and detailed design and subject to further assessment.

The IRR can be more difficult to interpret than either net benefits or a benefit-cost ratio. Presumably, an IRR that is higher than the rate that the resources could earn if invested elsewhere (e.g., the discount rates discussed in Chapter 3) suggests that undertaking the project may be worthwhile. However, given uncertainty about the appropriate rate to which the IRR should be compared, it may not be a very useful summary measure if it is within the range of reasonable rates. In addition, there may be more than one IRR for a policy if net benefits change sign (from positive to negative or the opposite) more than once over the time period addressed, and there may be no IRR if the net benefits per year are always positive or always negative. The IRR can be a useful measure for comparing policies with only near-term costs and future benefits, and for screening to identify which policies may be most worthy of further consideration, but should be used and interpreted with care.

More generally, these examples illustrate that the scale of the project matters as does the type of decision the analysis is meant to inform. Regardless of the summary measure used, analysts should include information on important nonquantified effects as well as the implications of uncertainties, as discussed in Chapter 8. Otherwise, the results of the analysis may be misinterpreted and misused.

## 9.2 BCA Checklist

The following checklist describes the essential elements of a BCA that adheres to these guidelines. More information on each component is provided in the previous chapters. We first discuss requirements that apply to the individual analytic components, as introduced in Chapter 2 (see especially Figure 2.1); we then discuss requirements that apply throughout the analysis.

### Analytic Components

- 1) **Define the problem:** Is the problem that the policy is intended to address clearly defined, including the characteristics of the harms to be mitigated and the target population?

- 2) **Identify the policy options:** Does the analysis address a reasonable number of feasible options for addressing the problem? Are these policy alternatives clearly defined?
- 3) **Determine who has standing (perspective):** Does the analysis clearly state whose costs and benefits are to be counted? If the impacts on some potentially affected individuals or groups are excluded, is the rationale for exclusion clearly stated and well-justified? Are the results reported in the aggregate and disaggregated for groups of particular concern?
- 4) **Predict baseline conditions (comparator):** Are expected conditions without the policy clearly defined? For prospective (*ex ante*) analyses, does this projection consider expected changes that may affect the policy impacts; e.g., in the population, the economy, or the technology available? For retrospective (*ex post*) analyses, are the effects of the policy clearly separated from the effects of other changes that occurred over the same time period? If an alternative comparator is used, is the rationale clearly stated and the comparator well-defined?
- 5) **Predict policy responses:** Are the impacts of the policy on individual and organizational behavior clearly defined and distinguished from changes attributable to other factors? Are these impacts based on strong evidence that establishes a causal link between the policy and the behavioral changes? If the evidence is weak or inconsistent, are the associated uncertainties clearly stated and assessed?
- 6) **Estimate costs and benefits:** Does the analysis include a list of all potentially-significant impacts and discuss the rationale for focusing the quantitative analysis on a particular subset? Is the approach for estimating costs and benefits, including the data sources and methods used, clearly communicated?
  - a) Do costs include a reasonably complete list of the inputs or investments needed to implement and operate the policy – including real resource expenditures such as labor and materials? Are any off-setting savings included in these costs?
  - b) Do benefits include a reasonably complete list of the outputs or outcomes of the policy; i.e., the changes in welfare such as reduced risk of death, illness, or injury? Are both improvements and any off-setting harms included in these benefits?
- 7) **Compare benefits to costs:** Are summary measures, such as net benefits, reported for each policy option, including both quantitative and qualitative analysis of uncertainty? If benefit-cost ratios are reported, are the impacts included in the numerator and denominator clearly defined and consistent with the categorization of costs and benefits discussed above? Are the implications for decision-making clearly stated, including the likelihood that each policy yields positive net benefits and the relative ranking of the policy options?
- 8) **Estimate the distribution:** Does the analysis identify groups of concern defined by income or other relevant attributes and describe the distribution of both costs and benefits across these groups?



### **Cross-Cutting Issues**

- 1) Are all data sources and studies used to develop each assumption and estimate each parameter value clearly referenced?
- 2) Are all monetary values inflated (or deflated) to a common currency year? Is this currency year and the approach used to estimate inflation clearly identified?
- 3) Are monetary values reported in both the local currency and an internationally comparable measure? Is the approach used for currency conversions clearly identified?
- 4) Is the base year used in calculating present values clearly stated? Is the discount rate reported? Is the justification for alternative rates discussed? Are the costs and benefits that accrue in each year also reported without discounting?
- 5) Are uncertainties that affect the results clearly described in qualitative terms and assessed quantitatively, including both those that are and are not quantified?
- 6) Are the results and their implications summarized in terms that can be understood by a general audience?

Ensuring that these issues are addressed in the main text, or in supplemental materials as necessary, will aid readers in appropriately interpreting and using the results.

### **9.3 Summary Tables and Figures**

All analyses should include tables and figures that clearly convey the results for each policy option considered, including:

- The distribution of benefits and costs over time (undiscounted);
- The present value of total benefits, total costs, and net benefits and the benefit-cost ratio or IRR if desired; and,
- The distribution of benefits and costs across members of different income and other groups of concern.

In each case, the estimates should be accompanied by information on uncertainties in the estimates and on important nonquantified impacts.

