Handbook for the Economic Analysis of Health Sector Projects

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Foreword

This *Handbook for the Economic Analysis of Health Sector Projects* is an output of a study undertaken by the Economics and Development Center (EDRC) of the Asian Development Bank (ADB) under the regional technical assistance *RETA 5761: Strengthening the Capacity for Economic Analysis of Health Sector Projects in Developing Member Countries*. The study was preceded by the preparation of an Issues Paper based on a review of methods and approaches in health sector project economic analysis. A summary version of the Issues Paper has also been published as an EDRC Economic Staff Paper entitled *Economic Analysis of Health Sector Projects—A Review of Methods and Approaches*.

This *Handbook* was prepared in a participatory way by interacting with ADB's economists and health sector specialists and in cognizance of ADB's Policy for the Health Sector. The various stages of preparation in the early draft of this *Handbook* went through interdepartmental reviews and discussions in several workshops, thus benefiting from the comments and suggestions received. In addition, a workshop for government officials of selected developing member countries involved in health sector project planning and evaluation was conducted on 9–13 August 1999 at the ADB headquarters in Manila. The workshop provided an opportunity for the government officials to familiarize themselves with the concepts and methods illustrated and recommended in this *Handbook*, as well as with ADB's policy and practice in the health sector. During the workshop, and also subsequent to it, the workshop participants provided feedback to the finalization process of this *Handbook*, further enhancing its quality and user-friendliness.

It is intended that this *Handbook* assist in enhancing the quality of health sector projects before their approval; and also in monitoring their implementation and post-evaluation. For this reason, concerned ADB staff, government officials and their consultants are encouraged to avail of its proper use in both the processes of planning and evaluation of health sector projects. This *Handbook* provides techniques as well as illustrations of their applications. Since time, resources, and data availability vary from country to country and from project to project, project economists will have to choose the most appropriate approach for project decision making, with due consideration to the trade-off between the resources required and the resulting improvement in the quality of the economic analysis and its implication. Furthermore, this *Handbook* should be used together with ADB's *Guidelines for the Economic Analysis of Projects, 1997* mainly for general aspects of project economic analysis which are referred to but not repeated in this *Handbook*.

Finally, on behalf of the EDRC, I would like to express sincere gratefulness as well as congratulations to all the ADB staff, consultants, and the workshop participants for their generous contribution to the preparation and finalization of this *Handbook*—and for a job well done.

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Acknowledgement

This *Handbook* is a product of the work of Asian Development Bank staff and consultants under the overall supervision of Jungsoo Lee, Chief Economist and David Edwards, Assistant Chief Economist. ADB Senior Economist Ramesh Adhikari led the team while Anneli Lagman provided research assistance and Rina Sibal, administrative and word processing support.

Ramesh Adhikari developed the concept, designed the project, and worked with consultants and other ADB staff in the preparation of this *Handbook*. He also designed the consultative workshop held in Manila on 9–13 August 1999 with the health sector government officials of the developing member countries involved, providing a capacity building and training opportunity to them. Manabu Fujimura, Economist, Project Economic Evaluation Division (EDEV) took the responsibility of implementing the workshop and overseeing the publication of this Handbook, with assistance from Marcelia Garcia.

Gerard Russo, professor from the University of Hawaii, U.S.A., contributed to the early part of the work, particularly in the area of conceptual exposition of demand analysis for health sector projects. Paul Gertler, professor, HAAS, Berkeley, U.S.A., contributed the section on sector review and its scope in health sector project planning. John Weiss, professor, University of Bradford, United Kingdom contributed in the area of developing quantitative economic analysis techniques and their illustrations. He also consolidated the entire *Handbook* and assisted in the conduct of the workshop as the resource person. Masako Ii, associate professor, Yokohama National University, Japan and Yasushi Ohkusa, associate professor, Osaka University, Japan contributed the appendix on price elasticity of demand for health care services. Many ADB staff including Ben Loevinsohn, Indu Bhushan, Vincent de Wit, Patricia Moser, Isabel Ortiz, Jacques Jeugmans, Steve van der Tak, and Armin Bauer, also contributed to this *Handbook* by providing valuable feedback, comments, and suggestions.

Consuelo Macapagal, staff consultant, did the copy editing and overall design of the *Handbook*, while Ruby Razon of the Editing Unit, EDEV and Judy Yñiguez of the Printing Unit handled format editing and layouting of the final manuscript for publication.

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Abbreviations

ADB	Asian Development Bank
AIDS	acquired immunodeficiency syndrome
ARI	acute respiratory infection
BCG	bacille calmette guerin
CEI	cost-effectiveness indicator
DALY	disability adjusted life years
DECS	Department of Education, Culture and Sports
DMC	developing member country
DOH	Department of Health
DPTT	Diptheria-Pertussis-Tetanus
DSWD	Department of Social Welfare and Development
GNP	gross national product
HIE	Health Insurance Experiment
HIV	human immunodeficiency virus
HLD	healthy life days
HYLG	healthy years of life gained
IRR	internal rate of return
LSMS	Living Standards Measurements Study
NGO	nongovernment organization
NHA	National Health Account
NPV	net present value
ORS	oral rehydration solution
ORT	oral rehydration therapy
PHC	primary health care
RRP	report and recommendation of the President
SCF	standard conversion factor
SERF	shadow exchange rate factor
SI	sensitivity indicator
STD	sexually transmitted disease
SV	switching value
TB	tuberculosis
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VHW	village health worker
WHO	World Health Organization
WTP	willingness to pay
YLG	years of life gained

Note: In this *Handbook*, "$" refers to US dollars.

1 Introduction

Development of the health sectors within the developing member countries (DMCs) is consistent with the Asian Development Bank (ADB) major goal of social and economic progress of member countries. Because health and physical well being are essential to the formation and maintenance of human capital, success in the health sector is inextricably linked to ADB's strategic objectives of economic growth, poverty alleviation, human resource development, and improved status of women. Nevertheless, careful consideration must be taken as to which potential health projects are undertaken and which members of the DMCs' populations will be the ultimate beneficiaries. Public interventions in health and other sectors should be as efficient as possible, maximizing benefits and minimizing costs. Economic analysis of projects has an important role in achieving these objectives.

Health Sector Strategy

Economic analysis of health sector projects is an internal activity consistent with and supportive of ADB's health policy and overall health sector strategy. As set out in ADB's *Policy for the Health Sector* (February 1999), ADB's activities in the health sector will be guided by the following strategic considerations:

(i) ADB will work to improve the health of the poor, women, children, and indigenous peoples by (a) increasing its lending for the health sector and maintaining its current emphasis on primary health care (including reproductive health, family planning, and selected nutrition interventions); and (b) focusing on vulnerable groups with particular attention to women as well as measuring the extent to which the poor, women, and indigenous peoples have access to health services.

(ii) ADB will maintain a focus on achieving tangible, measurable results by (a) further strengthening the monitoring and evaluation of all health sector activities; (b) emphasizing interventions with strong evidence of effectiveness; (c) improving the quality of loans at entry; and (d) improving implementation of health sector activities.

(iii) ADB will support the testing of innovative approaches and the rapid deployments of effective and affordable new technologies by (a) financing pilot tests of new approaches to health care financing, organization, and management; and (b) helping support the deployment of new technologies, particularly new vaccines.

(iv) ADB will play a significant role in health sector reform by encouraging DMC governments to take an appropriate and activist role in the health sector. This will involve engaging in policy dialogue to encourage DMCs to (a) increase their budgetary allocations for primary health care; (b) diversify their resources of health care financing; (c) collaborate more extensively with the private sector; and (d) increase support for public goods such as research, health education, and regulation.

(v) ADB will increase the efficiency of its health sector investments by (a) helping to strengthen management capacity of the public sector in the DMCs; and (b) improving its economic and sector work, and strengthening linkages with other sectors.

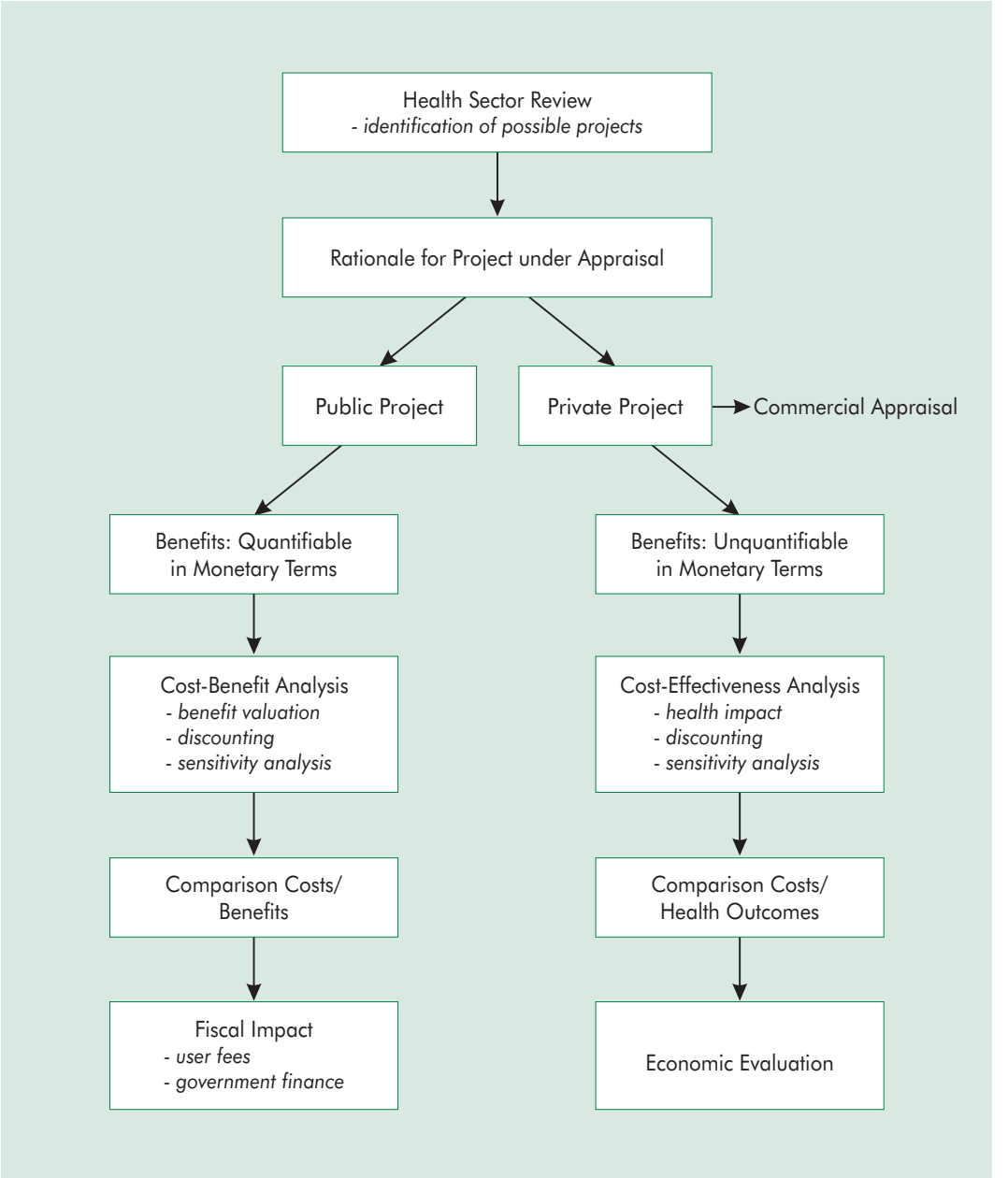
Scope of Economic Analysis in the Health Sector

Unlike in other sectors, benefit valuation in health is both difficult and controversial since it involves placing values on changes in health outcomes. Even where it is possible to accurately estimate individuals' own subjective valuations, the full social value involved may still not be captured because of either the external effects which the individuals are unconcerned with or the merit want characteristic of health impacts. Hence, although there may be situations wherein approximate estimates of benefits from health projects may be necessary, these will be relatively rare and, by necessity, such estimates will be largely illustrative of the possible monetary benefits. The general procedures of economic analysis across all sectors are set out in ADB's general economic guidelines (*Guidelines 1997*) which highlights areas of special concern for health projects.

Project economic analysis in the health sector is concerned primarily with finding the most efficient projects to meet government and ADB objectives for the health of the population. These objectives will normally include a major focus on equity in access to health services. *Figure 1* gives a simple depiction of the steps involved.

The ideas for projects will emerge from an assessment of the health sector and alternative versions of project ideas should be considered early in the planning sequence. Further, since in all DMCs public resources are constrained and private involvement in the sector is encouraged, there will be a choice as to whether a project should be in the public or the private sector. If the private sector is willing to invest to meet particular needs, the project involved should be subject to a form of commercial or financial appraisal by the private investors. The *Handbook* does not cover commercial appraisal explicitly because it is a relatively straightforward exercise without the need for much economic skills. General economic skills required in commercial appraisals such as demand analysis is covered in Chapter 4. But if it is to be in the public sector, an economic appraisal will have to be required. *Figure 1* indicates that this can take two forms: a full cost-benefit analysis where benefits and costs are compared; or a more limited cost-effectiveness analysis where costs are compared with health outcomes. The latter is likely to be far more common and hence, in this *Handbook*, more attention is given to the application of cost-effectiveness analysis. There should be important feedback between the results of project economic analysis and sector reviews since the former should supply information to the latter on the operation of agents within the sector. This, in turn, will have implications for the identification and design of future projects.

Figure 1
Steps in the Economic Analysis of Health Projects



Economic analysis should be used in guiding investment decisions within the publicly financed health sector. It can advise on both the alternative ways of meeting narrowly defined objectives (such as use of family planning techniques) or the alternative broader multiple interventions (such as preventive versus curative treatments). In the first instance, relatively simple cost-effective indicators (described here as process indicators) is adequate; in the latter, more complex weighted cost-effective indicators such as Disability Adjusted Life Years (DALY) are needed. On the other hand, there may be a few situations where health projects will compete for funds with projects from other sectors. Here, a full cost-benefit analysis comparing economic rates of return and net present values (NPVs) is, in principle, desirable. *Box 1* summarizes the possibilities.

In summary, the *Handbook* suggests the following main conclusions:

(i) Economic analysis of health sector projects is meant to assist decision making by selecting projects that achieve desired health out comes at the minimum possible cost of resources.

(ii) Economic analysis should be broad enough to look at the macro economic and sector implications, economic efficiency, equity considerations, and project sustainability.

(iii) As in the case of any project, it is desirable for all health sector projects at the initial planning stage to assess demand or need for the proposed project and to consider alternative variants of the project, then select the most appropriate one.

(iv) Normally, cost considerations in relation to desired health outcome/ benefit should be one of the key factors in selecting what alternative to pursue.

(v) An economic rationale for public sector involvement should be established and a most efficient delivery system, regardless of public or private sector involvement, should be formed.

(vi) Regarding economic evaluation techniques, in the case of projects where health benefits/outcomes are meaningfully valued in monetary terms, they may be subjected to a full cost-benefit analysis in which the economic values of health benefits are compared with the economic costs of the project, and an internal rate of return (IRR) higher than economic opportunity cost of capital, commonly 10-12 percent in ADB's practice, will be the bases for project selection.

(vii) Where health benefits/outcomes are not possible to value in monetary terms because of the intrinsic difficulty of health benefit valuation,

Box 1
Possible Analytical Tools for Economic Evaluation of Health Projects

Health Sector Interventions and Scope of Comparisons	Possible Choice of Analytical Tool	Examples
• Single intervention • Single disease • Single age group	• Cost-effectiveness, when definition of effects is narrow	• Tuberculosis therapy • Measles immunization • Family planning methods
• Multiple interventions • Multiple diseases • Single age group	• Broader definition of effects; weighted cost-effectiveness (cost-utility) analysis	• Child health program • EPI (immunization)
• Multiple interventions • Multiple diseases • Multiple age groups		• Formulation of primary health care programs, public health strategy
• Alternative delivery systems and interventions across the sector		• PHC vs. hospitals • Preventive vs. curative, lower- vs. upper-level services
• Health sector investment compared to investments in other sectors • Complex project objectives	• Must use cost-benefit analysis	• Education vs. health • Health vs. agriculture • Industry project with both health status and economic efficiency objectives

Source: Barnum, H. 1995. *Economic Evaluation of Health Projects,* Human Development Department, Human Capital Development and Operations Policy, The World Bank.

cost-effectiveness to health outcome ratio based on weighted and discounted cost per unit of health outcome such as healthy years of life gained (HYLG) may be relied upon.

(viii) Like in the case of any project, economic analysis of health sector projects should go beyond the calculation of cost-benefit or cost-effectiveness ratios and examine the project's distributional impact to find out whether the benefits are likely to reach the targeted beneficiaries, as well as to

assess whether there are adequate arrangements for necessary institutional capability and financial resources to sustain project activities.

(ix) A project framework analysis is useful in both the design and implementation of health sector projects.

The *Handbook* explains basic economic principles and analytical techniques as applied to health sector projects, and demonstrates their applications in real life project situations.

Organization of the Handbook

The rest of the *Handbook* is organized as follows. Chapter 2 discusses the importance of a detailed review of the health sector in a health sector project or program preparation while looking at, among others, demand for and supply of health care services, regulations, institutions, and financing aspects. Chapter 3 presents discussions on project rationale, alternative project designs, and the role of government or situations where public interventions could be justified. Chapter 4 focuses on the importance of the analysis of demand and need for health sector projects and the basis for their size and operation. Chapter 5 provides the details on the concept and application of conventional cost-benefit analysis and cost-effectiveness analysis in health sector projects. Chapter 6 is devoted to the discussion on the valuation of health benefits and identification of beneficiary impact. Chapter 7 demonstrates the use of sensitivity analysis in the same context. Finally, Chapter 8 discusses economic evaluation and decision rules, highlighting project acceptability criteria, fiscal impact, project framework analysis, required policy reforms, ex-post evaluation and monitoring provision, and generic terms of reference for consultants. In addition, the *Handbook* provides boxes, appendixes, an annotated bibliography, and a list of references.

2 Sector Review

The key to a good project evaluation is a thorough sector review. As such, good health sector projects are developed in the context of an analysis of the country's health sector. Analysis like this is frequently conducted as part of technical assistance projects. A good sector analysis helps government sort through priorities, identify projects in the context of priorities, and provide the basic data to evaluate projects and assess the risks. Completed before project preparation begins, a health sector review helps identify key areas for policy reform, capacity building, and improvement of health services leading to efficient and sustainable health sector development; it also provides inputs into project evaluation. A health sector analysis should cover the following areas:

- epidemiological profile,
- utilization patterns,

- public expenditures,
- system of financing,
- supply of medical care,
- demand analysis,
- health sector personnel,
- quality of care,
- health information and management systems, and
- implications for sector development strategy.