Analysts may find it useful to prepare a summary table similar to the template provided in Figure 9.1, to aid in comparing results across analyses. Ideally, the table would report the results in both the local currency and in internationally-comparable units (see Chapter 3) and would report the results for all of the policy options assessed. Whether estimates are annualized or present values should also be reported.

**Figure 9.1: Summary Table Example**

<b>Identifying information</b> Title: Researchers and affiliations: Date completed: Problem addressed: Policies addressed: Country and specific geographic area addressed: Link to full publication:				
<b>Cross-cutting parameters</b> Currency year: Inflation index: Currency conversion approach and source: Featured discount rate: Alternative discount rates: Time period covered: Base year used in calculating present values:				
<b>Benefits:</b> <ul style="list-style-type: none"> <li>• If benefit is not quantified or monetized, insert N/A in the appropriate cell and discuss potential importance in the comments column.</li> <li>• Values in parentheses should reflect results of uncertainty analysis.</li> </ul>				
<b>Outcome</b>	<b>Units</b>	<b>Value per Unit</b>	<b>Total Value</b>	<b>Comments</b>
Example: Mortality risk reduction	100 statistical cases averted (50 to 200 cases)	\$200,000 (\$70,000 to \$300,000)	\$20 million (\$3.5 million to \$60 million)	Total is annualized value.
<b>Costs:</b> <ul style="list-style-type: none"> <li>• If cost is not quantified or monetized, insert N/A in the appropriate cell and discuss potential importance in the comments column.</li> <li>• Values in parentheses should reflect results of uncertainty analysis.</li> </ul>				
<b>Outcome</b>	<b>Units</b>	<b>Value per Unit</b>	<b>Total Value</b>	<b>Comments</b>
<b>Summary (net benefits, benefit-cost ratios, and/or IRRs):</b>				
<b>Distribution</b> <ul style="list-style-type: none"> <li>• Describe the distribution of costs, benefits, and net benefits (and/or benefit-cost ratios and IRRs) across income and other groups of concern.</li> <li>• Summarize the results of any quantitative assessment.</li> </ul>				

## 9.4 Summary and Recommendations

Clear and comprehensive documentation of the analysis is essential both to inform the decision-making process and to allow comparison of the results to the results of other analyses. It is not possible for any one analysis to address all possible policy options or to explore the effects of all possible analytic approaches and assumptions. This means that even if an analysis is intended to inform a one-time, narrowly-defined decision, it is also likely to be useful in other contexts. These guidelines are intended to promote the extent to which these analyses are both useful and used, by clarifying the conceptual framework and recommending approaches for application. However, if the approach and results are not well-documented, the analysis will not fulfill its intended purpose regardless of its underlying quality.

- **Recommendation 9(a): Categorizing Impacts as Costs or Benefits**
  - i. ***Impacts categorized as “costs” should relate to the implementation of the policy; impacts categorized as “benefits” should relate to its consequences.*** Whether a consequence is categorized as a “cost” or “benefit” is arbitrary and varies across analyses. However, consistent categorization is essential for comparability of benefit-cost ratios, total costs, and total benefits. To promote such comparability, the analysis should distinguish between inputs (costs) and outputs (benefits). Under this scheme, costs are the required inputs or investments needed to implement and operate the policy – including real resource expenditures such as labor and materials, regardless of whether these are incurred by government, private or nonprofit organizations, or individuals. Benefits are then the outputs or outcomes of the policy; i.e., changes in welfare such as reduced risk of death, illness, or injury.
  - ii. ***Counterbalancing effects should be assigned to the same category as the impact they offset.*** For example, “costs” might include expenditures on improved technology as well as any cost-savings that result from its use; “benefits” might include the reduction in disease incidence as well as any offsetting risks, such as adverse reactions to vaccines.
  
- **Recommendation 9(b): Reporting Summary Measures**
  - i. ***The summary measure highlighted in presenting the analytic results should reflect the decision-making context.*** These summary measures may include net benefits (benefits minus costs), the ratio of benefits to costs (benefits divided by costs), and/or the IRR (the discount rate at which the net present value is zero).
  - ii. ***Regardless of whether a benefit-cost ratio or IRR is featured, analysts may often find it useful to report net benefits along with information on the distribution of the impacts.*** Because neither ratios nor IRRs provide information on the magnitude of the potential welfare gains, reporting estimates of net benefits is often useful regardless of whether it is featured in summarizing the results. As discussed in Chapter 8, the distribution of the impacts should also be reported.

- **Recommendation 9(c): Documenting the Approach and the Results**
  - i. ***The analysis should be clearly and comprehensively documented.*** The documentation must describe the problem the policy is designed to address, the options considered, the analytic approach, and the results, as well as the implications of uncertainties. Where the publication format limits the length of the text, supplemental material should be published online where it can be easily accessed by interested readers. Analysts may find it useful to complete a standard table and checklist to ensure that this documentation covers key issues.
  - ii. ***The documentation should be comprehensible to the lay public while also providing adequate information for expert review.*** To inform decision-making, the documentation should be written so that members of the lay public can understand the analysis and conclusions. It should also provide enough detail for expert review; ideally, competent analysts should be able to reconstruct the analysis or at minimum explore the implications of changing key assumptions.

Presenting the analysis so that it can be easily understood by decision-makers and stakeholders and compared to other analyses may require significant effort. However, without such effort the analysis may not play its intended role in the decision-making process and may be misconstrued in ways that lead to suboptimal decisions. Avoiding technical jargon, and using tables and graphics to illustrate key points, will aid in ensuring that the analysis is both useful and used for decision-making.

# Glossary

**Baseline (or counterfactual):** Expected future conditions in the absence of a policy change (Chapter 2).

**Benefits:** Consistent categorization of impacts as costs or benefits is essential for comparability across analyses. In these guidelines, we define benefits as the value of the intended outcomes of a policy, such as reductions in mortality or morbidity risks, as well as any countervailing effects on these outcomes, such as health risk increases. See also definition of “costs.” (Chapters 2 and 9).

**Benefit-cost ratio:** The ratio of benefits to costs. This ratio can be a useful measure of how effectively a policy produces benefits per unit of cost. Benefit-cost ratios cannot be meaningfully compared across analyses unless the classification of benefits and costs is consistent (Chapter 9).

**Benefit Transfer:** See “Value Transfer.”

**Bounding Analysis:** The application of reasonable high and low parameter values to determine the extent to which the analytic results might change given the likely variation in these values (Chapter 8).

**Breakeven Analysis:** Determining the value of an unknown or uncertain parameter at which benefits and costs would be equal, indicating how large the value would need to be to bridge the gap between the quantified benefits and costs. Also referred to as “threshold” analysis (Chapter 8).

**Costs:** Consistent categorization of impacts as costs or benefits is essential for comparability across analyses. In these guidelines, we define costs as the value of the inputs required to implement a policy, including labor, capital, and materials, as well as any offsetting savings. See also definition of “benefits.” (Chapters 2 and 9).

**Disability-Adjusted Life Year (DALY):** A nonmonetary measure that sums years of life lost and years lived with disability. One DALY equals one year of life lost that would otherwise be lived in good health; time spent living in less than full health is measured using weights that indicate the degree of disability. (Chapter 5).

**Discounting:** The process for converting values that accrue in different years to their present value, to reflect individual time preferences and the value of investments forgone (Chapter 3).

**Distribution:** The allocation of costs and benefits across different population groups, defined, for example, by income level (Chapter 7).

**Health-Related Quality of Life (HRQL):** A numerical indicator of health status estimated using a scale anchored at zero and one, where one corresponds to full health and zero corresponds to a state that is as bad as dead (Chapter 5).

**Income Elasticity:** The proportional change in price or quantity associated with a proportional change in real income (Chapter 4).

**Inflation:** Economy-wide increases in prices (Chapter 3).

**Internal Rate of Return (IRR):** The discount rate at which net benefits are zero. There may be more than one IRR for a policy when its net benefits change sign more than once over time and no IRR if net benefits per year are always positive or always negative. The IRR provides a measure of how effectively a policy converts near-term costs to future benefits (Chapter 9).

**Net Benefits:** The difference, benefits minus costs (Chapters 2 and 9).

**Nominal Value:** Values expressed in current-year currency units, reflecting the effects of both inflation and real changes in value over time (Chapter 3).

**Opportunity Cost:** The value of a resource in its best (most welfare-enhancing) use, which is forgone when the resource is used for another purpose (Chapter 2).

**Policy:** Used as a generic term in this document to include projects, programs, interventions, and other actions that affect the wellbeing of multiple individuals in a society (Chapter 1).

**Present Value:** The monetary value in a single base year that is equivalent to a stream of monetary values in different time periods. Values in future periods are discounted to the base year, which is the year in which the costs or benefits of the policy first begin to accrue (Chapter 3).

**Probabilistic Analysis:** The use of distributions of parameter values to explore the effects of uncertainty on an analytic result (Chapter 8).

**Quality-Adjusted Life Year (QALY):** A nonmonetary measure that integrates the duration and severity of health impairment. Calculated by multiplying the amount of time an individual spends in a health state by the HRQL associated with that state, and summing over health states (Chapter 5).

**Real Value:** Values adjusted to a common currency year, removing the effects of inflation (Chapter 3).

**Revealed-Preference Methods:** Estimation of values based on observed behaviors or market prices (Chapter 2).

**Screening Analysis:** Use of readily-available information and simple assumptions to provide preliminary information on potential impacts (Chapter 2).

**Sensitivity Analysis:** Varying one or more key parameter values to explore the effects of uncertainty on the analytic results (Chapter 8).

**Standing:** The definition of whose benefits and costs are to be counted in an analysis (Chapter 2).

**Stated-Preference Methods:** Estimation of values based on surveys or other self-reported data (Chapter 2).

**Statistical Cases:** The expected number of cases, calculated by summing risk changes over the affected population within a defined time period; for example, if 10,000 people each experience a risk reduction of 1 in 10,000 in a given year, then one statistical case is averted (Chapter 4).

**Transfer Payment:** Monetary payments between individuals or groups that do not affect the total resources available to society (Chapter 7).