Epidemiological Profile

The current health status of the population provides a baseline in evaluating project impact and helps identify areas of high priority. Describing the epidemiological profile of the population involves collecting data on measures of overall health status, disease incidence, and health-related behaviors. Overall trends in these indicators should be presented. The current information should be disaggregated by sociodemographic group (e.g., age, gender, economic status, and minority) and by geographic region. Where possible, it is useful to compare the epidemiological profile with other countries in the region.

At minimum, health sector reviews should assess the trends and current distribution of summary health status measures. Almost all countries collect information on overall health indicators, including infant and child mortality and life expectancy. Many countries collect information on height and weight of children and incidence of low weight. Some countries collect information on the height and weight of adults and the ability to perform physical activities or so-called activities of daily living. Child height and weight can be used to construct measures of stunting and wasting. Adult height and weight can be used to construct Body Mass Indexes that are used to measure Chronic Energy Deficiency and Obesity. These overall summary measures are sensitive to changes in the underlying disease and nutrition environment and can be used to identify areas and groups with serious health issues.

In most countries, sector reviews are able to analyze some selected disease specific information. Some countries collect information on the incidence and prevalence of specific diseases, especially those that are communicable. For example, the Demographic and Health Surveys collect information on communicable diseases like diarrhea in many countries. Others employ sentinel systems to collect data on tuberculosis, malaria, dengue fever, HIV/AIDS, and other diseases in the region. A

few countries have information on the prevalence and incidence of noncommunicable diseases such as cancer and cardiovascular problems.

A critical aspect of the analysis is to assess the quality of the data, particularly the methods used to collect the information. This involves source of information and measurement. One source of information is a vital statistics registration, which implies that the information is from a census rather than a sample. But while the broad coverage here is an advantage, registration data, however, can be unreliable where deaths are under-recorded. A second source is a random sampling of the population. It is important to note that most sample surveys are not simple random samples and are therefore not self-weighting. The last source of information is from institutional-based sources. This, however, suffers from selection bias as only those who have sought treatment are counted. One should be cautious in using these sources of information and provide an assessment of the degree of error due to selection bias.

Statistics computed from surveys must use the sample weights. In addition, many surveys are not representative of the whole population or are at lower levels of aggregation. The representativeness of the sample should be discussed and adhered to in all analyses and presentations. Methods and reliability of measurement should also be presented and discussed. For example, cause of death using verbal autopsies is likely to be less reliable than real autopsies. Finally, key gaps in the epidemiological profile should be identified. The recommendations should not only cover sampling and measurement but also frequency of collection. The project should provide technical assistance to fill in these gaps for project evaluation and future project design purposes.

Utilization Patterns

Utilization patterns provide a baseline in evaluating project impact and help identify areas of high priority. The analysis should identify all types of medical care providers and services covering the public sector, the NGO private sector, the for-profit private sector, and the traditional sector. Types of providers include the levels of hospitals (e.g., central, provincial, and local), types of primary care facilities, and types of drug suppliers. Outpatient utilization is measured in visit rates per standardized period of time. Since outpatient utilization is relatively frequent and therefore harder to recall over a longer period of time, the unit of time should be no more than one month. Inpatient utilization is measured in terms of admission rates per standard unit of time and average length of stay. Since inpatient care is rare and easier to recall, the unit of time recommended is one year. If possible inpatient utilization should be disaggregated by type of room accommodation (e.g., VIP, private,

semiprivate, pay ward, charity ward). Drug utilization is easiest measured in terms of expenditures. If possible, trends in utilization should be presented. Current utilization patterns should be broken down by age, gender, socioeconomic status, ethnic group, and geographic region. It is also useful to compare utilization patterns with those of other comparable countries in the region. As with the epidemiological data, the quality of the data used for the analysis should be assessed in terms of sampling, measurement, and frequency of collection.

Public Expenditures

An analysis of public expenditures is critical in understanding the role of the health sector in the overall budget process and in identifying current and future priorities. Several levels of analysis are useful. The first level of analysis is to present the trends in the level of total public expenditures and share of the budget over time. It is also useful to present these numbers in per capita terms for comparison with other countries in the region. It is important that these calculations include all levels of government and not just central level allocations. In addition, not all health expenditures are administered through the Ministry of Health. For example, family planning and reproductive health expenditures may be dispensed through family planning agencies while public health activities, such as clean water and sanitation, may likely be found in other ministries' budgets.

The second level of analysis is to describe resource allocation within the health sector across major expenditure categories (e.g., central, provincial, and local hospitals; primary care facilities; drugs, public health, and vector control; manpower and education; health promotion, administration, etc.). The first step is to describe the budget process and categories of expenditure in terms of what the categories are, who makes the decisions and based on what criteria. Then, levels and shares of the allocations across categories should be presented.

The third level of analysis is to forecast how budget allocations are likely to change in the near future, at the sector level and by category of expenditure. This is based both on trends and on government priorities set forth in planning documents and official opinion. It is critical to assess what projects or programs are being constrained by lack of budget.

A fourth level of analysis is to measure the benefit-incidence of public subsidies. The benefit-incidence measures the distribution of public subsidies across income groups. The benefit-incidence of a subsidy program captured by income groups is measured as the unit subsidy (fee minus unit cost) times the utilization rate.

Benefit-incidence analysis measures the extent to which program benefits are accruing to the targeted beneficiaries and the extent to which program expenditures are leaking to other lower priority groups.

Analyzing the budget process and allocations is critical to project identification. In many cases, the true effect of project funds may have little to do with the specifics of the project being proposed. Governments may have intended to do the projects anyway and the additional money from the loan simply allows them to finance another project, which they consider of marginal importance. Regardless of the project being evaluated, the project actually being funded is the one that would not have been done if the project funds were not available. This is because funds are *fungible* across purposes so that their actual use is different from their formal accounting.

The most rigorous way to assess the use of funds is to look at how the additional project funds affect total budget allocations. If the project that is being evaluated could not have been funded without the loan, then that is the project being funded. The most obvious concern is when project funds simply reduce government allocations to the health sector and thus fund, instead, education or energy or other budget demands. More subtle cases concern the effect of project funds on allocations within the health sector. For example, over the last 20 years, the international public health community has stressed the need to shift resources to basic primary care. Since then, this has been the focus of much of the donor assistance to developing countries. In some countries, however, when government allocations across programs are examined in total (local funds plus donor assistance), only small portions of their budgets have been found to go to primary care activities; moreover, these proportions have been stable over time.

In some countries, government priorities may differ from those of donors with project funding for basic primary care services, leaving Ministry of Health funds to satisfy other pressures from political constituencies or stakeholders for the provision and subsidy of urban, tertiary services. These problems arise when donor priorities differ from government objectives and when the government, as a whole, does not share Ministry of Health objectives. Project evaluations must document that potential project objectives are government priorities. Project objectives should be derived from, and placed in the context of, broader development and government objectives. Good project evaluation should document that the project's objectives are encompassed in government plans, but that implementation is constrained by funding. These objectives may be explicitly stated in a government plan or implicitly through a public investment program. An analysis of disaggregated health sector budgetary and expenditure trends will help to assess how potential project objectives fit into overall government objectives.

Financing of the Delivery System

A critical aspect of sector analysis is a thorough description of the financing of the entire health care delivery system. The first step is to construct National Health Accounts (NHAs). The NHAs summarize the sources and uses of funds in the health sector. Typically, the rows of the NHA table represent uses of funds divided between public, NGO private, for-profit private, and traditional sub-sectors. Each sub-sector is further divided into activities and programs (e.g., hospitals, primary care, public health, drugs, administration, etc.). The columns represent the sources of funds—e.g., government, social insurance, and out-of-pocket. The cells in the NHA identify how much is spent on each activity by source. The NHAs are useful in identifying how government subsidies are spent and the importance of financing each activity. Constructing separate NHAs for urban and rural areas investigates the degree of urban bias.

Supply of Medical Care

The supply of medical care is measured at several levels. The first is just a simple counting of the existing providers. Types of providers include the levels of hospitals (e.g., central, provincial, and local), types of primary care facilities, and types of drug suppliers. The second is availability of these providers to households where availability is measured in terms of travel time and monetary price. The third level is the dynamics of the supply of providers, including the payment incentive structure and degree of competition. The fourth is the measurement of unit costs of the various services in each sub-sector of the health care delivery system.

This first set of analysis involves presenting the number of providers per capita by type (e.g., hospital beds, primary care facilities, physicians, and ancillary health personnel) in each sub-sector. These analyses should be disaggregated by geographic region and data should come from administrative records and surveys of village infrastructure.

The second set of analysis involves measuring the distance from households to each provider type and the price charged. These analyses can be disaggregated by household characteristics such as income, ethnicity, and geographic location to investigate equity in access to medical care. The analyses use information from household surveys that inquire about the distance and price of available providers and not just providers used.

The third set of analysis investigates the nature of provider incentives and competition between the public and private sectors. Payment mechanisms include fee-for-service, capitation, salary, and blended rates. The review should assess the performance implications of these payment mechanisms in the context of the country concerned. Competition between public and private providers can be partially assessed by examining market shares and how they vary across geographic areas. A more in-depth analysis uses time series data to examine how the expansion of the public sector affects the availability and price of private provider care.

The last set of analysis measures the unit costs of services in each sector. Costing is well known in the health literature and one should follow the general guidelines for these analyses.

Demand for Medical Care

In addition to baseline utilization rates, estimates of how utilization changes when prices, income, and quality change are important inputs into several areas of project evaluation, including demand analysis and sustainability. Normally, demand and need are discussed separately. However, estimates of price and income elasticity of demand are useful and should be conducted as part of the sector study. The *price elasticity of demand* is defined as the percentage change in utilization corresponding to a 1 percent increase in price. The higher the price elasticity, the bigger the drop in utilization and the lower the amount of revenue generated from a given price increase. The *income elasticity of demand* is defined as the percentage change in demand corresponding to a 1 percent increase in income. Services which are income elastic are used more by the non-poor while those that are income inelastic are used more by the poor. Price elasticity is critical in forecasting utilization and revenues under alternative user fee scenarios. Income elasticity is useful in identifying services that are used more by the poor and should, therefore, be more heavily subsidized.

Estimates of the price elasticity of demand can be obtained by using household level data or facility level data. However, facility level data cannot be used to estimate income elasticity of demand. The analysis requires multivariate analysis and is best conducted using panel data to control key confounding variables. The analysis can also be done using cross-sectional data. The key is to have sufficient variation in prices and income in the data. An important issue, however, is that price elasticity is likely to vary with the level of the price. Therefore, estimates of price elasticity used to estimate demand responses to price changes outside the range of the data

are less reliable. Application of price and income elasticity for forecasting is complicated by the fact that in principle, elasticity can vary between groups depending on factors like income level, gender, and ethnicity. In practice, however, it is rare to find disaggregate elasticity estimates.

Human Resources

Expansion of the health sector requires qualified medical personnel. Moreover, projects often need health sector personnel willing to relocate in rural and less desirable areas. Thus, a key element of a sector review concerns the supply and demand for health sector personnel. The analysis involves several steps. The first is part of the analysis of the supply of medical care—estimating types of medical personnel per capita by geographic region. The second step is to describe where the future supply of medical personnel will come from. This involves reviewing the capacity and quality of local training institutions and regulations concerning the licensure of foreign-trained medical personnel. This information can then be used to assess whether there is sufficient supply of medical personnel necessary to keep medical personnel per capita ratios constant as the population grows. This will determine whether there are sufficient medical personnel for an expansion of the delivery system. The third step involves understanding why medical personnel choose to work in the private versus public sectors. Even if there are sufficient personnel, projects may fail if many of them enter the private sector or choose to relocate in urban and over-served areas. Key to the location decisions is the level and form of remuneration. An analysis of the provider payment incentives will be useful to assess retainability for health sector personnel. Lastly, there should be an assessment of the quality of health sector personnel, medical schools and training facilities, and licensure regulations.

Quality of Care

Many projects are devoted to improving quality of care through actions such as improvements in drug supplies, infrastructure, equipment, training, etc. Therefore, a review of the current quality of services identifies areas of weakness and provides a baseline for monitoring and evaluation. Quality is measured in three ways: structure, process, and outcome. The best measure of quality is in terms of health outcomes. Facilities of higher quality improve health more, holding other factors constant.

However, assessing outcomes is difficult both in terms of measurement and analysis. The second method of quality assessment is measuring the process of care; specifically, scoring the extent to which actual practice deviates from a generally accepted standard of care, where the standard is defined globally, whenever possible. Finally, the crudest measure is visiting the facilities and establishing whether they have the necessary manpower, equipment, and drugs to diagnose and treat illnesses. An additional part of the assessment of quality of care is to review government regulation and enforcement policy regarding provider licensure, provider quality, and drug prescriptions.

Information Systems

A sector review must review information systems. It should list and critically review all sources of information being used by the government for decision making and describe how this information is used. Sources of information include:

- central, provincial, and local budgets and expenditures;
- vital statistics registration of births and deaths;
- facility reports of utilization, disease incidence, expenditures, and revenues;
- life tables;
- licensure information;
- epidemiological sentinel systems;
- regular and special household surveys; and
- regular and special provider surveys.

Management and Operational Capacity

Key to the successful and efficient operation of projects is the managerial and operational capabilities of the health sector. The first step in this analysis is to describe the organization and decision-making authority in all levels of government including central, provincial, and local levels. Authority over both programmatic content and resources should be identified. There should be a discussion of the extent to which governmental units are integrated in terms of planning, implementation, and resource allocation. There should be an assessment of the capabilities of managers to run their programs. The review should pay special attention to the provincial and local levels in countries that have or are planning to decentralize, and the capacity of

facility managers to implement resource mobilization, to bill insurance plans, and to manage their own resources.

Implications for Sector Development Strategy

Finally, the sector review needs to draw the policy and programmatic implications of the analysis. However, the recommendations must be in the context of the appropriate role of the public sector as agreed with the government. At minimum, this concluding section should make recommendations for changes in the following areas:

- allocative efficiency of the health sector,
- infrastructure investment that affects quality of care and access to public facilities,
- health promotion and public health activities,
- human resource development,
- health care financing,
- private sector development and regulation of private activities that impinge on health status, and
- institutional organization and capacity.

3 Project Rationale and the Role of Public Intervention

Alternative Project Designs

Essential at the early stage of a project analysis is a clear statement of a project's goals; that is, what aspect of health the project aims to improve. Virtually all health objectives can be met in alternative ways and it is important at the design stage to consider the feasible range of alternatives available. Cost-effectiveness analysis, discussed in detail below, is an important tool for comparison between alternatives.

Good project appraisals consider a range of alternative approaches. The range of project designs should consider the following factors:

(i) the variation in the combination of components needed to address a particular objective;
(ii) the range of intervention modalities, e.g., whether an intervention should be provided in health facilities or through outreach workers;
(iii) different types of inputs, e.g., medicines, contraceptives, equipment, personnel;
(iv) alternative institutional arrangements for the management and delivery of services including whether the services could be contracted through the private sector; and
(v) different scenarios for the timing and phasing of the project.

The project should identify the components needed to achieve its objectives. This involves not only what will be done but also when, by whom, and how well. In terms of the combination of inputs, substitutability of inputs should be explored, especially when there are weaknesses in the delivery system. For example, if the country does not have enough qualified doctors, how then can lesser-trained medical personnel be used to achieve the same outcomes? Rather than using expensive equipment that is costly to maintain, are there simpler technologies that may require more personnel but are equally effective? Evaluation of alternative designs should consider the role of pilot projects and operational research on alternative strategies, and the process of scaling up from pilot projects to more general implementation. This is especially true for activities with limited operational and scientific evidence on implementation issues and impact. However, lack of data on impacts of specific interventions will always be a problem in certain areas. Hence, it is unrealistic to expect that the consequences of alternative designs can be specified in detail for all projects.

Role of Government

The question of whether health projects should be in the public, private, NGO or traditional sectors is part of the comparison of project alternatives. Although a majority of health expenditures within the region now goes to private providers, there are still strong grounds for arguing that the public sector will continue to play a key role. In the present policy environment where private initiatives in all areas are

encouraged, the location of a project in the public sector will have to be justified as part of the appraisal procedure.

In theory, the economic rationale for intervention in the health sector can be formulated on both efficiency grounds and equity grounds. Public intervention in the health sector is justified when private markets fail to function efficiently, or when the social objectives of equity in access and improved status of women, the poor, and indigenous peoples are unlikely to be attained under given income and resource distributions. Market failures due to public goods and externalities, informational imperfections in health service markets, and informational imperfections in insurance markets have long been recognized to comprise the logical basis for public health programs and social insurance schemes directed at health care. *Public good* properties of the treatment and prevention of communicable diseases, *externalities* associated with infectious diseases, and *informational imperfections* in the markets for medical services and insurance products are all reasons why market solutions may be suboptimal. Together with equity considerations, market failures provide a rationale for health sector interventions and a motivation for ADB projects directed at health investment.

The clearest justification for public provision of health services, as opposed to subsidization of private provision, is the public good factor. Public good has two essential features. First, it is *non-rivalrous* in consumption. That is, as benefits accrue to one individual or household, the consumption of those benefits does not interfere with or detract from the consumption of those same benefits by other individuals and households. The second property of a public good is *nonexcludability.* Once the public good has been produced, for example the eradication of an infectious disease like small pox, there is no way to prevent (exclude) others from enjoying the benefits such production confers. Pure public goods are both non-rivalrous and nonexcludable while pure private goods are both rivalrous and excludable. Since it will not be able to capture user willingness-to-pay, the private sector will have no incentive to produce public goods, unless contracted by government to do so. The precise distinction between pure public and private goods is not always clear, but *Figure 2* gives an illustrative classification for health programs.

Although in principle only and not necessarily public provision, externalities or health impacts on others apart from particular individuals also justify public involvement. In the case of contagious diseases, the response of the private sector, particularly consumers of preventive care, will be insufficient to ameliorate the health risk. Private benefits from immunization are substantially less than social benefits because immunized individuals protect not only themselves but also others they come in contact with and potentially expose to risk.

Figure 2
Illustration of Public and Private Goods

	RIVALROUS	NON-RIVALROUS
EXCLUDABLE	**Private Good** • Cancer Therapy • Kidney Transplant • Dialysis Treatment	**Mixed Good** • Medical Research
NON-EXCLUDABLE	**Mixed Good** • Fresh Water	**Public Good** • Health Sanitation • Vector Control • Immunization Programs

In the extreme case, if all individuals in an area except one person were immunized against a contagious disease, that one would have no incentive to be immunized as there would be no private benefit from doing so. A similar phenomenon categorized under the general rubric of *externalities* is dramatically and tragically evident in the case of the AIDS epidemic. Once an individual has contracted the HIV virus, private incentives for prevention are substantially diminished with the spread of the virus as a possible consequence. Additionally, lack of treatment causes the spread of communicable diseases and improper use of antibiotics gives rise to resistant strains of bacteria.