**Uncertainty:** Lack of knowledge about a parameter value that could be addressed by more research (Chapter 8).

**Value per Statistical Life (VSL):** An individual's marginal rate of substitution between money and mortality risk in a defined time period; often estimated by dividing an individual's WTP for a small change in his or her own risk by the risk change (Chapter 4).

**Value per Statistical Life Year (VSLY):** An individual's marginal rate of substitution between money and life years remaining; often estimated by dividing VSL by remaining life expectancy (Chapter 4).

**Value Transfer:** The application of values from the available research to a policy context that differs in some respects from the context studied. Involves evaluating the quality of the research and its applicability to the policy context, and often includes adjusting the value for differences in income or other factors. May be called "benefit transfer" when used for in valuing benefits (Chapter 2).

**Variability:** Real world heterogeneity (Chapter 8).

**Willingness to Accept Compensation (WTA):** For an improvement, the minimum amount of money an individual would accept to forgo the improvement, such that his or her wellbeing is as good with the money and without the improvement as with the improvement. For a harm, the minimum he or she would require to accept the harm (Chapter 2).

**Willingness to Pay (WTP):** For an improvement, the maximum amount of money an individual would exchange to obtain the improvement, given his or her budget constraints, such that his or her wellbeing is as good with the improvement and having made the payment as without. For a harm, the maximum an individual would pay to avoid the harm (Chapter 2).

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# Appendix A: The iDSI Reference Case

## Methodological Specifications and Reporting Standards

<p><b>Principle 1: Transparency.</b> An economic evaluation should be communicated clearly and transparently to enable the decision maker(s) to interpret the methods and results.</p>	
<p><b>Methodological Specifications:</b></p> <ul style="list-style-type: none"> <li>a) The decision problem must be fully and accurately described.</li> <li>b) Limitations of the economic evaluation in informing policy should be characterized.</li> <li>c) Declarations of interest should be reported.</li> </ul>	<p><b>Reporting Standards:</b></p> <ul style="list-style-type: none"> <li>a) The decision problem should be stated, clearly identifying: <ul style="list-style-type: none"> <li>o population (description and characteristics) in which the intervention would be used</li> <li>o intervention(s) that are being evaluated and its comparator (see principle 2)</li> <li>o outcome that is being assessed (see principle 4).</li> </ul> </li> <li>b) The characteristics of the economic evaluation should be stated, clearly identifying: <ul style="list-style-type: none"> <li>o the relevance for health practice and policy decisions</li> <li>o the constituency that the economic evaluation would seek to inform</li> <li>o the intended user of the economic evaluation.</li> </ul> </li> <li>c) The limitations of the economic evaluation should be transparent, including: <ul style="list-style-type: none"> <li>o limitations in the design, analysis and results</li> <li>o aspects of the economic evaluation that would limit generalisability of results to other constituencies.</li> </ul> </li> <li>d) Declarations of interests should be reported that include: <ul style="list-style-type: none"> <li>o all pecuniary and non-pecuniary interests of the study contributors</li> <li>o all sources of funding that supported conduct of the economic evaluation</li> <li>o nonmonetary sources of support for conduct of the economic evaluation.</li> </ul> </li> </ul>
<p><b>Principle 2: Comparators.</b> The comparator(s) against which costs and effects are measured should accurately reflect the decision problem.</p>	
<p><b>Methodological Specifications:</b></p> <p>At a minimum, the following comparative analysis should be undertaken:</p> <ul style="list-style-type: none"> <li>a) The intervention(s) currently offered to the population as defined in the decision problem as the base case comparator</li> <li>b) A “do nothing” analysis representing best supportive (non-interventional care) for the population as additional analysis</li> </ul>	<p><b>Reporting Standards:</b></p> <ul style="list-style-type: none"> <li>a) Clear description of comparator(s) that includes: <ul style="list-style-type: none"> <li>o basic descriptive information including setting where comparator is administered (especially if setting is different to the intervention)</li> <li>o statement of availability of the comparator across the population being considered.</li> </ul> </li> <li>b) Differences between mean costs and effects of the intervention and chosen comparators should be reported as incremental cost effectiveness ratios.</li> </ul>
<p><b>Principle 3: Evidence.</b> An economic evaluation should consider all available evidence relevant to the decision problem.</p>	
<p><b>Methodological Specifications:</b></p> <ul style="list-style-type: none"> <li>a) Apply a systematic and transparent approach to obtaining evidence and to judgments about evidence exclusion.</li> <li>b) Estimates of clinical effect of intervention and comparator(s) should be informed systematic review of the literature.</li> <li>c) Single-study or trial-based analyses should outline how these are an adequate source of evidence and should ensure that the stated decision problem is specific to particular context and time of the study or trial.</li> <li>d) Budget and time allocated to perform an economic evaluation should not determine selection of evidence.</li> </ul>	<p><b>Reporting Standards:</b></p> <ul style="list-style-type: none"> <li>a) Describe approach used to obtain included evidence.</li> <li>b) Systematic review protocol and evidence search strategies should be made available.</li> <li>c) List sources of all parameters used in economic evaluation.</li> <li>d) Describe areas where evidence is incomplete or lacking.</li> </ul>