Lack of information is also an important concern of the health sector. Markets work best when information about goods and services are readily available and producers and consumers are equally well informed. Health care is a particularly complex service and is not easily understood or cheaply sampled, unlike many consumer goods. The users of health services have difficulty gauging the quality and the appropriateness of the care they receive and rely heavily on advice from health service providers. As a result, there is a tremendous asymmetry of information between the users of health care, who are drawn largely from the general population, and the providers of health care, many of whom are highly-trained professionals. This asymmetry exists within the health care systems of all societies but is particularly acute in DMCs where many users of care are poorly educated. Under these conditions, private proprietary providers may be tempted to provide a low quality of service,

such as inappropriate or non-efficacious care, and to charge prices too high for the services provided. Furthermore, even the more obviously private good elements of the health sector, such as hospital treatment for noncommunicable diseases like cancer or kidney failure, may require significant public sector support, either through the training of medical staff or basic research on forms of treatment.

Given the impossibility of operating the health sector on a purely commercial basis, various forms of intervention have been used by DMCs in the region. Project analyses should consider which is most appropriate for the objective at hand.

Direct Public Provision of Health Services and Products

Direct public provision of health services is an intervention favored by many developing countries because it affords control of the quality, type of care, and geographical distribution of facilities. Importantly, it allows public health to be provided either free of charge or at low cost to target groups, thus meeting an important equity objective, particularly in rural and low-income areas where effective demand is insufficient to stimulate private provision. Where private providers are poorly developed or nonexistent, equity in health services may be achieved only through direct government delivery, at least in the short run. This approach, however, involves public funding and raising additional public finance may entail macro economic costs through deficit financing or higher taxation. Hence, it should not be automatically assumed that public provision is preferable to the other alternatives. The impact of a project on private sector health providers should also be considered. If some are crowded out, the health benefit of the project will be its net effect (allowing for any displacement of private provision) rather than its direct impact. Further, there may be an area for collaboration between public and private sectors in the contracting out aspects of health provision to private providers.

Promotion of Voluntary Non-Profit Providers and NGOs

Voluntary nonprofit providers and other NGOs came about partly in response to the failure of the private sector to fully meet the social need for health services. NGOs have different objectives than proprietary health care providers. Although the private for-profit sector has incentives that encourage the efficient production of services, these same incentives also lead to lower quality of services and even inadequate service for low-income clientele. In the attempt to meet the needs of clientele not served or not served well by the private for-profit sector, NGOs have an advantage over government because their internal organization and structure lead to the efficient production of services much like that of the private for-profit sector.

Unlike those of the for-profit private sector, however, the objectives of NGOs tend towards quality service and care for the underprivileged. Where government regulation is weak and monitoring of the private sector difficult, NGOs may be particularly well suited to provide high-quality care.

Contracting Out to Private Providers

An increasing amount of experience has accumulated internationally on the issue of the public sector contracting out various health services to private or nongovernment provision. Although this process has not been carried to many of the DMCs, it nevertheless has a number of potential advantages. For example, it focuses on tangible outcomes with financial reward linked directly to achievement; it draws on the experience of NGO or other non-public sector suppliers; it allows governments to focus on financing and regulation rather than on day to day management of health services. On the other hand, its disadvantage is that for its success, a competent public bureaucracy is required to ensure the adequate regulation and monitoring of the private contractors involved so that appropriate national standards of health coverage are assured. As part of on-going health sector reform initiatives, ADB is encouraging DMCs to look into ways of involving private providers in the sector. *Box 2* describes the introduction of an experimental contracting out system in Cambodia.

Regulation of Services and Licensure of Private Providers

Poor quality of service from private providers is a serious issue and public licensure and regulation are a possible response. In DMCs, non-efficacious counterfeit pharmaceuticals pose a quality-control problem within the private sector.

Unqualified physicians and other health providers are other sources of ineffective care and inefficiency in the system. Regulation and licensure will likely improve quality, or at least assure minimal levels of it. Regulation, however, will generate a new set of direct and indirect costs. Moreover, licensure and regulation tend to reduce competition and may lead to the accrual of economic rents by the regulated sector.

Health Education and Information Dissemination

The public sector can provide direct education and information to compensate for informational imperfections in the private sector and the existence of external effects associated with contagious diseases. The government can maintain a health

Box 2
Contracting out Health Services: Cambodia Basic Health Services Project

The ADB project will support the testing of the contracting out of basic health services to NGOs and other private providers in five districts with five other districts monitored as comparator areas. The Government will define the standards of service delivery the contractor must meet and will incorporate these in tender documents. For example, the successful bidder will be required to immunize 90 percent of children, ensure that 80 percent of children receive vitamin A supplements, and ensure that 95 percent of pregnant women obtain prenatal care. Tender documents will state which districts are to be covered and what inputs the government will supply. Bids are to be evaluated on both costs and scope of services offered and the winning bidder will be given a four-year contract. The performance of the contractor will be monitored annually or bi-annually by the provincial health office, the Government through the Ministry of Health, and an independent consultant appointed by the Project. Performance bonuses will be given to the contractor if substantial improvements in health services are achieved. If minimum standards are not met, the contract will be cancelled. As part of the comparison to establish the impact of management improvements alone resulting from contracting out rather than simply using additional financial inputs, the comparator areas will be given additional funds from the Ministry of Health if they submit a plan of action of acceptable quality.

Source: Loan 1447-CAM: *Basic Health Services Project*, 1996.

information system that reports on training and professionalism of physicians and the quality of care provided by hospitals and clinics. This, in turn, can provide consumers of medical services with some of the information they need to make more efficient choices.

Public Health Insurance

Health insurance provides protection against the risk of medical expenses by allowing the insured to share that risk with other members of the group. The financial pool is supported by all members of the group through taxes or premium contributions. With subgroups placing claims on the group's financial resources in a more or less random fashion, the risk is spread over many individuals, becoming substantially lower than that faced by an individual in financial isolation. Although most public insurance and some private insurance perform a redistributive function as well, risk-sharing is considered the fundamental function of insurance. This risk-sharing function is particularly important in DMCs where the financial burden of ill health can have a catastrophic effect on the well-being of households. The greatest underlying

demand for health insurance is the protection against large, catastrophic expenses that are unpredictable. Unfortunately, the same characteristics that create the need, namely large expenses and lack of predictability, also make insurance against catastrophes the most difficult to underwrite and the least attractive for the private sector to supply. Private insurance markets may also fail to spread risks properly due to informational imperfections. Because the financial risk of ill-health can have a devastating impact on family welfare particularly in poor households, many DMCs look to public health insurance as a potential intervention. Motivations for interventionist policies are further strengthened by the recognition of private market failures due to moral hazard and adverse selection.

Adverse selection, a classic asymmetric information problem, results from unobservability of the risks by the insurer. It occurs when high-risk patient-consumers self-select a favorable insurance coverage, thereby driving up insurance premiums and driving out low-risk patient-consumers, causing in turn a further increase in premiums. Eventually, the insurance market shrinks, leaving some individuals and households uninsured or with less than full coverage. If private insurers can screen out high-risk patients, those patients may be uninsured. But screening of patients by insurers for the purpose of exclusion uses valuable resources and may result in a misallocation. In either case, some segment of the population is left uninsured or underinsured in response to adverse selection problems. With universal coverage as a remedy, all members of a society or community can be covered by health insurance. This is typically accomplished by mandatory participation in a public health insurance program, requiring everyone to purchase private insurance, or a combination of the two. The main advantage of universal coverage is that it eliminates the adverse selection problem by preventing individuals from self-selecting and insurers from screening. Within the region, however, public insurance schemes still remain poorly developed, covering no more than 10–15 percent of public health financing. Carefully designed schemes may, in the future, provide a significant means of increasing health care finance; but as yet, their role is minor.

4 Analysis of Demand and Need

Demand

Demand is an economic concept which describes the quantity of a good or service per unit of time (e.g., aspirin tablets per year) that an individual or household will purchase and consume given the price of the good or service, prices of alternatives or related items, income of the individual or household, preferences, and other factors. It must be a quantity which the individual will actually be willing and able to buy. Demand is distinct from *need* which, in the context of health projects, can be seen as the level of health services which good medical opinion deems necessary to meet particular health targets. Problems arise in health planning when demand and need do not coincide. Individuals who demand health care when medical opinion suggests that they do not need it will waste resources. On the other hand, if individuals do

not demand health care when medically they require it, they will be jeopardizing their own health and that of others, if their condition is communicable.

Private sector providers are market-driven and plan on the basis of demand, while public sector projects are initially designed on the basis of perceived need. But even when need provides the idea behind a project, it is also necessary to consider individual and household demand for the services of the project. This is because even freely available services, for which there is no user fee, are not cost-less to individual users. A rural clinic may make immunizations or tablets freely available, but patients will still have to bear the costs of traveling to the clinic and waiting to be seen. How potential patients evaluate these costs relative to their perception of benefits from attendance at the clinic will determine whether or not they will use its services. A demand assessment will be needed to judge the scale of the clinic and the number of patients it can cope with.

An important distinction that arises in the analysis of health sector activities is the difference between utilization and demand. *Utilization* refers to the actual use of health services and facilities. An analysis of utilization looks at trends in use while an analysis of demand attempts to explain behavior patterns. Demand that differs from utilization will be unsatisfied. For example, there are more households who would like to visit a clinic than those who can actually do so. Planning, therefore, should aim to avoid unsatisfied demand, provided the demand corresponds with the perceived medical need.

A demand analysis is advantageous in knowing the impact of health projects and predicting the effects of health interventions. Although analysis of need will be based on epidemiological data and health targets for the population, demand analysis will assess the market for health services in the same manner as for any other commodity. Demand analysis can be conducted at many different levels. Because demand is based on economic theories of consumer choice, the individual is the most basic economic unit to analyze. Frequently, however, decisions are made at the family or household level. This is particularly true in children for whom decisions will be made by the mother or other adult family member. Demand by a household can be further aggregated to give the community demand, provincial demand, and national demand for health care. The correct market level will depend on the scale of the project and the objectives of the health intervention. For example, a reproductive health project might analyze the demand for family planning services by households with married women of reproductive age within the geographical vicinity for which the project was planned.

In analyzing the demand for health services and utilization rates, it is important to take into account the factors that influence this phenomenon. These factors include, but are not limited to, financial price (direct out-of-pocket expenses), household income

and wealth, travel time and travel costs to health facilities and service locations, waiting times, health status of the individual, the educational attainment of the individual (or mother in the case of children), and the household size-age-sex composition. Often, the special social and cultural norms of a DMC have far greater influence on demand and utilization patterns than economic and demographic phenomena. Nevertheless, income and childbearing tend to be among the most important determinants of health care demand in DMCs.

Demand analysis addresses the following sorts of questions. Which segments of the population are currently using health services? How does the use of health care vary with income level? Will beneficiaries be willing to cost-share? What effect will the proposed project have on the demand for private services and traditional medicine? Will alternative providers be "crowded-in" or "crowded-out"? What proportion of income do households spend on public services, private services, and traditional medicine and how will these proportions change with the introduction of the project? How can we design user fees to maximize revenue while maintaining access for women, the poor, indigenous peoples, and other disadvantaged groups? Will the targeted beneficiaries seek care? What are some of the possible unintended effects of the project? What are the most important economic and noneconomic barriers to seeking health and medical care? These are some of the main issues demand analysis attempts to address.

The primary objective of ADB's assistance to the health sector will be to improve the health status of the poor, women, indigenous peoples, and other vulnerable groups. It is important to identify these groups and specify their number, geographic location, socioeconomic status, health status, and most pertinently, health needs. By careful delineation of their particular health risks, interventions can be designed to be more effective and efficient in targeting these groups. However, it is not enough to simply identify needy beneficiaries. Analysis must be undertaken to assure that the targeted groups will also participate in the program. Examination of current utilization rates and projections of the project's impact can be useful in this regard. Analysis of data gathered via focus groups is a way to identify and overcome specific barriers. Interventions that take account of social and cultural norms have a much greater chance of success.

Demand analysis can also be conducted using household surveys. Most national statistical offices within DMCs conduct such surveys on a routine basis. Relevant data may be obtained from a national health survey, demographic health survey, or household expenditure survey. Occasionally, more specialized surveys addressing pricing policies and insurance schemes or containing detailed health examinations are conducted. Using existing surveys and associated statistical reports is a low-cost and relatively quick way to obtain basic information on household

utilization rates, household income, demographic composition, geographic location, and overall material well-being of households.

Price Elasticities and User Fees

In any demand study, it is necessary to consider the impact to households of the cost of using health services. For visits to clinics or hospitals, there will normally be costs even where user fees are not involved since patients will still have to bear the cost of traveling and waiting. But if a project can reduce these costs (for example, due to a more convenient location for the patients), this will stimulate health service use. This must be considered in planning the scale of the project. Most studies of demand for health and medical care in developing countries find price elasticities to be less than one in absolute value (implying that demand changes less than proportionately to price), although the results vary over a substantial range. Some estimates place the price elasticities for outpatient and delivery care as well as prenatal, well-baby, and immunization services at values very close to zero. The implications are that for such services, user fees would do little to discourage health and medical care use while serving the self-financing function. However, some analysts have reported estimates closer to unity, implying that user fees might undermine the goals of the project by discouraging participation by the targeted beneficiaries. Where user fees are to be introduced or raised significantly, or where nonfinancial costs to users are altered significantly by a project, the impact of such change on demand should be allowed for. There are several ways of measuring price elasticity of demand for health care services. *Box 3* summarizes the results of an important study on price elasticity of demand in Indonesia. This is categorized as an *experimental* method, which is ideal if sufficient financial sources are available for the study. The *behavioral* method, which is based on the past actions of the respondents, may be most appropriate for the typically resource-constrained developing country governments. Appendix 1 summarizes the advantages and weaknesses of different methods of measuring price elasticity of demand.

Charging for public health services, although politically unpopular, is under discussion in many DMCs. User fees in health have both advantages and disadvantages. On the positive side, the first and most obvious is that user fees help finance health and medical services by directly generating revenues at the point of delivery, rendering the services at least partially self-financing. This is increasingly important as DMCs seek to maintain or expand their social services under binding resource constraints. Second, public providers can earn operating profits on services

Box 3
Health Price Elasticity Estimates: Indonesia

The most rigorous way of estimating price elasticity is to use data from randomized controlled tests which allow user charges to be experimentally varied, holding other influences on demand constant. Such data were made available in Indonesia for the provinces of Kalimantan Timur and Nusa Tenggara Barat. The study design was integrated into the local decision-making body and rather than raising fees everywhere in the two provinces, fee changes were staggered to generate price variation based on an experimental design. User fees were increased in health centers in some districts but not in others. The study assesses not just the impact of higher fees on demand for public health centers but also their effect on access to health care, since some who cease to use public facilities in response to higher fees may switch to private providers. Of those who cease to use public facilities, those switching to the private sector are distinguished from those relying on self-treatment or ignoring their health condition. In addition, the study collects information on how private providers (whether doctors, nurses or paramedics) respond to higher public sector charges. In general, there is a positive response, which is highest among nurses and paramedics in rural areas; on average, the rise in charges by the latter is nearly 60 percent of the proportionate increase in health center charges. Other things being equal, for a given rise in health center fees, the larger the rise in charges by competing private suppliers the greater will be the decline in access to health care. The price elasticity estimates from the study are shown in the table below. They give the ratio of the proportionate change in demand (as measured by visits to health providers) for a given proportionate change in price, allowing for the impact of higher public center fees on the charges of private providers. A figure of –1.07 implies that a 10 percent change in user fees is matched by a 10.7 percent decline in use of health facilities; a figure of –0.01 means that a 10 percent rise in fees leads to only a 0.1 percent decline in use.

Price Elasticity of Demand for Public Health Center Visits and Visits to all Providers

	Children		Adults		Seniors	
	Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Visits to health centers	-1.07	-0.63	-1.04	-0.01	-0.45	-0.47
Visits to all providers	-0.48	-0.49	-0.70	-0.01	-0.22	-0.39

The figures in the second row of the table give total demand elasticities and in all but one instance, are below the figures in the first row relating to health centers only. Since total demand falls by less than demand for health centers, this implies that for all but one group, some patients switch to other providers in response to the increase in health center fees. Hence, the price elasticity estimates for health centers alone will give useful information on the effect

Box 3
Health Price Elasticity Estimates: Indonesia *(continued)*

of higher fees on health center revenue, but will not give the full picture of the effect of higher fees on access to health care. An elasticity of above unity implies that raising fees will not bring in extra revenue since quantity will decline proportionately more than the rise in price. This is only relevant in urban areas, not in rural ones, where raising fees will bring in extra revenue. In urban areas where it is likely that more private alternatives are available, the difference between the total elasticity and health center elasticity is greatest. This is particularly the case for children, where the total elasticity is about half the health center elasticity, implying that roughly half of those who switched from using health centers will seek private alternatives. The study also shows that the reductions in utilization of health centers are not merely for minor conditions since after the increases, there was evidence of higher incidence of infectious disease and longer duration of illness. The implication is that while higher fees are only likely to raise more revenue in rural areas, the policy will have adverse effects on health care. If the government chooses to raise fees, there is a case for using the revenue to finance a subsidy program to protect the health of the more vulnerable.

Source: Gertler, P. and J. Molyneaux. 1996. *Financing Public Health Sector Expenditures through User Fees: Theory and Evidence from an Explicit Social Experiment in Indonesia*. Santa Monica: RAND.

that are of high demand in the health care market and use these excess revenues to cross-subsidize services to needy beneficiary populations. This practice combines the financing and equity objectives of health care policy. Third, public sector user fees may stimulate private sector activities as consumers substitute private services for public care in response to charges. Fourth, implementing even modest user fees may raise the consciousness of beneficiaries and give them a sense of value and ownership in the services and products they receive. This can increase compliance and give rise to fuller participation, thereby improving health outcomes and leading to more medically efficacious and efficient programs.

On the negative side, user fees generally have a high administrative cost; and where they have been used in the region, they have only financed a relatively small proportion of operating costs of health projects. Second, implementing user charges in the public health sector may lead the private sector to raise their fees, further limiting uptake of health services. Third, where the services involved have significant external effects (like prevention of contagious disease), by discouraging use, charging will limit the effectiveness of control of the disease. Finally, and often critically, user charges are likely to have their most significant impact on the use of the services by the poor and vulnerable. There is empirical evidence that price elasticity

of demand for health services is inversely related to income, so that it is those with the lowest incomes who curtail their demand proportionately more for a given rise in charges.

The imposition of user fees is frequently criticized as a policy with unfavorable equity consequences. Formally, this depends on whether the poor benefits more from a dollar of health subsidy than from what they would pay in taxation, or the cost of deficit financing to finance the dollar of subsidy. Although there is empirical evidence on the regressivity of user fees, free care in general may not entirely remove inequities because time and travel costs replace price as a rationing mechanism. When health care is financially subsidized, waiting time, travel time, and travel costs become more important in rationing the use of services. Because the geographical dispersion of facilities, particularly those of higher quality, provides favorable access to the rich, this group will face lower time and travel costs. In relation to the rich, therefore, the poor will face higher real costs even when the user price is zero.

The formal economic case for user subsidies in health can be summarized around the following principles.

(i) Subsidies should be higher where social gains exceed private gains due to the presence of health externalities, most obviously in the case of communicable diseases.

(ii) Subsidies should be higher for those services where public care is superior to private, in the sense that it yields better health outcomes. If the alternative to public care is an untrained pharmacist or an ineffective traditional healer, the case for introducing or raising user charges will be weak.

(iii) Subsidies should be higher for those services of high quality for which demand is elastic. The higher the price elasticity, the more demand will be reduced for a given price increase. Hence, the more users will be discouraged from accessing health facilities.

(iv) Subsidies should be higher for those users whose health demand is price elastic. Again, these individuals will be the ones whose use of health facilities is most discouraged. Insofar as the poor have a more price elastic demand than the rich, there is an efficiency argument for subsidizing the poor, which is distinct from the equity or distributional case.

(v) Subsidies should be higher for those services and in those areas where there are limited private alternatives. Subsidies will have weaker health impact if they only cause users to shift from private to public suppliers. They will have the strongest impact when they encourage new utilization so that illnesses that would otherwise go untreated are now treated. This implies that certain preventive services and health facilities in rural areas should be subsidized because of the lack of private alternatives.

The two competing factors that must be balanced in health pricing are: the need to mobilize revenue for the sector, and the need to minimize the adverse impact of new or higher charges on the use of health services and thus on health status. From the point of view of minimizing damage to health status, strong candidates for subsidization are services or groups for which higher prices have a strong negative impact on health utilization (that is, where total demand is price elastic). On the other hand, where demand is price inelastic, more revenue can be raised from higher charges, creating a weaker impact on utilization and health status; although for some poor families, higher charges may substantially reduce real income with inelastic demand. *Box 4* summarizes some of the main implications of user charges.

Box 4
Illustrations of Implications of User Charges

Charges	Elasticity	Use	Other Income	Private Provision	Macro
yes	<1.0	–	–	+	+
yes	>1.0	–	+	+	–
no	n.a.	+	?	–	–

Notes:

Charges refer to either increases of existing user charges or charges imposed by a new project.

Elasticity is price elasticity of demand for health services supplied by a project.

Use is change in uptake of health services relative to a previous situation either with lower charge or no charge (for a new project).

Other Income is real income after deduction of health and health-related expenditure (situations covered refer to short-run effects since, in the long-run, improved health should raise incomes).

Private Provision refers to change in competing private for-profit suppliers (price rises for public providers are assumed to lead to greater private supply).

Macro refers to change in government macro budget position.

n.a. is not applicable.

Sign (+/-) indicates direction of change.

? refers to ambiguous outcome.

The arguments above can be used to identify certain categories of patients and services for which fees should be heavily subsidized or considered for complete exemption. For example, there are substantial positive spillover effects from the prevention and treatment of certain communicable and infectious diseases and adequate private provision is often lacking. In addition, maternal and child health programs are relatively cost-effective and may generate substantial resource saving through prevention. Moreover, women and children may be disproportionately represented among the economically disadvantaged. Based on such criteria, a number of categorical exemptions can be constructed.

Exempt Patients

Children under 5 years of age
Individuals from low-income households
Pregnant and lactating women

Exempt Services

Immunization services
Family planning services
Antenatal and postnatal clinical services
STD clinical services

Exempt Illnesses

TB, STDs and HIV/AIDS
Antenatal complications of pregnancy

Exempt Areas

Rural clinics

The most effective means of implementing an exemption scheme would have to be considered. Some of the issues discussed in this section are illustrated in *Box 5* with reference to an ADB project in Pakistan.

Box 5

Need and Demand Illustration: Maternal and Child Health Services Pakistan

Maternal and perinatal conditions account for roughly 12 percent of the losses of healthy life due to disability and premature death in Pakistan. A sector review revealed that only 28 percent of pregnant women use rural health facilities for antenatal services and of these, only two-thirds receive tetanus toxoid immunization. Over 90 percent of rural deliveries are performed at home. Rural health facilities are not meeting the needs of mothers and babies. From sample data, one-third of facilities has no female staff, which is seen as a precondition for effective maternal and child-care. Only 10 percent of facilities were doing growth monitoring of children and only slightly more than 10 percent reported nutrition education and demonstration sessions.

In surveys of potential users of maternal services, reasons given for not using existing facilities include unavailability of medicine, poor service quality, and distance from home. To meet the objective of improving the health of mothers and babies, the sector review showed the need for a project to develop a package of services to address women's nutritional, family planning, and pregnancy-related health needs (TA 2577-PAK: *Women's Health Project*, for $500,000, approved on 4 June 1996). However, demand for such services depends on uptake by mothers, which will be a function of social attitudes and information as well as cost and, in terms of time, any user fees.

A major component of the Project involves matching demand with need by developing outreach programs for local communities to raise awareness of women's health issues, strengthening existing programs that involve female community-based workers, and developing a network of community health committees. In addition, the Project will help identify new mechanisms for cost-recovery through funding of willingness-to-pay studies and focus group inquiries to assess the scope for recovering some of the operating costs of improved maternal and child health services from beneficiaries.

A form of user charge is already widely used in the public health sector in Pakistan; but where price elasticity is above even a modest level of –0.50, there is still a real risk of weakening the health objectives of the Project by causing women to shift back to self-care or untrained practitioners. One possible means of discouraging this trend is to ensure community control over the revenue proceeds of user charges so that those paying the fees can see them reinvested in the local health facility.

Focus Group and Community Interviews/Rapid Appraisals

Formal methods of demand analysis, especially on price elasticity, are summarized in Appendix 1 and in *Box 3*. Rapid appraisals lie between formal and informal modes of data collection used to inform project or program conceptualization, formulation, and evaluation. Where detailed household surveys are not possible because of the limited time and financial resources, rapid appraisal survey methods can be relied on. There are five methods of rapid appraisal for data collection:

- key informant interviews,
- focus group discussions,
- community/group interviews,
- structured direct observation, and
- informal surveys (Kumar, 1993).

There are, however, limitations in rapid appraisal methods:

- the reliability and validity of the information generated can be questionable in many instances due to factors such as the use of informal sampling, individual biases of the investigator/interviewer, and the difficulty in recording, coding, and analyzing the quantitative data;
- they do not generate quantitative data from which generalizations can be made for a whole population; and
- the general credibility of these methods is low compared to formal survey methods.

These limitations should be weighed against the obvious strengths of rapid appraisal methods. Such methods can rapidly generate relevant information with relatively low investment of resources. Moreover, experience shows that they can provide in-depth understanding and information in the project or program conceptualization and design. Nevertheless, rapid appraisal methods should be relied on with due regard to the purpose of the study, availability of time and resources, and more importantly, the nature of the information required. Focus group discussions, community interviews, and structured direct observations have been used in rural health sector projects, particularly in data-scarce situations. *Box 6* describes the application of a direct observation approach to generate data on the operational effectiveness of primary health care services in the Philippines.

Box 6

Rapid Appraisal through Direct Observation: Primary Health Care in the Philippines

In the late 1980s, a USAID-financed Project was conducted in several countries to strengthen primary health care delivery. In the Philippines, an important aspect of the Project was to use a novel approach of direct observation to collect information on the weaknesses in the performance of health care workers, particularly in relation to pediatric services. Direct observation involved placing teams of observers in rural health units and requiring them, as unobtrusively as possible, to complete narrowly defined forms that required yes/no answers to questions on operational procedures, such as "Did the health worker take the child's temperature?" or "Did the health worker read the child's weight correctly?". The aim was to minimize inter-observer variation by avoiding judgmental questions. Useful information was obtained on the problems in the delivery of health care at the local level. For example, in the direct delivery of services, common problems found included:

- patients diagnosed with acute respiratory illness were not asked whether tuberculosis was present in the household, even though this would have an important bearing on type of treatment required;
- mothers were not cautioned against continuing to feed children suffering from diarrhea, even though there is a strong tendency for mothers to withhold food when children are sick ;
- failure to accurately inform the mother regarding timing and administration of treatment dosage; and
- mothers were not involved in the plotting and weighing process for monitoring child development, which was itself not always carried out accurately.

Information obtained from this process of direct observation was used by the Department of Health to strengthen training programs for nurses, midwives, and their supervisors. However, despite the term "rapid appraisal", this approach can be very time-consuming.

Source: Blumenfeld, S., M. Roxas and M. de los Santos. 1993. Systematic Observation in the Analysis of Primary Health Care Services. In *Rapid Appraisal Methods*. Edited by K. Kumar. Washington, DC: World Bank.

5 Cost-Effectiveness Analysis for Health Projects

Given the well known difficulties in quantifying benefits in monetary value from health projects, quantitative economic analysis should normally concentrate on comparing costs in relation to health impacts from different project alternatives. The general procedure requires specifying incremental project impact (the difference between a health outcome with and without a particular project) and comparing this with incremental cost (the difference between resources used with and without the project). As with project evaluation in any other sector, both impacts and costs should be converted to a present figure by discounting.[1]

[1] The choice of discount rate for health projects is a matter of controversy and should normally differ from that used in productive sector projects where health impacts cannot be expressed as quantifiable monetary benefits. However, ADB practice is to use 10-12 percent in all the projects involving ADB financing (*Guidelines 1997*).

Hence, we can summarize a cost-effectiveness indicator (CEI) as

$$\mathbf{CEI = PV(C_w - C_{wo}) / PV(HI_w - HI_{wo})} \quad (1)$$

where C is annual project costs;
HI is annual health impact;
PV is the annual figures over the project life discounted to the present;
w and wo refer to with and without a project, respectively.

CEI can then be used to compare alternatives with the normal decision criteria when choosing between alternatives to select the cheaper (in terms of resource use per unit of health) impact. Application of this general procedure raises several complications. Project economists should, therefore, pay due attention to: project costs, discount rate, and health impacts as well as their indicators which are discussed below.

Project Costs

The costs to be included here are the resource costs over the project's life, which can be measured at both financial and economic prices. Hence, the accounting charge depreciation is excluded, as investment costs are included in the years in which they arise. Interest and loan repayments as financial rather than resource costs are also excluded. Health projects which are not revenue generating will pay no profits or corporation tax; however, they may pay indirect taxes or import duties on the inputs they purchase, such as equipment or drugs. In the calculation of CEI at financial prices, these taxes are part of project costs; but for CEI at economic prices, they must be excluded. Whenever there are significant distortions in an economy, it will be necessary to calculate CEI at both financial and economic prices. This means the principles of economic valuation set out in *Guidelines 1997* should be applied to the valuation of health project costs. National conversion factors – for example, relating to the shadow exchange rate factor (SERF) or its inverse, the standard conversion factor (SCF), or to an unskilled labor conversion factor – that are applied in the economic evaluation of projects from other sectors can be used for the valuation of health costs.

The financial and economic CEI will give different information on projects. The former shows costs from the budgetary viewpoint, while the latter shows the impact on the economy in general. Hence, any scarcity of resources not captured in its financial price (for example, where the exchange rate for local currency is overvalued) should be

incorporated through the use of economic prices (in the exchange rate case, through a SERF or SCF). In addition, the time of patients in waiting or traveling to receive medical attention will not be captured in a financial calculation; but where this is a significant item, it should be costed and included in the economic analysis of the project.

It will be important to include all relevant capital and operating costs in the CEI calculation. Capital costs will include buildings such as hospitals and clinics, laboratories, equipment, vehicles, technical assistance and training. Any residual values (for example, of buildings or equipment) must be entered as negative costs at the end of the project life. Operating or recurrent costs include supplies and drugs, utilities such as power, and the time of the health personnel involved. Often in health projects, services are produced jointly, making it difficult to allocate capital costs to a particular activity. One approach is to allocate capital costs to each activity on the basis of staff time inputs. If this cannot be done accurately (for example, immunization programs for delivery of BCG and DPTT vaccines from the same health clinic), one can establish the costs of the activities when implemented together and then separately for activities that use the same capital resources. One can also estimate the incremental cost of adding one of the alternatives (say a BCG program) to a project to implement the other alternative (say a DPTT program) and vice versa (the cost of adding a DPTT program to a project to implement BCG vaccinations). Different project combinations can be assessed to find the most cost-effective means of achieving a particular level of health benefits.

Discounting

Standard ADB practice, as stated in *Guidelines 1997*, is to apply 12 percent as a test discount rate (with 10 percent used in exceptional cases where there are some additional non-quantifiable benefits). In principle, this is to reflect the opportunity cost of the funds committed to a project. By assumption, funds can be used elsewhere with a national return of 12 percent. The same test rate is applied across countries, which implies that essentially, it is a rationing device to allocate ADB resources between borrowers in an efficient manner. If health benefits can be quantified and valued accurately, then, in principle, health projects can be compared with projects from any other sector. Benefits will be equivalent to an income figure and like any other stream of income, future benefits will be worth less than benefits received today due to the opportunity cost principle. Hence, if health projects are subject to a full cost-benefit analysis, it is clear that they must be treated in the same way as projects from any other sector and discounted at ADB's standard 12 percent rate.

The 12 percent discount rate is used to reflect the opportunity cost of ADB resources and, in principle, acts as a rationing device to efficiently allocate scarce funds between competing projects. This approach is not directly relevant to health projects. With productive sector projects, future benefits and costs are less valuable than present sums because if they were available immediately, they could be productively invested at the discount rate. However, where benefits cannot be quantified in monetary terms as with health projects, this justification for discounting is not valid. Nonetheless, future health impacts may still be less valuable than present impacts because individuals and society in general prefer present to future benefits either because of a dislike for waiting or because incomes are rising over time and hence, future benefits will accrue to a better-off population. This is the rationale for discounting based on social time preference. When the discount rate is defined as reflecting society's preference for better health now rather than in the future, it becomes a subjective parameter; although when specified in this way, there should be, in principle, a unique social discount rate for each DMC.

Most estimates of the social time preference rate of discount set it at below 5 percent. A common figure used in the analysis of health projects is 3 percent (see, for example, *World Bank, World Development Report 1993*). As discussed below, a 3 percent discount rate must be applied in cost-effectiveness calculations where the DALY indicator is used for consistency, since published international DALY estimates are conventionally based on a 3 percent rate. However, if other CEIs are applied, there are basically two choices: either discount at the same rate as for other ADB projects; or use a lower rate such as 3 percent to take account of the theoretical argument that in health, where benefits are not monetized, discounting should be at a time preference rate. All cost-effectiveness illustrations in this *Handbook* use 3 percent. Nonetheless, given the uncertainty involved, the sensitivity of the cost-effectiveness results to different discount rates should be tested if the time profile of project alternatives is very different. Appendix 2 discusses the issue of the discount rate for health projects in more detail.

Health Impacts

The procedure for identifying and valuing health project costs is relatively straightforward and does not differ in principle from that required for projects from other sectors. The assessment of health impacts, required for the denominator of the CEI, is more problematic. In practice, there are a number of alternative measures of project outcome. A realistic aim in health project analysis, therefore, should be to

calculate CEI using one or more of these measures. Which to use will depend on data availability and the nature of the project. Here are several possible indicators in quantifying health impacts, ranging from the relatively simple to the very sophisticated. Project analysts will have to judge if they will be able to apply them in their own cases.

Process Indicators

The simplest approach focuses on a narrow definition of health impact related to the specific goal of a project. Examples are number of patients served (as in, children immunized or pregnant mothers seen) or of medical staff (such as nurses and doctors) trained or of inputs provided (such as bed days or operations). This is termed a process approach to health impact since the process of provision of health services (such as hospital beds or immunizations) is assumed to have a clearly defined and constant relationship with health outcomes. Hence, different hospital projects can be compared on the basis of costs per hospital bed, or different leprosy programs by cost per patient seen. The assumption is that each project alternative is equally effective and differs only in costs. This approach uses relatively simple data and is, therefore, fairly straightforward to implement. Its main limitation is that it allows only narrow comparisons between similar projects and cannot be applied in comparisons between different types of health intervention.

To apply equation (1), the relevant indicator and cost data will have to be estimated for each year of the project and discounted to the present to derive the CEI ratio. *Table 1* illustrates possible process indicators for different types of projects.

To illustrate the use of process indicators, *Table 2* gives a summarized data on three alternative versions of a project to improve the health of mothers. The process indicator is the number of supervised deliveries which is taken as a proxy for improved health during pregnancy. Alternative 1 works through the Family Planning Ministry, alternative 2 through the Ministry of Health, and alternative 3 works at the village level to develop groups of local midwives. In this case, the CEI is cost per supervised pregnancy with alternative 3 providing the least cost at $27 per supervised pregnancy. It should be noted that the illustration makes the assumption (which may not be correct) that all forms of pregnancy supervision are equally effective.

Table 1
Process Indicators

Project	**Process Indicator** (number of)
Training	Doctors trained Nurses trained
Inpatient care	Bed days Surgical procedures (e.g., operations) Birth deliveries
General clinics	Outpatient visits
Mother and child health	Pregnancies monitored Children immunized Contraceptive prevalence
Specific diseases	Patients treated
Nutrition	Breast-fed children Supplemented person years

Table 2
Cost-Effectiveness of Alternative Maternal Health Projects

	Alternatives		
	1	**2**	**3**
Population (million)	1	1	1
Pregnancies (million)	0.027	0.027	0.027
Deliveries			
Home unsupervised (%)	70	30	30
Home with midwife (%)	10	30	70
In hospital (%)	10	40	0
In clinic (%)	10	0	0
Annual supervised pregnancies (million)	0.0089	0.0189	0.0189
Present value of supervised pregnancies[a] (million)	0.07	0.16	0.16
Present value of project cost[a] ($ million)	2.59	5.28	4.32
Cost per supervised pregnancy ($)	33	33	27

[a] Discounted over 10 years at 3 percent.