<b>Principle 4: Measure of Health Outcome.</b> The measure of health outcome should be appropriate to the decision problem, should capture positive and negative effects on length of life and quality of life, and should be generalizable across disease states.	
<b>Methodological Specifications:</b> a) Disability-Adjusted Life Years (DALYs) averted should be used. b) Other generic measures that capture length and quality of life (e.g., QALYs) can be used in separate analysis where information is available.	<b>Reporting Standards:</b> a) Clear description of method of weighting used to inform the DALY plus b) Discussion of any important outcomes insufficiently captured by the DALY. c) If DALYs not used, provide justification with description of impact of alternative measure.
<b>Principle 5: Costs.</b> All differences between the intervention and the comparator in expected resource use and costs of delivery to the target population(s) should be incorporated into the evaluation.	
<b>Methodological Specifications:</b> a) Estimates should reflect the resource use and unit costs/prices that may be expected if the intervention is rolled out to the population defined in the decision problem. b) Costs not incurred in study settings but likely if intervention is rolled out should be captured in the base case analysis. c) Costs of all resource implications relevant to the decision problem, including donated inputs and out-of-pocket inputs from individuals. d) Analysis should include estimation of changes in cost estimates due to scalability.	<b>Reporting Standards:</b> a) Quantities of resources should be reported separately from their unit costs/prices. b) Capital and fixed costs should be annuitized over the period of implementation. c) Description of how the costs have been validated (e.g. corroboration with other similar interventions in similar settings) d) Any major differences between predicted (modelled) and realized costs should be explained. e) Implications of changes in costs due to scalability of the intervention should be reported. f) Costs should be reported in local currency and in United States dollars. g) Costs should be converted to US\$ and local currency; date and source of the exchange rate should be reported.
<b>Principle 6: Time horizon and discount rate.</b> The time horizon used in an economic evaluation should be of sufficient length to capture all costs and effects relevant to the decision problem; an appropriate discount rate should be used to discount cost and effects to present values.	
<b>Methodological Specifications:</b> a) Lifetime time horizon should be used in first instance. b) A shorter time horizon may be used when shown that all relevant costs and effects are captured. c) 3% annual discount rate for costs and effects in base case, with additional analyses exploring differing discount rates. d) Additional analysis should explore an annual discount rate that reflects the rate for government borrowings. e) When the time horizon is > 30 years, the impact of lower discount rates should be explored in a sensitivity analysis.	<b>Reporting Standards:</b> a) State the time horizon over which costs and effects are being evaluated, including additional analysis if different time horizons have been explored. b) If lifetime time horizon is not used, justify why and report impact of different time horizon(s). c) Clearly state the discount rate used for both costs and effects, and include additional analyses using different discount rates. d) If a 3% annual discount rate is not used, justify why and report impact of different discount rate(s).
<b>Principle 7: Non-health effects and costs outside health budget (perspective).</b> Non-health effects and costs associated with gaining or providing access to health interventions that do not accrue to the health budget should be identified when relevant to the decision problem. All costs and effects should be disaggregated, either by sector of the economy or to whom they accrue.	
<b>Methodological Specifications:</b> a) Base case analysis should reflect direct health costs and health outcomes; however the analysis should adopt a disaggregated societal perspective. b) Non-health effects and costs that fall outside the health budget, to be included in additional analysis; the mechanism of inclusion will depend on the decision problem and context. c) When external funding or individual out-of-pocket payments substitute for costs that would otherwise fall on a health budget, these costs should be included in the analysis; the impact of excluding these should be explored insensitivity analyses.	<b>Reporting Standards:</b> a) Clear description of the result in a base case analysis, plus b) Alternative analyses exploring impact of patient out of pocket payments and external funding should be explored. c) Non-health effects and costs that fall outside the health sector should be reported and the mechanisms used to reported impact of these cost and effects should be explained and justified. d) If non-health effects and costs that fall outside the health sector are not included, the reasons should be reported and estimations of the potential impact of these exclusions made.



<b>Principle 8: Heterogeneity.</b> The cost and effects of the intervention on subpopulations within the decision problem should be explored and the implications appropriately characterized.	
<p><b>Methodological Specifications:</b></p> <p>a) Heterogeneity should be explored in population subgroups, where subgroup formation should be informed by:</p> <ul style="list-style-type: none"> <li>○ relevant effect of the intervention differs in different populations</li> <li>○ characteristics of different populations that may influence the absolute health effects</li> <li>○ characteristics that influence direct costs of provision or other associated costs across the constituency.</li> </ul> <p>b) Subgroup analysis should always be determined by:</p> <ul style="list-style-type: none"> <li>○ the evidence base regarding differences in relative effect, baseline risk, or other characteristics</li> <li>○ whether the differences have an important influence on costs and effects.</li> </ul>	<p><b>Reporting Standards:</b></p> <p>a) Clear reporting of:</p> <ul style="list-style-type: none"> <li>○ subgroup characteristics and justification of why particular groups are chosen for subgroup analysis</li> <li>○ evidence base used to determine subgroup specification</li> <li>○ the cost-effectiveness of the intervention in the different subgroups</li> <li>○ subgroups with potentially important differences in costs and effects but have not been included in analysis due to lack of evidence.</li> </ul>
<b>Principle 9: Uncertainty.</b> The uncertainty associated with an economic evaluation should be appropriately characterized.	
<p><b>Methodological Specifications:</b></p> <p>a) The economic evaluation should explore:</p> <ul style="list-style-type: none"> <li>○ uncertainty in the structure of the analysis</li> <li>○ uncertainty due to source of parameters</li> <li>○ uncertainty due to precision of parameters.</li> </ul>	<p><b>Reporting Standards:</b></p> <p>a) The effects of all types of uncertainty should be clearly reported, noting impact on final results.</p> <p>b) Uncertainty due to precision of parameters should be characterised using sensitivity analysis appropriate to the decision problem.</p> <p>c) The likelihood of making the wrong decisions given the existing evidence should be addressed.</p>
<b>Principle 10: Constraints.</b> The impact of implementing the intervention on the health budget and on other constraints should be clearly and separately identified.	
<p><b>Methodological Specifications:</b></p> <p>a) Budget impact analysis should estimate the implications of implementing the intervention on various budgets.</p> <p>b) Budget impact analysis should reflect the decision problem and the constituency in which the intervention will be used.</p>	<p><b>Reporting Standards:</b></p> <p>a) Disaggregated and annualized budget impact analysis should be reported that shows budget implications:</p> <ul style="list-style-type: none"> <li>○ government and social insurance budgets</li> <li>○ households and out of pocket expenses</li> <li>○ third-party payers</li> <li>○ external donors.</li> </ul>
<b>Principle 11: Equity considerations.</b> An economic evaluation should explore the equity implications of implementing the intervention.	
<p><b>Methodological Specifications:</b></p> <p>a) There are various mechanisms available for assessing equity implications of an intervention:</p> <ul style="list-style-type: none"> <li>○ The method chosen should be appropriate to the decision problem and justifiable to the decision maker.</li> <li>○ Equity implications should be considered at all stages of the evaluation, including design, analysis, and reporting.</li> </ul>	<p><b>Reporting Standards:</b></p> <p>a) The method used to incorporate equity implications should be clearly and transparently explained.</p> <p>b) A minimum level of reporting should include a description of particular groups within the constituency that may be disproportionately positively or negatively affected by a decision to implement (or not implement) the intervention.</p>
Source: <a href="https://www.idsihealth.org/resource-items/idsi-reference-case-for-economic-evaluation/">https://www.idsihealth.org/resource-items/idsi-reference-case-for-economic-evaluation/</a> as viewed May 2019.	

# Appendix B: Population-Average VSL

## Estimates by Country

In this appendix, we provide VSL estimates for the countries categorized as low- or middle-income by the World Bank, based on their 2015 income levels. All estimates are reported in international dollars based on purchasing power parity. The countries are listed in order of GNI per capita, from highest to lowest.

### VSL Estimates for Standardized Sensitivity Analysis (2015 international dollars)

Country Name	GNI per capita <sup>a</sup>	Value per Statistical Life		
		GNI per capita *160	GNI per capita *100	Extrapolated from U.S. VSL with elasticity = 1.5 <sup>b</sup>
Malaysia	\$25,880	\$4,140,800	\$2,588,000	\$2,809,030
Turkey	\$24,570	\$3,931,200	\$2,457,000	\$2,598,470
Russian Federation	\$24,030	\$3,844,800	\$2,403,000	\$2,513,279
Kazakhstan	\$23,530	\$3,764,800	\$2,353,000	\$2,435,246
Romania	\$21,060	\$3,369,600	\$2,106,000	\$2,062,042
Panama	\$20,210	\$3,233,600	\$2,021,000	\$1,938,472
Argentina	\$19,950	\$3,192,000	\$1,995,000	\$1,901,185
Mauritius	\$19,940	\$3,190,400	\$1,994,000	\$1,899,756
Equatorial Guinea	\$19,920	\$3,187,200	\$1,992,000	\$1,896,898
Bulgaria	\$17,750	\$2,840,000	\$1,775,000	\$1,595,539
Iran, Islamic Rep.	\$17,620	\$2,819,200	\$1,762,000	\$1,578,043
Belarus	\$17,550	\$2,808,000	\$1,755,000	\$1,568,649
Azerbaijan	\$17,100	\$2,736,000	\$1,710,000	\$1,508,704
Mexico	\$16,860	\$2,697,600	\$1,686,000	\$1,477,054
Montenegro	\$16,690	\$2,670,400	\$1,669,000	\$1,454,771
Gabon	\$16,430	\$2,628,800	\$1,643,000	\$1,420,909
Botswana	\$16,090	\$2,574,400	\$1,609,000	\$1,377,032
Iraq	\$15,780	\$2,524,800	\$1,578,000	\$1,337,428
Maldives	\$15,780	\$2,524,800	\$1,578,000	\$1,337,428
Suriname	\$15,640	\$2,502,400	\$1,564,000	\$1,319,669
Thailand	\$15,380	\$2,460,800	\$1,538,000	\$1,286,899
Brazil	\$15,280	\$2,444,800	\$1,528,000	\$1,274,369
Turkmenistan	\$15,220	\$2,435,200	\$1,522,000	\$1,266,870
Costa Rica	\$15,180	\$2,428,800	\$1,518,000	\$1,261,879
China	\$14,400	\$2,304,000	\$1,440,000	\$1,165,880