Health Impact Indicators

Years of Life Gained (YLG)

A more complex indicator of health impact relates to deaths averted or years of life gained (YLG). Use of this indicator allows a comparison between different types of projects (for example between different forms of immunization or between preventive or curative treatment). The comparison now in the CEI is on the basis of costs per year of life saved. Calculation of years of life saved requires an estimation of the difference between expected duration of life with and without the project for all those affected by a project. This requires data on diseases that the project will combat. Such data include: average age at onset of the disease, average age at death as a result of the illness, incidence of the disease in the population, fatality rates from the disease, survival rates for those not affected, and life expectancy without the disease at the age of premature death. These data can be combined in equation (2) below to give life years gained. YLGs are given per 1,000 of the population affected but any unit can be used.

$$\mathbf{YLG = IN * CF * SR * PV(ad..ar)} \qquad (2)$$

where
- YLG is years of life gained;
- IN is the incidence of a disease (new cases per 1,000 of the population);
- CF is the case fatality rate (percent);
- SR is the probability of survival without the disease between years ao and ad, where ao and ad are average age at onset of the disease and average age at death with the disease respectively;
- ad and ar are average age at death with the disease and average age of death without the disease respectively; and
- PV(ad..ar) is present value of years survived between ad and ar discounted to the present.

To use equation (2) in comparisons between health projects, apply data on the disease involved and make an assumption about how effective different projects will be in reducing its incidence. Different levels of effectiveness will imply different figures for IN and possibly, different ages for average premature death ad for those

for whom the treatment is not fully effective. CEI, in this case, compares discounted costs with discounted YLG, so that for project j,

$$\mathbf{CEI_j = PV(C_w - C_{wo})/ PV(YLG)} \quad (3)$$

where as before,

C_w and C_{wo} are costs with and without the project;
YLG is net years of life gained as a result of the project; and
PV is discounted present value.

Use of equation (2) requires national life expectancy tables to identify the expected age at death of someone of age ad who does not contract the disease concerned. However, use of such tables rests on two simplifying assumptions that should be made explicit. First, if a death is saved by a health intervention, the individual affected is assumed to have the same survival probability as the average individual in the population. Second, survival rates and life expectancy in the future are calculated at currently observed rates of mortality. Mortality patterns may change significantly as incomes rise and medical science advances; hence, using contemporary figures for calculations over the lifetime of individuals may be misleading. Appendix 3 discusses the procedure for compiling life tables.

YLG has an advantage over process indicators, like patients seen or bed days, since it is based on health outcomes rather than on an assumed constant link between certain measurable variables and health outcomes. Unfortunately, it does require epidemiological data that may not always be forthcoming. But it can be a highly important indicator in dealing with diseases with high mortality effects, particularly childhood diseases. If the main objective of health interventions is mortality reduction, then YLG will be the appropriate indicator. In projects which have large morbidity effects however, judging projects on cost-effectiveness grounds using YLG as the measure of health outcome can be misleading. Hence, YLG may give a misleading picture of the impact of projects that combat chronic diseases with a large morbidity but low mortality impact. To address this problem, several alternative indicators have been devised.

Healthy Years of Life Gained (HYLG)

This is the simplest of the alternative indicators that combine mortality and morbidity effects. HYLG is the sum of the years of life saved as a result of a project plus the years of life that will no longer be affected by morbidity, with weights applied to the latter to make them comparable with healthy years saved. HYLG extends the

formula for YLG by calculating the years affected by disability before premature death (YD) plus the years of chronic disability for those affected by a disease who do not die prematurely (YCD), and finally, plus years lost to temporary illness (YT). Calculating these additional health outcomes requires further information on the degree to which those affected by a disease suffer disability between the onset of the disease and premature death, on the proportion of those affected who survive but are permanently disabled, and on the severity of their chronic condition. With these data, YD, YCD, and YT can be calculated from the following formulas:

$$\mathbf{YD = IN * CF * SR * w_1 * PV(ao..ad)} \quad (4)$$

where
- YD is years of life affected by disability before premature death;
- IN and CF are as defined in equation (2);
- ao and ad are average age at onset of the disease and average age of death with the disease respectively;
- SR is the probability of survival without the disease between years ao and ad;
- w_1 is the disability weight attached to a year of morbidity from the onset of the disease to premature death; and
- PV(ao..ad) is the value of the years survived between ao and ad discounted to the present.

$$\mathbf{YCD = IN * PD * w_2 * PV(ao..ar)} \quad (5)$$

where
- YCD is years of chronic disability;
- IN is as defined in equation (2);
- PD is the percentage of those affected by the disease who do not die but are permanently disabled;
- w_2 is the disability weight attached to a year of morbidity from the onset of the disease to death at the normal expected age; and
- PV is the value of the expected years survived between ao and ar discounted to the present.

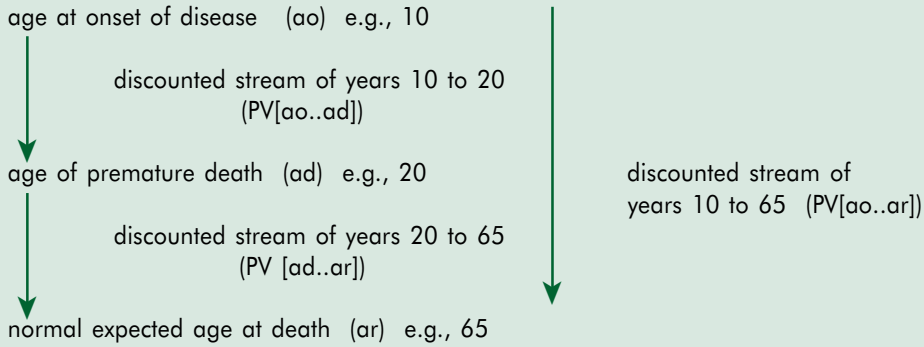
Survival probabilities do not appear explicitly in (5), but they are implicit in the estimate of ar.

$$\mathbf{YT = PV(IN * [1\text{-}CF\text{-}PD] * t * w_3)} \quad (6)$$

where YT is years of temporary disability;
IN, CF, and PD are as defined in equations (2) and (5);
(1-CF-PD) is the proportion of those affected by a disease who suffers only temporary disability in year ao;
t is the proportion of a year affected by disability
w_3 is the disability weight attached to a year of temporary disability; and
PV is the value of (IN * [1-CF-PD] * t * w_3) discounted to the present.

Box 7 illustrates the general procedure for identifying healthy years of life gained.

Box 7
Healthy Years of Life Gained (HYLG) in Present Value Terms



The HYLG indicator can therefore be derived as the sum of YLG, YD, YCD and YT so that

$$\mathbf{HYLG = YLG + YD + YCD + YT.} \quad (7)$$

Use of this indicator for cost-effectiveness comparisons will require an assessment of how different projects affect the incidence of a disease (and for those for whom the treatment is not effective, the fatality rate), the disability rate in the period up to premature death, and the age at premature death. Hence, for project j,

CEI now becomes

$$\mathbf{CEI_j = PV(C_w - C_{wo})/\ PV(HYLG)} \quad (8)$$

where PV(HYLG) is discounted net healthy years of life gained and other terms are as above.

The main departure in composite indicators like HYLG as compared with the simpler indicator YLG is the use of disability weights w_1, w_2, and w_3. These convert a year of morbidity saved by a project into the equivalent of a year saved. Hence, a year saved through the avoidance of premature death has a weight of 1.0. A year of morbidity and disability that is saved will have a weight of less than 1.0; but the greater the level of disability that the disease would have created, the higher will be the weight. Disability weights of this type should be constant over the life of the project. Weights may be derived from judgment on the proportion of a year in which an individual is not in full health due to the disease concerned. However, this does not take account of the varying degrees of the severity of the disability. Two individuals may be in less than full health for 200 days of the year, but one may be in great pain during this time while the other may be only immobile. To allow for this, an alternative approach is to base these weights on expert opinion on the severity of particular illnesses. For example, the weight on disability suffered during the period from the onset of leprosy to premature death might be 0.5, while the weight on disability suffered from tuberculosis might be 0.25. But because of the contentious nature of this type of weighting, use of HYLG as an indicator is more controversial than the more straightforward YLG. Nonetheless, where morbidity effects are important, HYLG could be applied either as the sole CEI or in conjunction with the YLG. It is probable that if this approach were to be adopted, ADB staff would have to develop their own weighting system to be used consistently across projects. Appendix 4 gives an illustration of YLG and HYLG calculations.

Table 3 gives the basic data which, in addition to life tables, are needed to estimate YLG and HYLG impacts. Where data specific to a particular country or location within the country are not available, it may be necessary to apply data available for a broadly similar country or location.

Disability Adjusted Life Years (DALY)

HYLG is only one of several composite indicators that combine morbidity and mortality impacts (there is also Quality Adjusted Life Years or QALY but will not be covered in this *Handbook* because there is limited empirical research on QALY in

Table 3
YLG and HYLG: Data Requirements for Diseases

- Incidence of cases (per 1,000 of population at risk)
- Fatality rate per case (%)
- Permanent disability rate per case[a] (%)
- Temporary disability rate per case[b] (%)
- Proportion of year for which temporary disability applies (%)
- Average age at onset of disease
- Average age of premature death with disease
- Life expectancy at various ages[c]
- Weights on temporary and permanent disability[d]

[a] Proportion of cases who do not die prematurely but are permanently disabled.
[b] Proportion of cases who neither die prematurely, nor are permanently disabled.
[c] From life tables.
[d] Necessary for HYLG calculation. Can be derived from medical data (for example, number of days per year patient cannot work), from expert opinion on severity of disease, or from surveys of patients' opinions.

developing countries). It is simpler than the other well-known indicator, the DALY. The difference between the two is that the DALY adds another level of complexity and uses not only disability weights but also weights for years of life saved at different ages. Appendix 5 gives the age and disability weights used in the *World Development Report 1993* and applied in our illustration. If we view society's preference for saving life as based on the productivity of those affected (or alternatively, on their responsibility to the young and the old), then clearly, saving the lives of those of working age will create a higher social gain than saving the lives of the elderly and the very young. For example, the original DALY age weighting gives a weight of more than one to ages between 9 and 54, and weights of below one for those in the age groups 1-8 and 55 upwards. The maximum weight is at age 25. This reasoning has controversial implications and it should be clear that it is implicit whenever DALYs are applied.

DALYs can be defined by amending equations (2), (4), (5), and (6) and including age weights. As with healthy years of life estimates, whenever there are both mortality and morbidity impacts, the total DALY effect will be the sum of: years of life gained; years affected by disability before premature death; years of chronic disability for those who do not die prematurely; and years of temporary disability. The expressions for YLG, YD, YCD, and YT are as before, except that now, each year saved has a weight that differs from unity. Now, using d to denote

that YLG, YD, YCD, and YT refer to DALY calculations, equations (2), (4), (5), and (6) become as follows:

$$\mathbf{YLG_d = IN * CF * SR * PV(wa[ad..ar])} \quad (9)$$

where YLG_d is years of life gained in DALYs;
IN is the incidence of disease (new cases per 1,000 of the population);
CF is the case fatality rate (percent);
SR is the probability of survival without the disease between years ao and ad, where ao and ad are average age at onset of the disease and average age of death with the disease respectively;
ad and ar are average age at death with the disease and average age at death without the disease respectively;
PV(wa[ad..ar]) is the value of the weighted expected years survived between ad and ar discounted to the present; and
wa is the age weight that differs for each year of life.

$$\mathbf{YD_d = IN * CF * SR * w_1 * PV(wa[ao..ad])} \quad (10)$$

where YD_d is years of life affected by disability before premature death in DALYs;
IN and CF are as above;
ao and ad are average age at onset of the disease and average age of death with the disease respectively;
SR is the probability of survival without the disease between years ao and ad;
w_1 is the disability weight attached to a year of morbidity from the onset of the disease to premature death;
PV(wa[ao..ad]) is the value of the weighted expected years survived between ao and ad discounted to the present; and
wa is the age weight that differs for each year of life.

$$\mathbf{YCD_d = IN * PD * w_2 * PV(wa[ao..ar])} \quad (11)$$

where YCD_d is years of chronic disability in DALYs;
IN is as above;
PD is the percentage of those affected by the disease who do not die but are permanently disabled;

w_2 is the disability weight attached to a year of morbidity from the onset of the disease to death at the normal expected age;
PV is the value of the weighted expected years survived between ao and ar discounted to the present; and
wa is the age weight that differs for each year of life.

$$\mathbf{YT_d = PV_{ao}(IN * [1\text{-}CF\text{-}PD] * t * w_3 * wa)} \quad (12)$$

where YT_d is years of temporary disability in DALYs;
IN, CF, and PD are as defined in equations (9) and (11);
[1-CF-PD] is the proportion of those affected by a disease who suffer only temporary disability in year ao;
t is the proportion of a year affected by disability;
w_3 is the disability weight attached to a year of temporary disability;
wa is as above; and
PV is the value of (IN * [1-CF-PD] * t * w_3 * wa) discounted to the present.

The DALY indicator can therefore be derived as the sum of YLG_d, YD_d, YCD_d, and YT_d so that

$$\mathbf{DALY = YLG_d + YD_d + YCD_d + YT_d}. \quad (13)$$

Hence, for project j, CEI now becomes

$$\mathbf{CEI_j = PV(C_w - C_{wo})/\ PV(DALY)} \quad (14)$$

where PV(DALY) is discounted years of life gained in DALYs and other terms are as above.

Once YLG, HYLG or DALY figures have been calculated per 1,000 of population, total impact will depend on the population reached by the projects. Appendix 4 illustrates the approach using YLG and HYLG indicators for two projects: one to combat meningitis and the other to combat schistosomiasis. To illustrate, assume that the projects have different costs but same total populations. In each case, however, assume that the aim will be to reach 20 percent of the target population in each of the first five years of the project; and for an additional 5 years, reach only the population growth in the project area of influence. To allow for under-achievement, assume these targets at 95 percent. Annual HYLG and YLG estimates per 1,000 of population are

converted into annual total health impacts by multiplying by the population reached in each year of project life. These annual total life figures are then discounted to the present, so that there is a process of double discounting as the annual HYLG and YLG are also discounted. Hence, altering the discount rate involves not just a revaluation of the benefit and cost flows but also a change in the HYLG and YLG figures used to calculate benefit streams.

In this comparison, at a 3 percent discount rate, the base case results are set out below.

	Meningitis	**Schistosomiasis**	
	$/YLG	$/HYLG	$/YLG
CEI	23.3	22.2	305.5

In this case, since meningitis has no chronic disability effects, its $/YLG is directly comparable with the $/HYLG for schistosomiasis. The latter is approximately 4 percent below the meningitis cost. Hence, if the weighting scheme used to compare mortality and morbidity effects is acceptable, the schistosomiasis project is the more cost-effective of the two. However, if we are only interested in lives saved and are unconcerned with reducing morbidity, then the meningitis project is far more cost-effective than the schistosomiasis project since costs per YLG are more than 10 times higher for the latter due to its weak impact on mortality rates. Hence, it is clear that objectives must be made explicit if this type of cost-effectiveness comparison is to give meaningful results.

Appendix 5 shows how the DALY approach can be applied to the same illustrations. The disability weights are the same for all calculations so that the only difference lies in the application of age weights in the calculation of DALYs. But because of the differential impact of the two projects on different age groups, use of the DALY indicator reverses the original ranking since the meningitis project is now slightly more cost-effective, with a cost per DALY just below that of the schistosomiasis project. See also Appendix 6 which reworks the calculation of cost per DALY using data from the Pakistan Women's Health Project.

Although it is increasingly used for the analysis of health projects, the DALY is the most complex of the indicators discussed here. The calculation of the DALY for specific conditions and individual projects is a major research task. However, a shortcut procedure is already available since a large international database of global DALY estimates had been produced by the World Health Organization (WHO) in 1996 (*The Global Burden of Disease*, edited by C. Murray and A. Lopez). Appendix 7 explains how, with some adjustments, these global data can be used to generate the approximate DALY for individual DMCs. The appendix also gives the results of an exercise to derive this approximate country-specific DALY for use on new projects.

6 Valuation of Health Benefits and Identification of Beneficiary Impact

Benefit Valuation

Although cost-effectiveness analysis is the test normally applied to health projects, there may be occasions when it is necessary to go further and carry out a full cost-benefit analysis. This involves the complex and controversial step of valuing the benefits of health projects. Such an analysis may be required in the appraisal of a multipurpose project (for example, an urban development scheme) with productive as well as health effects where, to complete the analysis, it is desirable to include health benefits. There may also be occasions when additional funds are made available and health projects may be in competition with projects from other sectors for the

receipt of these funds. For such cross-sectoral comparisons, estimates of economic returns to projects in competing sectors may inform decision-takers of the consequences of whatever pattern of allocation is chosen. In general, however, we recommend that health benefit valuation be attempted only occasionally, and that such calculations be taken as illustrative of the potential economic impact of health projects rather than as definitive data.

Health projects may generate a diverse set of benefits such as productivity gains due to fewer life years lost to mortality and morbidity, consumption gains due to a higher quality of life and increased life expectancy, and cost savings on curative treatment. In theory, under certain restrictive conditions, the willingness of health beneficiaries to pay for health services will be the appropriate measure of the benefits to society from these services. In practice, however, the most commonly used approach to benefit valuation in the health sector defines benefits solely as the productivity impact of a health project and thus treats only the production, not the consumption, side of health effects. Hence, if the impact of a project can be converted into years of life or into years of healthy life gained, a valuation of this benefit would require an estimate of the net output per year of life saved. A crude approach is to value years of life saved at average earnings per capita for the country concerned. This will be an underestimate of economic benefits, since few would accept the proposition that a year of human life saved is only worth the average income. But it will give a starting point for calculations; and if the project is economically acceptable with this approximate approach, there may be no need for further calculation. This is sometimes termed a human capital approach to valuation of life years. More sophisticated approaches attempt to directly estimate the economic value of the productivity effects of health projects. *Box 8* summarizes the cost-benefit analysis of an onchocerciasis control program using a production function methodology. Appendix 8 illustrates the valuation of benefits by future earnings using data from the Lao Primary Health Care Project.

Estimates of the value of life are largely confined to developed countries and have generally found wide variations in the implied value of reductions in the risk of death. United States data of this nature has occasionally been used in studies in developing countries by adjusting the implied US value of life figure by the ratio of the income per capita in the country concerned to US income per capita. Thus, if the suggested value of life in the USA is $2 million, and the country in which the health project under examination has a per capita income of 20 percent of the US level, a life value of $0.40 million will be implied for the country. This approach, while methodologically unsatisfactory, is also difficult to apply given the wide range of value of life figures derived from various studies. *Table 4* illustrates the range of possible values derived from US studies.