Country Name	GNI per capita <sup>a</sup>	Value per Statistical Life		
		GNI per capita *160	GNI per capita *100	Extrapolated from U.S. VSL with elasticity = 1.5 <sup>b</sup>
Palau	\$14,230	\$2,276,800	\$1,423,000	\$1,145,295
Algeria	\$14,140	\$2,262,400	\$1,414,000	\$1,134,447
Lebanon	\$14,060	\$2,249,600	\$1,406,000	\$1,124,833
Dominican Republic	\$13,610	\$2,177,600	\$1,361,000	\$1,071,266
Colombia	\$13,560	\$2,169,600	\$1,356,000	\$1,065,368
Macedonia, FYR	\$13,330	\$2,132,800	\$1,333,000	\$1,038,377
Serbia	\$13,210	\$2,113,600	\$1,321,000	\$1,024,387
Grenada	\$13,130	\$2,100,800	\$1,313,000	\$1,015,096
South Africa	\$12,840	\$2,054,400	\$1,284,000	\$981,652
Peru	\$12,100	\$1,936,000	\$1,210,000	\$898,024
St. Lucia	\$11,870	\$1,899,200	\$1,187,000	\$872,541
Sri Lanka	\$11,620	\$1,859,200	\$1,162,000	\$845,122
Bosnia and Herzegovina	\$11,600	\$1,856,000	\$1,160,000	\$842,941
Ecuador	\$11,250	\$1,800,000	\$1,125,000	\$805,080
Albania	\$11,170	\$1,787,200	\$1,117,000	\$796,507
Mongolia	\$11,160	\$1,785,600	\$1,116,000	\$795,438
Tunisia	\$11,090	\$1,774,400	\$1,109,000	\$787,966
St. Vincent and the Grenadines	\$11,080	\$1,772,800	\$1,108,000	\$786,900
Indonesia	\$10,680	\$1,708,800	\$1,068,000	\$744,675
Egypt, Arab Rep.	\$10,570	\$1,691,200	\$1,057,000	\$733,200
Namibia	\$10,560	\$1,689,600	\$1,056,000	\$732,160
Dominica	\$10,240	\$1,638,400	\$1,024,000	\$699,133
Kosovo	\$9,840	\$1,574,400	\$984,000	\$658,571
Georgia	\$9,350	\$1,496,000	\$935,000	\$609,997
Armenia	\$9,090	\$1,454,400	\$909,000	\$584,731
Jordan	\$8,940	\$1,430,400	\$894,000	\$570,317
Philippines	\$8,850	\$1,416,000	\$885,000	\$561,727
Paraguay	\$8,690	\$1,390,400	\$869,000	\$546,562
Fiji	\$8,610	\$1,377,600	\$861,000	\$539,032
Jamaica	\$8,350	\$1,336,000	\$835,000	\$514,801
Swaziland	\$8,340	\$1,334,400	\$834,000	\$513,877
Belize	\$8,120	\$1,299,200	\$812,000	\$493,678
El Salvador	\$8,000	\$1,280,000	\$800,000	\$482,775

Country Name	GNI per capita <sup>a</sup>	Value per Statistical Life		
		GNI per capita *160	GNI per capita *100	Extrapolated from U.S. VSL with elasticity = 1.5 <sup>b</sup>
Ukraine	\$7,850	\$1,256,000	\$785,000	\$469,261
Morocco	\$7,620	\$1,219,200	\$762,000	\$448,789
Guatemala	\$7,570	\$1,211,200	\$757,000	\$444,379
Bhutan	\$7,520	\$1,203,200	\$752,000	\$439,984
Guyana	\$7,470	\$1,195,200	\$747,000	\$435,603
Bolivia	\$6,720	\$1,075,200	\$672,000	\$371,675
Angola	\$6,250	\$1,000,000	\$625,000	\$333,373
Uzbekistan	\$6,200	\$992,000	\$620,000	\$329,380
Cabo Verde	\$6,070	\$971,200	\$607,000	\$319,075
India	\$6,060	\$969,600	\$606,000	\$318,287
Tuvalu	\$6,030	\$964,800	\$603,000	\$315,926
Nigeria	\$5,880	\$940,800	\$588,000	\$304,212
Lao PDR	\$5,860	\$937,600	\$586,000	\$302,661
Congo, Rep.	\$5,840	\$934,400	\$584,000	\$301,113
Samoa	\$5,800	\$928,000	\$580,000	\$298,025
West Bank and Gaza	\$5,700	\$912,000	\$570,000	\$290,350
Vietnam	\$5,610	\$897,600	\$561,000	\$283,501
Tonga	\$5,580	\$892,800	\$558,000	\$281,230
Moldova	\$5,410	\$865,600	\$541,000	\$268,476
Marshall Islands	\$5,400	\$864,000	\$540,000	\$267,732
Pakistan	\$5,310	\$849,600	\$531,000	\$261,067
Nicaragua	\$5,280	\$844,800	\$528,000	\$258,858
Myanmar	\$5,160	\$825,600	\$516,000	\$250,083
Honduras	\$4,280	\$684,800	\$428,000	\$188,919
Kiribati	\$4,200	\$672,000	\$420,000	\$183,647
Sudan	\$4,150	\$664,000	\$415,000	\$180,377
Micronesia, Fed. Sts.	\$4,140	\$662,400	\$414,000	\$179,726
Ghana	\$4,060	\$649,600	\$406,000	\$174,542
Papua New Guinea	\$4,040	\$646,400	\$404,000	\$173,254
Zambia	\$3,800	\$608,000	\$380,000	\$158,047
Mauritania	\$3,690	\$590,400	\$369,000	\$151,234
Timor-Leste	\$3,690	\$590,400	\$369,000	\$151,234
Bangladesh	\$3,550	\$568,000	\$355,000	\$142,709