Box 8

Benefit Valuation: Onchocerciasis Control Program

In operation in West Africa since the mid-1970s, the Program eradicates onchocerciasis or river blindness by controlling the black fly that transmits a parasitic worm, the source of the disease. The Program benefits the rural population by removing the threat of blindness and allowing large tracts of land previously unusable due to the risk of contracting onchocerciasis to be brought under cultivation. A study by the World Bank has examined the economic impact of this Project and estimated an economic IRR of 18 to 20 percent. Benefits from the Program are defined as its productive impact and are measured by the increase in agricultural output from subsistence farming. An increase in output occurs because of the additional labor and land made available by the eradication of the disease. The extent of the increase in output is quantified using a production function of the form

$$Q = A * L^a * K^b$$

where Q is value-added;
A is a constant reflecting productivity level;
L is labor input;
K is land input;
a and b are the elasticities of value-added with respect to labor and land; and
$a + b = 1.0$ so that production is assumed to exhibit constant returns to scale.

Elasticities give the increase in value-added due to a 1 percent increase in labor or land, with either one factor fixed. From other empirical works, the elasticity of labor is taken to be 0.66 (a 1 percent increase in labor input causes a 0.66 percent increase in value-added with land fixed) and of land, 0.34. An estimation of the productive effect of the program requires data on the population at risk, the incidence of river blindness, the productive years gained through control of the disease, the labor force without the Program, the new land freed for use, the land available without the Program, and the value-added in subsistence agriculture in the areas affected. A central assumption is the number of productive years saved per person affected. Following earlier works, it is assumed that on average, persons who are onchocercal blind will live another eight years with the blindness and then die 20 years prematurely. Preventing this blindness, therefore, adds 28 years to the productive capacity of each person affected. This annual increase in the labor force must be expressed as a proportion of the without-project labor force to give the percentage increase in labor supply. When this percentage increase in labor supply is multiplied by the assumed labor elasticity of 0.66, the proportionate change in value-added due to the labor effect of the Program is obtained. Similarly, judgments must be made concerning the land returned to productive use as a result of the Program, and this must be expressed as a proportion of the land available without the Project. This proportionate increase in land use must then be multiplied by the assumed elasticity of 0.34 to give the percentage increase in value-added due to the land effect of the Program. When the sum of these annual percentage increases in agricultural value-added are expressed in real monetary terms, it results in a quantitative measure of the productive benefits from the Health Project, which are compared with its costs in a full cost-benefit calculation.

Source: Kim, A. and B. Benton. 1995. *Cost-Benefit Analysis of the Onchocerciasis Control Program*. World Bank Technical Paper, Number 282. Washington DC: World Bank.

Table 4
Implied Values of Life from Expenditures or Regulations that Reduce Risk of Death

Basis for Calculation	**Value of Life** (1987 $)
• Desire for prompt coronary care	66,000
• Automobile air bag purchase	360,000
• Smoke detector purchase	373,000
• EPA requirements for sulphur scrubbers	500,000
• Seat belt usage	541,000
• Wage premiums for dangerous police work	850,000
• EPA regulation of radium content in water	2,500,000
• Wage premiums for dangerous factory jobs	3,200,000
• OSHA rules for workplace safety	3,500,000
• Premium for tire usage	3,600,000
• Desire for safer airline travel	11,800,000

Source: Folland, S., A. Goodman and M. Stano. 1997. *The Economics of Health and Health Care*. New Jersey: Prentice Hall.

Willingness-to-pay studies on health in the context of developing countries are relatively rare and attempts to apply this approach may have to rely on very simple approximations. *Guidelines 1997* puts forward a simple method for estimating willingness to pay in any sector with marketed output. This involves identifying two combinations of price and demand: price and demand without a project; and price and demand with a project. Provided certain simplifying assumptions hold—principally that the demand-price relationship is linear—the willingness-to-pay for additional project output is taken from the average of the price with and without the project multiplied by the increase in output generated by the project. Provided one knows the initial price-demand point without the project and what price the project will charge, then with an assumed price elasticity of demand, the final piece of information—demand with the project—can be derived (see *Guidelines 1997* Appendix 4). The approach can even be applied to freely available services, such as access to a free health clinic, provided alternative sources of supply are available, for which a price is charged or for which a cost can be imputed. *Box 9* gives a health project illustration taken from *Guidelines 1997*.

At some point in the future, it may be possible to value health benefits more accurately. At present however, most practical estimates of health benefits are either underestimates since they focus on production rather than on the full range of health effects, or controversial since they are based on individuals' perceptions of their own

Box 9
Estimating Willingness to Pay for Services of a Health Clinic

In this illustration, a primary health care project providing free care to a poor village is to be established. At present, the only available treatment is from a private clinic in a nearby town and for which a fee is charged. Costs to individual villagers are the fee plus cost of transport and time in getting there. For simplicity, it is assumed that without the Project, the private clinic would be fully utilized so that the supply from the new village clinic is wholly incremental. As incremental output, the services of the village clinic should be valued at willingness to pay. The figure below illustrates the situation providing a surrogate (as opposed to an actual) demand line. The situation without the Project is that the charge to villagers is P_{wo}. However, as no incremental services are available at this price, quantity supplied without the Project is zero. In the with-Project situation, the services of the clinic will be free; so the with-Project price P_w is zero. At this price, the needs of all villagers are met to give quantity of service of Q_w. The incremental output supplied by the Project is (Q_w - Q_{wo}) and the willingness to pay for this output is given by the shaded area (P_{wo} * Q_{wo} * Q_w). As there is a linear demand line, this shaded area is taken from the average of prices with and without the Project (P_{wo} + P_w)/ 2 multiplied by the incremental output of the Project (Q_w - Q_{wo}). Hence, willingness to pay (WTP) is

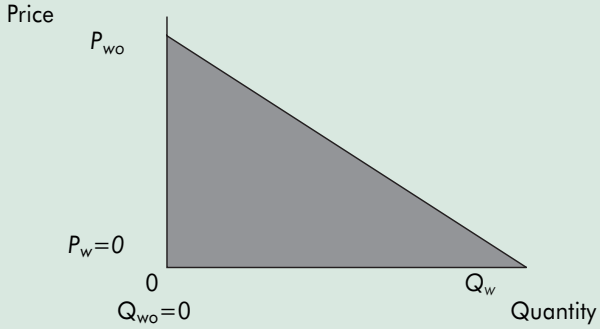
$$\mathbf{WTP = ([P_{wo} + P_w]/2) * (Q_w - Q_{wo}).}$$

In this case P_w = 0 and Q_{wo} = 0, so that WTP reduces to

$$\mathbf{WTP = (P_{wo}/2) * Q_w.}$$

The result means that based on individuals' willingness to pay, the benefit from the health clinic is derived by multiplying output of the Project by half the price charged in the without-Project case. The argument is simplified, particularly since no single service that should be valued at the unit price of $P_{wo}/2$ is identified; but it indicates a general procedure that can be applied to health projects. The analysis only changes slightly if the new project charges a fee. All that will happen is that WTP will no longer reduce to WTP = ($P_{wo}/2$) * Q_w and incremental output valued at the average of P_{wo} and P_w. Q_w will also be lower if charges are imposed.

Health Service provision Without Charge



Source: Asian Development Bank. 1997. *Guidelines for the Economic Analysis of Projects*. Appendix 11. Project Economic Evaluation Division, Economics and Development Resource Center. Manila, Philippines.

benefits from health effects, or subject to wide margins of error. Hence, it is preferable to use cost-effectiveness analysis as the main criterion for health projects while, where possible and relevant, attempting to establish a picture of a project's economic impact that might be used to complement the choice between alternatives based on costs alone.

Health Beneficiaries and Poverty Impact

Even if full social cost-benefit analysis of the conventional type is rare in the health sector, it is nonetheless important to establish who the beneficiaries of health projects are. ADB's priorities for the health sector are the poor, women, and indigenous peoples; and as much as possible, the expected impact of projects on these groups should be estimated as part of project economic evaluation. For example, if a project's health impact is expressed in YLG, HYLG or DALYs, the proportion going to different target groups could be estimated. Even if this formal analysis is not possible, it is also useful to have simpler indicators, as in the number of poor people served by a project and its impact on measures like their life expectancy or number of days of ill health. Where projects can be targeted directly at the poor, they will form 100 percent of project beneficiaries.

Ways of reaching the poor include: establishing health centers in poor and relatively inaccessible regions and having health workers travel to visit the poor; focusing on health problems that disproportionately afflict the poor such as TB, malaria, and diarrhea; and concentrating subsidies on facilities used by the poor such as health clinics rather than hospitals where the better-off are likely to be a much higher proportion of beneficiaries. Women's access to health facilities can be improved in various ways, but a central part of a gender-oriented strategy will be a focus of priorities on health projects that have a disproportionate impact on women. These include provision of user-friendly family planning methods, tetanus toxoid immunization, measures to control reproductive tract infections, and improvements to maternal health services. Measures to reach indigenous people may include development of a better database on their health status, establishment of more health centers in areas where they are concentrated, training of ethnic minority health workers who can provide services to their communities, and development of community-based schemes that encourage beneficial traditional medical practices alongside modern health services.

The methodology for assessing the poverty impact of any ADB project remains to be established definitively. In the case of health projects, it is well known that

improved health has not only medical effects that improve welfare but also directly productive ones that raise the capacity of individuals to work. Assessing the full impact of a health project on poverty would require incorporating both direct and indirect dimensions. In the absence of a comprehensive approach, it is nonetheless helpful to first establish the likely impacts, at least qualitatively. One framework is presented in ADB's Poverty Impact Assessment Matrix for program loans. It provides different channels for potential impacts on the poor and relates these to a series of impacts (direct, indirect, macroeconomic, and impacts on the non-poor). The discussion is expected to be qualitative in that only the direction of a poverty impact (either positive or negative) is shown. The approach is useful primarily for encouraging those designing the program loan to think about its range of possible consequences for the poor and, if necessary, to design mitigating features (for example, exemptions or subsidies for certain groups to offset user charges). *Box 10* illustrates this approach.

Box 10
Poverty Impact Assessment Matrix

Channel	Direct	Indirect	Impacts Macro	Non-Poor
Labor Market		+	–	–
Prices			–	
Access for Poor	+			
Transfers	+			

The matrix is supplemented by information on gender impact, mitigating measures planned, and assumptions concerning factors like price elasticity or levels of transfer. Here, macro refers to any macroeconomic or fiscal consequences of a program or project, and non-poor to possible effects on this group.

To illustrate the general approach, the matrix shows entries for a primary health care program that extends services to the rural poor (a positive direct impact) and raises long-run productivity (a positive indirect effect through higher wages). TheProject is assumed to avoid user charges (introducing a positive impact through transfers). This, however, will have negative macro consequences due to the demands on the government budget which, in turn, will impact negatively on the non-poor through higher taxes and, indirectly as well as negatively, on the poor themselves through inflation. The overall net effect will depend on the balance between these factors.

Source: ADB. 1997. *Guidelines on Operational Procedures*. GP6: Program Lending.

When individual projects are evaluated, it is desirable to complement this type of qualitative analysis with some more quantitative measures. At the project level, this can include a headcount indicator of the number of the poor (or other target groups) reached by the project. In addition, it may be possible to identify how their health status is affected by a project (for example, in terms of average life expectancy or annual days free from illness). Further, if household surveys are conducted among the poor, it may be possible to estimate the monetary cost to households (measured by a combination of medical expenditures, working time lost, and travel time incurred) of ill health. Improvements in health status can thus be expressed as equivalent to an income gain in monetary terms to the households concerned. This may be incomplete as a measure of the full benefits from a health project, but it should nonetheless allow judgments about its short-term impact on incomes of the poor.

7 Sensitivity Analysis

Given the uncertainty that is attached to parameters of all projects, sensitivity analysis is a useful tool for the analysis of projects from all sectors. *Guidelines 1997* Appendix 21 provides a general discussion of the role of sensitivity analysis, pointing out that it involves recalculating project results for different values of major variables that should be varied one at a time. The key issue is to identify the variables to which a project is most sensitive and to take mitigating action to ensure, as much as possible, that unfavorable shifts in these variables do not occur. For health projects, key areas of uncertainty are likely to occur in relation to project costing (have capital and operating cost estimates been prepared accurately?), epidemiological data (what are incidence rates, duration of illness, and average ages

at onset of illness and premature death?), and project coverage (what proportion of the target population is the project able to reach?).

Guidelines 1997 identifies several procedures for sensitivity analysis which can be used, with minor modifications, for the health sector:

(i) list the variables to which the project is likely to be most sensitive and based on experience and past data, assume alternative values for these variables that differ from the value used in the original or base case project calculation;
(ii) recalculate the project analysis using the alternative values for the key variables, changing these independently of each other;
(iii) compare the percentage change in the measure of project worth with the percentage change in the key variables to give a sensitivity indicator;
(iv) for variables to which the project is sensitive, show the switching value (that is, the percentage change in a variable which is sufficient to alter the original decision on the project) to make it acceptable if it was previously unacceptable, or vice versa; and
(v) if it is judged likely that some variables may move together, the impact of a change in a combination of two or more variables on project worth can also be tested.

Productive sector projects are normally appraised using the net present value (NPV) and IRR indicators of project worth. The sensitivity indicator and switching value should be calculated using a change in a project's NPV measured either at financial or economic prices, or both. For health projects, however, it is unusual for benefits to be in a form that can be quantified and valued. Hence, the normal procedure is to apply cost-effectiveness rather than full cost-benefit analysis. Sensitivity analysis will thus have to be applied to a CEI. The sensitivity indicator and switching value must therefore be redefined to allow for this modification. The sensitivity indicator (SI) will show the ratio of the change in CEI to the change in the variable concerned. Thus

$$\mathbf{SI = ([CEI_s - CEI_b]/CEI_b) / ([V_s - V_b]/V_b)} \qquad (14)$$

where CEI is a cost-effectiveness indicator (for example, cost per patient or per YLG or per HYLG);
V is the variable tested;
s refers to the sensitivity test; and
b refers to the base case.

Similarly, the switching value (SV) in a comparison between health project alternatives will be the change in the value of the variable tested, which is sufficient to make the superior alternative in the base case cease to be the preferred choice. Thus

$$\mathbf{SV = (V_s - V_b)/V_b} \quad (15)$$

which, for two alternatives 1 and 2 leads to CEI1 = $CEI2_s$, and where $CEI2_s$ refers to the value of the cost-effectiveness indicator in the sensitivity test.

Once these calculations have been carried out, the results of the sensitivity analysis should be reviewed to establish:

(i) which are the sensitive variables with high SI ratios;
(ii) whether the sensitivity calculations have used a plausible range of values for the tested variables;
(iii) whether the switching values for key variables are likely to occur; and
(iv) what initiatives in terms of project design and management are necessary to ensure successful completion of the project in as cost-effective a manner as possible.

These general procedures are illustrated for the projects examined in Appendix 3 using the YLG and HYLG indicators of health impact. There the sensitivity of the CEI was tested for changes in:

(i) discount rate,
(ii) effectiveness of projects in reaching target population,
(iii) incidence rates for meningitis and schistosomiasis per 1000 of population, and
(iv) disability weight for chronic disability from schistosomiasis.

Both projects are sensitive to the assumption concerning the incidence of the respective diseases in the target population. A 25 percent fall in the incidence increases the CEI of both diseases by 33 percent (SI = 0.333/0.250 = 1.07). Given the uncertainty concerning basic epidemiological data, this is a cause for concern. However, both projects are affected equally since a 25 percent fall in incidence reduces both streams of health impacts by the same proportion. The project choice between the most cost-effective alternative is sensitive to the assumed parameters—the discount rate and the disability weight on chronic illness from schistosomiasis. If no discounting is used, then the choice of the more cost-effective alternative switches from the schistosomiasis project to the meningitis project. However, at any positive discount rate, the latter is still more cost-effective provided one uses the HYLG indicator that allows for morbidity effects. Use of the HYLG indicator requires three weights for

different states of disability so that these can be compared with healthy life years saved by the meningitis project. The base case uses weights of 0.4, 0.2, and 0.1 for disability before premature death, chronic disability, and temporary disability, respectively. Of these, the second is by far the most significant because of the number of cases where chronic effects occur. A very small 5 percent change in the weight w_2—from 0.20 to 0.19—is sufficient in the base case to give equal CEI for the two projects. Under these conditions, this high sensitivity to what is a subjective parameter would probably be sufficient to give preference to the meningitis project, if the two were competing for the same funds.

8 Economic Appraisal and Decision Rules

Project Acceptability

In a few limited cases, it is possible to subject health projects to a full cost-benefit analysis in which the values of health benefits are compared with project costs in a conventional economic NPV and IRR calculation. In such instances, conventional decision criteria as discussed in *Guidelines 1997* can be applied. An acceptable project will have an IRR above the test discount rate, which would be 12 percent in a conventional calculation. Projects that are competing for the same funds should be judged on the size of the economic NPV at the test discount rate. Such calculations will be rare for the health sector because of the intrinsic difficulty

of health benefit valuation. Hence, cost-effectiveness criteria will be of more direct operational relevance.

Cost-effectiveness analysis for health projects is meant to aid decision-taking by selecting projects that create desired health outcomes at the minimum cost in use of resources. It is desirable for any project at the initial planning stage to consider alternative variants and select the most appropriate. Normally, cost consideration is one of the key factors in selecting which alternative to put forward. In principle, there is no reason why the same procedures cannot be applied in the health sector. CEI can be calculated for health projects in various ways. If the choice is between two versions of the same project, then use of a process indicator (for example, health impact in terms of patients served, beds provided, or nurses trained) may be adequate. Here, CEI comparisons will be based on discounted costs per discounted unit of health impact, however that is defined.

If, however, choices have to be made in the allocation of a given health budget, it will be necessary to look into the cost-effectiveness of different types of health projects (such as alternative immunization programs or preventive versus curative treatment). In broader comparisons, it will be necessary to use a measure of health outcome as the impact indicator for CEI. For projects whose primary effect is mortality reduction, YLG will be the appropriate measure. However, where morbidity as well as mortality effects are important, attempts should be made to calculate either HYLG or DALYs. Either composite measure can be used on its own or in conjunction with YLG. If the two versions of CEI are consistent in their selection of the lower cost project, then there will be an unambiguous ranking. But where use of either HYLG or DALY gives a different preferred choice to YLG, there will be a need to look closely at the alternatives to test how dependent the outcome is on the set of weights used to derive the composite measure. If the result is not very sensitive to the choice of weights, the implication is that allowing for morbidity effects of a project, regardless of how these are weighted, will reverse the decision taken on the basis of mortality effects alone. This suggests that the result based on the HYLG or DALY measure should form the basis for decision-taking.