Country Name	GNI per capita <sup>a</sup>	Value per Statistical Life		
		GNI per capita *160	GNI per capita *100	Extrapolated from U.S. VSL with elasticity = 1.5 <sup>b</sup>
Cameroon	\$3,450	\$552,000	\$345,000	\$136,722
Tajikistan	\$3,360	\$537,600	\$336,000	\$131,407
Côte d'Ivoire	\$3,350	\$536,000	\$335,000	\$130,821
Kyrgyz Republic	\$3,310	\$529,600	\$331,000	\$128,485
Cambodia	\$3,290	\$526,400	\$329,000	\$127,322
Lesotho	\$3,210	\$513,600	\$321,000	\$122,706
São Tomé and Príncipe	\$3,130	\$500,800	\$313,000	\$118,148
Kenya	\$2,990	\$478,400	\$299,000	\$110,310
Yemen, Rep.	\$2,710	\$433,600	\$271,000	\$95,184
Tanzania	\$2,610	\$417,600	\$261,000	\$89,964
Nepal	\$2,500	\$400,000	\$250,000	\$84,337
Senegal	\$2,370	\$379,200	\$237,000	\$77,845
Solomon Islands	\$2,170	\$347,200	\$217,000	\$68,202
Benin	\$2,110	\$337,600	\$211,000	\$65,393
Chad	\$2,110	\$337,600	\$211,000	\$65,393
Mali	\$1,980	\$316,800	\$198,000	\$59,444
Afghanistan	\$1,940	\$310,400	\$194,000	\$57,652
Zimbabwe	\$1,790	\$286,400	\$179,000	\$51,096
Rwanda	\$1,780	\$284,800	\$178,000	\$50,669
Guinea	\$1,770	\$283,200	\$177,000	\$50,242
Haiti	\$1,770	\$283,200	\$177,000	\$50,242
Uganda	\$1,740	\$278,400	\$174,000	\$48,970
South Sudan	\$1,700	\$272,000	\$170,000	\$47,292
Burkina Faso	\$1,630	\$260,800	\$163,000	\$44,401
Ethiopia	\$1,630	\$260,800	\$163,000	\$44,401
Gambia, The	\$1,620	\$259,200	\$162,000	\$43,993
Guinea-Bissau	\$1,570	\$251,200	\$157,000	\$41,972
Comoros	\$1,510	\$241,600	\$151,000	\$39,589
Madagascar	\$1,410	\$225,600	\$141,000	\$35,722
Sierra Leone	\$1,380	\$220,800	\$138,000	\$34,588
Togo	\$1,300	\$208,000	\$130,000	\$31,625
Mozambique	\$1,170	\$187,200	\$117,000	\$27,002
Malawi	\$1,120	\$179,200	\$112,000	\$25,289

Country Name	GNI per capita <sup>a</sup>	Value per Statistical Life		
		GNI per capita *160	GNI per capita *100	Extrapolated from U.S. VSL with elasticity = 1.5 <sup>b</sup>
Niger	\$940	\$150,400	\$94,000	\$19,445
Burundi	\$800	\$128,000	\$80,000	\$16,000 <sup>c</sup>
Congo, Dem. Rep.	\$740	\$118,400	\$74,000	\$14,800 <sup>c</sup>
Liberia	\$720	\$115,200	\$72,000	\$14,400 <sup>c</sup>
Central African Republic	\$670	\$107,200	\$67,000	\$13,400 <sup>c</sup>
American Samoa	NR	NR	NR	NR
Cuba	NR	NR	NR	NR
Djibouti	NR	NR	NR	NR
Eritrea	NR	NR	NR	NR
Korea, Dem. Rep.	NR	NR	NR	NR
Libya	NR	NR	NR	NR
Somalia	NR	NR	NR	NR
Syrian Arab Republic	NR	NR	NR	NR
Vanuatu	NR	NR	NR	NR
Venezuela, RB	NR	NR	NR	NR

Notes:

NR = GNI per capita (2015 international dollars) not reported by the World Bank.

a. The World Bank uses GNI per capita calculated using exchange rates and its Atlas method to classify countries by income level; this table includes the same list of countries but instead reports GNI per capita using purchasing power parity.

b. Derived from U.S. VSL = \$9.4 million, U.S. GNI per capita = \$57,900, income elasticity = 1.5. Values are not allowed to drop below 20 times GNI per capita as a lower bound. See main text for discussion.

c. Reported value is lower bound of 20 times GNI per capita.