The normal use of cost-effectiveness analysis is to select between competing uses of funds. However, there may be situations in which the CEI may be used not just to identify the cheaper alternative but also to decide whether to go ahead with the cheaper alternative. Costs per YLG, HYLG, or DALY may vary significantly between different types of health projects. It is helpful to identify an approximate average cost either for an individual country or for different types of health interventions internationally. This could be collected from past evaluations of health sector projects, for example. The data will give an indication of whether the expected costs per life saved from a project vary significantly from the norm for the country or internationally.

A project whose CEI (after prices and weights are put on a comparable basis) is above the average for the country or internationally need not be rejected; but an explanation for the higher than average cost as a result of project-specific conditions (such as remote location or high training costs due to staff scarcity) would have to be considered. Where no convincing explanation is forthcoming, the project would need to be redesigned or rejected.

As an illustration of a standard for cost per DALY comparisons, *Table 5* gives a range of estimates for different illnesses in both low and middle-income economies.

Table 5
Estimated Costs per DALY

	Cost/DALY (1990 $)
Low income economies	
Short course chemotherapy for tuberculosis	3–5
Prenatal and delivery care	30–50
Family planning	20–30
Treatment of STDs	1–3
Middle income economies	
Short course chemotherapy for tuberculosis	5–7
Prenatal and delivery care	60–110
Family planning	100–150
Treatment of STDs	10–15

Source: World Bank. *World Development Report 1993*. Table 5.3

Like projects from other sectors, health projects will be subject to varying degrees of uncertainty which relate not just to subjective weights but also to the underlying epidemiological data used to determine health effects. It must be clearly acknowledged that the strength of the scientific basis for predictions of health impacts will vary greatly between different forms of intervention. Appendix 9 of ADB's *Policy for the Health Sector* (February 1999) discusses this in detail. Again, sensitivity testing will be important since it will be necessary to establish whether a particular choice of project is dependent upon optimistic assumptions (for example, about changes in the incidence of and fatality rates from different diseases).

ADB's *Policy for the Health Sector* suggests a list of priorities for health projects based principally on the cost-effectiveness of the interventions, the scientific evidence supporting their likely impact, and the types of beneficiaries. Cost-effectiveness is

measured in $ per DALY. *Table 6* (pp. 72-75) lists the priority interventions and the estimated costs per DALY. These priority interventions are aimed at the poor and other priority groups. If social priorities are addressed by an identification of type of a project, then CEIs can be applied to such projects to assess their efficiency in resource use. This means that some such projects may be either rejected or redesigned if their costs per DALY (or per other indicator) are judged excessive relative to either international norms or to similar projects in the country concerned.

It is important to note that use of cost-effectiveness analysis as the basis for decision-taking on health projects can suggest implicit valuation judgments on health outcomes. This can arise where two projects that reach populations of different sizes are compared. One project may save 100,000 discounted life years while the smaller project may save only 75,000. The discounted costs may be $2.5 million for project 1 and $1.5 million for project 2. Use of a CEI comparison would recommend project 2, since it has a cost of $20 per life saved (1.5/0.075=20), while project 1 has a cost of $25 (2.5/0.1=25). However, selection of project 2 would mean that 25,000 less life years would be saved at a resource cost saving of $1.0 million. This decision, therefore, suggests that if there is no other way of saving the 25,000 life years then, implicitly, they are being given up for $1.0 million or $40 per life year. Hence, although a valuation of life is not made explicit, it is still implicit in this type of decision. Where this type of situation arises, the implications in terms of valuation of lives foregone should be made explicit so that decision-takers can be made aware of what is implied by their decision. *Box 11* taken from the *Guidelines 1997* gives another illustration of this problem.

Box 11

Implicit Values and Cost-Effectiveness Analysis

Three alternative combinations of vaccination programs and village health worker (VHW) programs are being considered to serve a particular population. An epidemiological study reveals that a vaccination program saves between 50 and 70 healthy life days per vaccination, while a village health worker program is estimated to save between 7 and 15 healthy life days per visit. The three different programs with different costs and combinations of vaccinations and visits are compared in the table below. Program 2 with a cost of $4.71 per healthy life day is the most cost-effective. In the table below, costs and days saved are shown on an annual basis so that no discounting is needed.

Choosing Between Health Project Alternatives

	Program 1	Program 2	Program 3
Annualized cost ($)	300,000	200,000	160,000
VHW visits per year	2,000	2,500	2,100
HLDs saved per visit (visits x 10 HLDs per visit)	20,000	25,000	21,000
Vaccinations	500	350	200
HLDs saved by vaccinations (vaccinations x 50 HLDs per vaccination)	25,000	17,500	10,000
Total HLDs saved	45,000	42,500	31,000
Cost per HLD saved ($)	6.67	4.71	5.16

Note: HLD is healthy life days
VHW is village health worker

A complication arises because program 2 reaches less people than program 1, which is the largest of the three alternatives in terms of days saved. Program 1 has a higher cost and its annualized cost exceeds that of program 2 by $100,000. However against this it saves 2,500 more days. In the comparison between 2 and 1, program 1 saves an extra 2,500 days at an extra cost of $100,000, which is a cost of $40 per day saved. The most cost-effective solution would be to expand program 2 to reach as many people as program 1, as this will generate maximum days saved for a given budget. A problem will arise if there is a constraint in expanding program 2 (for example, because of a shortage of village health villages). If 2 cannot be expanded, the extra 2,500 days saved annually can only be achieved at a high marginal cost from program 1. A decision will have to be taken as to whether this should be done. If program 1 were selected, the implication is that the extra days saved were worth more than $40 each. If 2 were selected, then the implication is that the extra days are worth less than $40.

Source: Asian Development Bank. 1997. *Guidelines for the Economic Analysis of Projects*. Appendix 19. Project Economic Evaluation Division, Economics and Development Resource Center. Manila, Philippines.

Table 6
Priority Public Health Interventions Required in All DMCs

Interventions are listed in approximately decreasing order of priority. Issues are highlighted in ***bold and italics.***

Intervention	Efficacy	Ease of Implementation	
		Quality of Evidence[1]	Burden of Disease in Asia
Immunization: Measles, Diphtheria-Pertussis-Tetanus (DPT), Polio, Hepatitis B, Tuberculosis (BCG), Tetanus Toxoid (TT)	Prevents 72–98% of cases, 50% of TB.	Class II, many studies. Class I for Hepatitis B.	Fifth leading cause of DALYs lost.
Vitamin A Supplements	Reduces overall mortality by 23% in children ages 6–72 months and maternal mortality by 38%.	Class I	23% of mortality in children 6–72 months. Prevalence of subclinical vitamin A deficiency is widespread.
Family Planning: Modern Methods for Birth Spacing	80–95% effective in preventing pregnancy. Decreases maternal morbidity and mortality by reducing high risk pregnancies.	Class I Class II	Unmet demand among married women in Asia (excluding China) is >62 million or 19% of married women of reproductive age.
Iodine: Supplementation; iodization of salt or water supply	Prevents goiter and cretinism 100%	Class II	130 million with goiter, 5 million cases overt cretinism, 680 million people at risk.
Treatment of TB, short-course chemotherapy	Full treatment 95–98% effective in treating disease and in stopping transmission.	Class I	1.4 million deaths, 6th leading cause of DALYs lost, 1990.

[1] Evidence: Class I = randomized controlled studies; Class II = prospective studies with non-random assignment to comparison group and case-control studies; Class III = cross-sectional studies or studies with historical data and regression analysis to isolate potential causal factors; Class IV = case series, case studies, and anecdotes.

Source: ADB *Policy for the Health Sector*. February 1999.

Demand Issues	Supply Issues	Cost/DALY Saved	Burden on the Disadvantaged (Equity)
Demand high. Parents appreciate immunizations.	Most immunization is provided by public sector. Governments are able to implement programs covering 80% of children ages <1 year.	$25	Poor are disproportionately affected due to crowded conditions.
High demand by parents.	Capsules require no refrigeration, can be administered by lay people. ***Difficulty in reaching older children.*** Supplements must be sustained until food fortification is in place.	$1	Poor children and women are more susceptible to deficiency.
High demand by couples, although education and marketing are still needed to reach high use rate.	***Serious issues of supply, wide variety in technical quality of services.*** Subsidies reach poor, who disproportionately use public services.	$25–$75	Cost of raising children is disproportionately burdensome for poor families. Poor women are at higher risk of maternal mortality.
Demand unknown.	Salt fortification is making progress but is ***complicated by large numbers of small producers. Regulation required.***	$8–$19	Prevalence highest in marginal areas where soils are iodine deficient and where disproportionate number of poor live.
Demand, as reflected in adherence to therapy, is a major issue.	**To increase therapy completion requires very careful implementation, including logistics and supervision.** Much of treatment occurs in private sector. **Quality of care in public and private sectors is a major issue.**	$3–$5	TB affects poor disproportionately due to crowding, poor ventilation, poor light, and inadequate nutrition. Poor have less access to care.

Table 6
Priority Public Health Interventions Required in All DMCs *(continued)*

Intervention	Efficacy	Ease of Implementation	
		Quality of Evidence[1]	Burden of Disease in Asia
Treatment of STDs in High-risk Groups	Cures and prevents transmission of STDs. May reduce HIV incidence by 40%.	Class I: clinical drug efficacy in most cases certain; treatment reduces HIV transmission.	Increasing STD cases; increasing multi-drug resistance, increasing HIV.
ARI Case Manangement	Treatment 80% effective; ARI case management reduces infant mortalityby 20%.	Class I, II	First leading cause of death among children; second leading cause of DALYs lost, 1990.
Management of Diarrhea with ORT; ORS in community	ORT reduces by 40% deaths due to dehydration from diarrhea.	Class II	Fourth leading cause of lost DALYs; 1.4 million deaths, 1990.
Programs to Reduce Use of Tobacco: taxes, health promotion	Taxation reduces consumption by estimated 0.5% for every 1% increase in price. Health promotion effects	Class III - taxes Class II - education	1990: 5% of deaths and 2% of DALYs lost; 2020 projection - 13% of deaths and 11% of DALYs lost.
Hygiene Education: hand washing	23–26% reduction in diarrhea	Class I: 2 studies	1990: Diarrhea is fourth leading cause of lost DALYs; 1.4 million deaths, 1990.

[1] Evidence: Class I = randomized controlled studies; Class II = prospective studies with non-random assignment to comparison group and case-control studies; Class III = cross-sectional studies or studies with historical data and regression analysis to isolate potential causal factors; Class IV = case series, case studies, and anecdotes.

Demand Issues	Supply Issues	Cost/DALY Saved	Burden on the Disadvantaged (Equity)
Demand high when when symptomatic but **adherence to treatment is weak. Demand low in asymptomatic cases.**	**Lab tests and medications are expensive. Drug supply is often inadequate.** Syndromic treatment approaches need to be validated. Much of treatment occurs in private sector. **Quality of care in public and private sectors is a major issue.**	$1–$55	Women are biologicall more vulnerable to STD and HIV infection and more likely to be asymptomatic. Poor are more likely to be involved in commercial sex.
Demand for treatment is high, but parents may bring children in late stages of disease.	Much of treatment occurs in private sector. **Quality of care in public and private sectors is a major issue. Misuse of antibiotics is widespread.**	$25	Crowding and poor nutrition are risk factors for ARI.
ORS does not stop diarrhea. Cultural views of diarrhea may interfere with early treatment; parents bring children late.	Most treatment occurs in the private sector. **Quality of care in public and private sectors is a major issue, with high reliance on antibiotics.**	$25–$75	Poor are disproportionately affected due to poor nutrition and contaminated water.
Reducing demand is difficult and time-consuming, requires considerable health promotion efforts and tax increases.	Taxes are sources of government revenue. **Tobacco control efforts are opposed by commercial interests. Smuggling may occur if taxes are too high. Limited experience with education and cessation efforts on broad scale.**	$25	Price elasticity is most pronounced among poor and youth. Youth are targeted by industry advertising.
Demand constrained when water supply is limited.	Existing strategies too costly for widespread implementation.	high	Poor are disproportionately affected by diarrhea.

Fiscal Impact

The financial sustainability of most public sector health projects will be determined by their impact on government finances. Financial sustainability first requires that there are adequate funds to cover the capital expenditure of the project, including working capital, so that it has an adequate financing plan. Second, it requires that there are sufficient funds to cover the operating and maintenance costs of the project. Even when user charges are imposed, it is still rare that public sector health projects in the region would be able to generate sufficient revenue to cover all operating and maintenance costs. Hence, it is important to ensure that government support be forthcoming to cover the balance.

Often, governments have been able to fund capital expenditure on health projects while failing to cover recurrent or operating costs. The *r* coefficient (defined as the ratio of incremental recurrent expenditure to total capital investment) taken from past projects has been used to forecast the extent of the need for covering operating budgets for new projects. Within the category of operating costs, it is often wage and salary costs which are covered first when funds are scarce because of a commitment to the staff. This can lead to a scarcity of essential drugs and supplies.

The impact of a project on the fiscal balance is defined as the difference between the income a project creates for the government and the government income it uses. In project calculations, this should be identified on an annual basis and these annual figures can also be discounted (at the standard test discount rate) to give a present value. Public sector health projects will be net users of government income and establishing the impact on government finances, principally of counterpart local funds in the capital costs and recurrent expenditure, is an important part of an economic analysis. Once the magnitude of this fiscal impact has been established, it can be put in the context of the total government health budget to establish if there is a financial gap that must be bridged by higher taxation, borrowing or user charges. Public funding for health projects can come from the local as well as the central government; and where significant funds come from the former, it will be necessary to do a separate impact calculation for this lower level of government. This is illustrated in Appendix 9 on the Philippines Early Childhood Development Project.

Use of public funding to cover health project costs is a subsidy to health beneficiaries. This is often rationalized on equity grounds, although some studies on the distributional impact of past programs of health subsidies have revealed significant leakage of the benefits of subsidies to the better-off rather than to the main target groups. The issues underlying the levels of subsidies and their incidence have been

discussed above. Once a charge for health services, and thus a level of subsidy, has been agreed, the implications of this level of fee for the revenue of the project must be determined. A higher fee should only be imposed if the price elasticity of demand for project services is below –1.0, since if it is greater than unity, use will decline proportionately, more than the increase in price and revenue will fall. Projections for future revenue must take account of expected growth in use due to greater awareness, higher income, and other factors such as lower waiting or traveling time, plus the negative effect of a higher price. An elasticity estimate, however crude, is required for this calculation.

Projected project revenue must be compared with projected costs to establish the operating shortfall that must be covered by government funding. This can then be compared with the total government health budget; and if it appears that funds will not be available from the budget, other sources must be found. Most project calculations are at constant prices partly to avoid making explicit assumptions about inflation over a relatively long period ahead. Hence, it will be simpler to conduct fiscal impact calculations at constant prices, which will allow a comparison of future shortfalls with the existing health budgets in real terms. In relation to fiscal impact, there is no categorical criteria to apply at the decision-taking stage. What is important is that the project is financially sustainable, which presupposes that whatever level of subsidy is implied by the difference between project revenue and costs can be covered by government transfers or other sources of funding. What a sustainable level of subsidy is will vary depending upon the overall macro-economic government accounts, the health budget and the demands of other projects and agencies. Judgment will have to be exercised in this area in the light of government policy and the macroeconomic situation.

Project Framework Analysis

The project framework is not an economic analysis tool but a project cycle management tool. Like in other bilateral and multilateral development organizations, it is a requirement in ADB's project preparation and processing cycle.

The project framework is useful in the design of projects and in facilitating monitoring and evaluation of project implementation and management. It has three main purposes. First, it is used to clarify and define more precisely and logically a project's objectives (goals and purposes), outputs, activities, and inputs, and to make apparent the linkages between these elements of a project's design as well as the assumptions on which they are based. Second, it is used as a participatory planning

tool as it facilitates the incorporation of a range of views from various stakeholders of the project, the beneficiaries, the implementing agencies, concerned NGOs, and other private and public sector bodies. The project framework is, therefore, both an ex ante project design and ex post evaluation tool.

The nature and usefulness of the project framework are based on the following premises: (i) projects are designed to achieve quantifiable and measurable objectives and outputs; (ii) project quality and success need to be monitored and measured by the extent to which these projected objectives and outputs are actually achieved; (iii) the projected achievement of these objectives and outputs is based on a series of hypotheses of cause and effect relationships which should be clearly explained, agreed to, and monitored; and (iv) key parties to the projects (e.g., the executing agencies, the beneficiaries, ADB, etc.) are in agreement on the project design, its underlying assumptions, and identified risks. At the project identification stage in health sector projects, overall goals and main objectives are defined. As the project processing and project quality evaluation proceeds, information on outputs including process and outcome indicators, inputs, assumptions, and risks are provided. These indicators and information later provide the basis for monitoring project implementation and evaluating the extent of project success. Those who are not familiar with the use of project framework can refer to any ADB loan or technical assistance documents.

Health Sector Policy Reform

There is a tendency for an increased share of ADB lending to finance a program of health sector reform in a particular country rather than a specific health project. It is well known that for any sector, it is considerably more difficult to assess the impact of a program as opposed to a project loan because of the diverse range of effects generated by program lending. However in health, as in other sectors, the principles of project analysis can still be applied in discussions of program loans. Two key principles must be applied. First, it is important that health policy reform (whether, for example, in relation to the management or financing of hospitals and clinics or to the reform of the whole sector) is linked with tangible indicators of impact that can be monitored in a form of policy matrix during the process of reform. These indicators will be needed in drawing up a Program Framework (similar to a Project Framework) and progress of the reform can be monitored in relation to such indicators. Measures of health status (such as mortality and birth rates) will probably change too slowly to be useful indicators and more indirect indicators (such as patients seen,

numbers immunized, drugs available or increased participation of NGOs or private providers) relative to a baseline set before the reform may have to be applied. See the discussion of Process Indicators in page 43.

The second principle to be applied in program lending is that of cost-effectiveness which is central to an assessment of individual health projects. ADB interventions supporting policy reform must aim to use available resources as effectively as possible and hence, individual components of a health reform program must be designed with this goal in mind. For example, if the goal is to improve health sector administration and management, the planning criteria should be to achieve the maximum improvements for the minimum financial cost involved in training and restructuring. For program lending, it will often not be possible to do detailed cost-effectiveness calculations of the type described in this *Handbook* for individual projects. However, the important general point is that an effort should be made to ensure that individual components of a health program can be justified in cost-effectiveness terms.

Health sector reform in transition DMCs poses an even more demanding reform agenda due to the major social and economic changes affecting these economies. Often, reform will involve overhauling the entire health sector to introduce, for example, policy and legislative changes, institutional strengthening for better oversight and regulation, human resource development for training and international accreditation, private sector involvement in health provision, and consideration of alternative means of health finance. *Boxes 12* and *13* illustrate examples of the agenda for health policy reform program from ADB's experience in two very different situations: Papua New Guinea and Mongolia.

Ex Post Evaluation and Monitoring

For all types of projects after completion, it is important to monitor effectiveness. This requires collecting information to re-assess the original ex-ante analysis. For all projects, it will be necessary to collect cost data to see how, in real terms, actual and projected costs differ. For health projects, success will have to be monitored by collecting information on various health outcomes. If cost-effectiveness analysis had been carried out, it would then have been based on a series of assumptions regarding the with- and without-project scenarios, and the accuracy of these could have been checked. In particular, it will be important to assess data such as the proportion of the target population reached by the project and the impact of the project on relevant health indicators. The indicators to be studied will vary between projects and between

Box 12

ADB Experience with Program Lending for Health Policy Reform—Papua New Guinea

In Papua New Guinea, ADB is providing assistance to the government through a health sector development program to allow a major reform of health provision. The key objectives are to create:

- greater participation of users and local governments;
- increases in autonomy for hospitals and other key institutions;
- greater availability of drugs and medical supplies;
- better financial management of the sector, including cost-sharing arrangements with users;
- enhanced participation of non-public sector suppliers, principally NGOs and churches.

The policy reform has four main dimensions to achieve these objectives.

(i) A shift of emphasis from urban to rural areas by allocating greater financial, staff and drug resources to local communities while, at the same time, introducing decentralization by allowing local committees to manage health facilities and to retain fee income collected from patients for re-investment in the system.

(ii) A change in orientation from curative to preventative health services. This will involve improved outreach facilities aimed at maternal and child health, immunization programs, increased supply of safe drinking water, and education campaigns aimed at improving nutritional and health related practices.

(iii) Reform of health care financing through improved financial planning, greater cost recovery by hospitals, promotion of health insurance, and the mobilization of community resources. In particular, the Department of Health will develop mechanisms for better expenditure monitoring and compare expenditures with health status indicators to assess the effectiveness of different activities. There is a target that user fees should cover 10 percent of hospital operating costs by the year 2000.

the level of aggregation. For a safe motherhood project, for example, there will be overall indicators (like infant and mother mortality rates, which reflect the aggregate impact of the project) as well as more specific indicators relating to particular conditions (such as the incidence of maternal hemorrhage or abortion among mothers or of measles or respiratory infections among children). The latter illness-specific information will be required if DALY or HYLG impacts are to be recalculated to reassess the original cost-effectiveness analysis.

In addition, there will be various process targets identified in the Project Framework for most health projects, such as the number of patients visiting a health

(iv) Institutional reform aims to increase the efficiency of health delivery by setting up Health Boards at national, provincial, and local levels and by restructuring the administration of hospitals. In addition, NGO and church provision will be supported by the integration of their services into provincial systems and the basis for their financing (for example, from donors) will be formalized and made more transparent.

A Policy Matrix also sets out quantitative targets to be achieved during the implementation of the reform by March 2000. Targets are related to two main areas: health treatment and financial expenditure. For illustration, some baseline figures and their corresponding targets are set out below. These figures are the monitorable part of the reform program.

Health Treatment (selected districts)	**baseline**	**target March 2000**
Antenatal visits (coverage)	68%	80%
Supervised delivery (coverage)	30%	50%
Measles immunization (coverage)	35%	70%
Triple antigen immunization (coverage)	59%	70%
Health Expenditure		
Health/total government expenditure	7.7%	10%
Revenue collection/hospital costs	4%	10%

Source: ADB. 1997. Loan 1517/1518-PNG: *Health Sector Development Program*. Manila: ADB.

clinic or the number of women receiving contraceptive advice. These are useful intermediate indicators but they do not really reveal project impact on health outcomes. For a full evaluation of a health project, it will be necessary to convert process data of this type into data on health outcomes. This latter step requires data collection on the health status of the population affected by the project; and if this is not possible, assumptions on the relation between achievement of a process target, like number of children visiting a clinic, and changes in various indicators of child health, like incidence of vitamin deficiency or diarrheal illness. This procedure of collecting or estimating data on health impacts of on-going projects is an important source of

Box 13
Health Policy Reform: Objectives in Mongolia

In Mongolia, ADB is financing a major restructuring of the health sector. The main policy objectives, intermediate medium term objectives, and some illustrations of policy interventions are set out below.

Policy objective	Medium term objective	Examples of intervention
Promotion of primary health care model	Allocate more finance to primary health care	Family group practice in all districts
Encouragement of private	Alter legal framework sector provision	Authority for accreditation and licensing
Restructuring health facilities	Rationalize health infrastructure	Rationalization of hospitals
Rationalization of health personnel	Improve training facilities	New job descriptions and performance-linked incentives
Improved finance and management	Develop capitation payment	Experimental insurance fund and hospital boards
Protection of poor	Identify target groups	Monitoring mechanisms for target groups

Source: ADB.1997. Loan 1568/1569-MON: *Health Sector Development Program*. Manila: ADB.

information not just for the evaluation of the projects concerned but also for the planning of future projects since it gives a picture of health impacts that can be expected from different types of project interventions.

Terms of Reference

Draft terms of reference for consultants working on the economic analysis of health projects are given in Appendix 10. These are not intended to be prescriptive, but they try to cover the main areas of economic work discussed in this *Handbook*. Clearly, separate terms of reference will be required for the other professionals working in a project team.

Appendixes

Contents

APPENDIX 1
Summary of Methods to Estimate Price Elasticity of Demand

There are several ways to measure price elasticity. Three common methods, experimental, behavioral and hypothetical, are summarized here. In the context of a typical situation in developing countries, the behavioral method would be most relevant. The analysts are advised to check whether the Living Standard Measurement Studies (LSMS) has been done by the World Bank in the country and review its health section as part of their initial literature survey.

Experimental Method

Advantage:

(i) Measurement of price elasticity is simpler than other methods.
(ii) The result will be most specific to and accurate for the health intervention being considered.

Weakness:

(i) Most expensive (can be $5,000 per person per year).
(ii) Sample size tends to be small. Randomized controlled tests may be difficult to carry out in practice.
(iii) Administration is laborious.
(iv) Respondent might take strategic action. For example, if she/he knows that experiment will be ended by a certain date, she/he might overuse the medical services during the experiment.
(v) Ethical problems might occur. For example, some respondents who are covered by the experimental health insurance become uncovered once the experiment is over.

In the experimental method, theoretically, *panel data* based study is ideal because the econometric estimation procedure for price elasticity can be simple and accurate. But panel data requires tracing of the same subject respondents over a long period of time and that is often infeasible in practice. The usual approach is to

collect *cross section data* within a relatively short period of time. But on the other hand, the latter approach requires information on individual characteristics to control individual respondents' attributes unrelated to price elasticity of demand, and also it involves relatively complex estimation method. Examples of this approach include the studies done by Rand Corporation in Indonesia (described in Box 3 of the main text) and in the U.S. (described below).

The Design of the Rand Health Insurance Experiment (Newhouse [1993] provides fuller descriptions of the study design.)

RAND Health studies originated in the 1960s, when policymakers were engaged in a rigorous debate about how patients should share the costs of their medical care. To provide a factual basis for the debate, in 1971 the Department of Health, Education, and Welfare funded the RAND Health Insurance Experiment.

Between November 1974 and February 1977, the Health Insurance Experiment (HIE) enrolled families in six sites: Dayton, Ohio; Seattle, Washington; Fitchburg, Massachusetts; Franklin County, Massachusetts; Charleston, South Carolina; and Georgetown County, South Carolina.

Families participating in the experiment were assigned to one of 14 different fee-for-service insurance plans or to a prepaid group practice; additionally, some members already enrolled in the prepaid group practice were enrolled as a separate group. The fee-for-service insurance plans had different levels of cost sharing, which varied over two dimensions; the coinsurance rate (percentage paid out-of-pocket) and an upper limit on annual out-of-pocket expenses. The coinsurance rates were 0, 25, 50 or 95 percent. Each plan had an upper limit (the Maximum Dollar Expenditure or MDE) on annual out-of-pocket expenses of 5, 10, or 15 percent of family income, up to a maximum of $1,000. Beyond the MDE, the insurance plan reimbursed all covered expenses in full.

Covered expenses included virtually all medical services. One plan had different coinsurance rates for inpatient and ambulatory medical services (25 percent) than for dental and ambulatory mental health services (50 percent). And on one plan, the families faced a 95 percent coinsurance rate for out-patient services, subject to a $150 annual limit on out-of-pocket expenses per person ($450 per family). In this plan, all inpatient services were free; in effect, this plan had approximately an outpatient individual deductible.

Families were assigned to these insurance plans using the Finite Selection Model (Carl Morris, 1979). This model was used to achieve as much balance across plans as possible while retaining randomization; that is, it minimizes the correlation between the experimental treatments and health, demographic, and economic covariates.

HIE employed four randomized subexperiments (Newhouse et al, 1979). For example, to test for transitory demand effects (Metcalf, 1973), 70 percent of

the households were enrolled for three years; the remainder for five years. Families were paid a lump sum payment to ensure that no one was worse off financially from participating in the study. To test for a possible stimulus to utilization, 40 percent of the families were given an unanticipated increase in their lump sum payment during the next to the last year of the study.

Behavioral

Advantage:

(i) Respondent will not take strategic action.
(ii) No ethical problems arise.
(iii) Cost is moderate (can be $100 per person).

Weakness:

(i) Information on individual characteristics is necessary. Burden on respondents is heavy and usually it needs honorarium.
(ii) Complicated statistical analysis is needed to calculate price elasticities.
(iii) It lacks accuracy compared with the experimental method.
(iv) A variation of prices in the analysis is limited to the actual pricing in the past, which may not be sufficient for the health intervention being considered.

Diary (Respondents keep questionnaires for a certain period)

Advantage:

(i) Information is relatively accurate.

Weakness:

(i) Survey period is bounded, limiting the informational coverage.
(ii) High literacy is required and may be more suitable for developed countries.

Data and Estimation Method (example: Ii & Ohkusa, 1999)

The data for the research were obtained from a survey conducted from November 1, 1997, to January 20, 1998, in Kanto (Tokyo, Kanagawa, Saitama, and Chiba) and Kansai (Osaka, Kyoto, Nara, and Hyogo) areas. The questionnaire asked about household and individual characteristics, as well as their illness histories,

treatments, and progress. Of the total 600 questionnaires distributed, 548 were completed and returned. Multinomial probit estimation method is used.

Retrospective

The most useful reference is the World Bank LSMS in which household surveys are done by field interviews.

Advantage: Longer survey period is possible.
Weakness: Information can be less accurate since it depends on memory.

Data

In 1980 the World Bank established the LSMS to explore ways of improving the type and quality of household survey data collected by statistical offices in developing countries (Some data sets are available through the World Bank homepage).

For example, 1990 Bolivian LSMS was conducted by the National Statistical Institute in Bolivia (INE) with the financial support of the World Bank. The survey was conducted in departmental capital cities and in a sample of cities with populations greater than or equal to 10,000. The survey covered 6,346 households with 30,350 individuals from the nine departments (similar to states in the United States) of Bolivia in 1990. The stratified random sample of 6,346 households was chosen to reflect the population in 10 cities. In the stratification, neighborhoods were randomly selected in each of the statistical zones used by INE and then households were randomly selected within the selected neighborhoods. There are 319 neighborhoods in the data set.

The main objective of HIE is to provide household level data for evaluating the effects of various government policies on the living conditions of the population. The survey collected data on all major aspects of household well-being. It is a multipurpose survey, gathering data on migration, education and training, employment (for both first and second occupations and for both formal and informal sectors), unemployment (for both active and inactive people), health, fertility, children's health, housing (including housing materials, water service and sewer service), income, and expenditures. Collecting data on these topics from the same households has the added advantage of allowing for the analysis of relationships among these different aspects of the quality of life.

For the health sector, detailed information on the quantity and type of health care used was obtained from all household members who reported an illness or injury

during the four weeks prior to the interview. There were also separate sections on fertility and child health.

Some LSMS data as well as questionnaires are available from the World Bank home page (www.worldbank.org). Questions covered in the health section of the Bolivian LSMS are as follows.

1) During the last 30 days, have you been
   1. Injured
   2. Sick
   3. Healthy (go to question 14)
2) Because of sickness or accident that happened during the last 30 days, how many days were you unable to carry out your normal daily activities? (write in days/30)
3) Were you examined by a doctor to check your sickness or accident?
   1. Yes
   2. No (go to Question 5)
4) Why not?
   1. Sickness or accident was not important
   2. Medical center too far
   3. Believe service is of bad quality
   4. Believe service is too expensive
   5. Do not have time
   6. Self-medicated
   7. Other reason
5) Who assisted you?
   1. Physician
   2. Dentist
   3. Nurse/aide
   4. Pharmacist, responsible for health unit
   5. Midwife
   6. Quack doctor
   7. Relative/neighbor
6) Where did you go for attention?
   1. Hospital
   2. Clinic or private doctor
   3. Polyclinic or health unit
   4. Health post
   5. Drug store (Question 8)
   6. Other (Question 8)
   7. Home (Question 8)

7) How long did you have to wait before being assisted for the first time?
   Time in:
   1. Days
   2. Hours
   3. Minutes
8) How much did you pay?
   Please write the total amount
9) Did you stay in the hospital because of this sickness or accident?
   1. Yes
   2. No (Question 11)
10) How much did it cost?
11) Did you receive a prescription for your illness?
   1. Yes
   2. No (Go to Question 11b)

11a) For what part of your illness did you receive prescription?
   1. All (Go to Question 12)
   2. Some (Go to Question 12)
   3. None (Go to Question 14)

11b) Did you take any of the medicines for the treatment of your illness or accident?
   1. Yes
   2. No (Go to Question 14)

12) How did you get these medicines?
   1. They were given at Social Security hospital or where attended.
   2. You bought them at the same place as you received medical attention.
   3. You bought them in a private drug store
   4. You bought them in a public drug store
   5. You bought them from street sellers or in the black market
   6. Other
13) How much did you pay for all the medicines you used because of your sickness or accident?
14) During the last 5 years did you receive yellow fever vaccination?
   1. Yes
   2. No

For all women older than 13 years old.

15) During the last five years, how many times did you receive anti-tetanus vaccinations? (If none, write zero)
16) Have you
    1. Given birth in the last 12 months,
    2. Are pregnant,
    3. Had a miscarriage during the last 12 months
    4. Were pregnant more than 12 months ago
    5. Were never pregnant
17) Who assisted you during your childbirth?
    1. Physician
    2. Nurse/aide
    3. Responsible for public health unit
    4. Midwife
    5. Quack doctor
    6. Relative/neighbor/by yourself
    7. Other
18) Where did you go for assistance?
    1. Hospital
    2. Clinic or private doctor
    3. Polyclinic or health unit
    4. Health post
    5. Home
    6. Other
19) How much did you pay for medical attention? (Write the total amount)
20) What month of pregnancy were you in when you had your first pre-natal care visit? How many pre-natal care visits did you have?
    (Write the month of pregnancy)
    (Write the number of pre-natal care visits)
21) Who performed your pre-natal care?
    1. Physician
    2. Nurse/aide
    3. Person responsible for health unit
    4. Midwife
    5. Quack doctor
22) Where did you go for your pre-natal care visits?
    1. Hospital
    2. Clinic or private doctor

3. Polyclinic or health unit
4. Health post
5. Home
6. Other

23) How much did you pay for medical care during your pregnancy?

23a) During your pregnancy did you take iron tablets?
1. Yes
2. No

24) How many children did you have that were born alive?

25) How many of them are presently alive? Please also count the ones that do not live with you.

About the children under 5 years old, answered by the head of household

26) During the last two weeks, did _____ (name) have
1. Diarrhea
2. Cough/Cold/Pneumonia
3. Measles or other eruptives
4. Other sicknesses
5. Accident
6. Was healthy

27) How many times received anti-polio vaccination?

28) Received anti-TB vaccination which leaves a scar on the shoulder
1. Yes
2. No

29) How many times did you receive the D.P.T. vaccination (anti-Diphtheria, anti-tetanus, anti-whooping cough)

30) Received anti-measles vaccination?
1. Yes
2. No

30a) Do you have a vaccination card?
1. Yes
2. No

31) How long did you breast feed your child ? (Name)

32) How old was your child when you gave him/her other food or liquids?

When the variable representing the demand for medical services is discrete (e.g., Questions 3-6), that is, whether to visit a clinic, hospital, or private doctor or treat themselves, one often uses *multinomial probit* or *multinomial logit* model in

estimating price elasticities. Dependent variables are choices while independent variables are price, demographic (age, gender, education, occupation, etc.), and household (income, household composition, etc.) variables. Unlike the outpatient medical care, prenatal care can be considered a homogeneous good. In such a case we can set up the demand specification using the number of pre-natal care visits (e.g., Question 20) as the quantity demanded (dependent variables). In this case, one often uses *Tobit* specification since many pregnant women receive no prenatal care, while the other observations spread over a wide range of positive values. Ii (1996) is referred to for econometric details. Amemiya (1985) is a good reference for various econometric techniques. Those with limited research resources and econometric skills are advised to look for the existing LSMS study in the country or may try simplified estimation models, although at some risk of inaccuracy or errors. Even without rigorous statistical analysis, there will be much qualitative insight to be gained from the questionnaire results.

Hypothetical

Advantage:

(i) Least expensive (can be $20 per person).
(ii) Detailed information on individuals is not necessary.
(iii) Ethical problems will not arise.

Weakness:

(i) There is no guarantee that respondents will act as they say they will. For example, they have incentives to overstate their willingness to pay for medical services knowing such hypothetical answer cannot be enforced once the service is provided.
(ii) The result is least accurate.

A recent effort to improve on the hypothetical method is called conjoint analysis (CA). CA has been widely used in the field of environmental economics and transport economics. It has recently been applied to health economics, such as evaluation of new medical treatment technology. Useful references for CA include Ryan (1999), Ryan and Hughes (1997), Van der Pol and Cairns (1997) and Bryan et al (1998). Application of CA specifically to willingness-to-pay and price elasticity of demand for health care is still rare. One recent example is Suzuki and Ohkusa (1999) in which they conducted a two-month survey of residents in western Japan, with their age ranging 20-60 years old. The sample was chosen randomly from a telephone book.

They sent the questionnaire to respondents after they had confirmed by telephone that they would cooperate. Some 544 respondents replied to the questionnaire. The question mainly used in this research was: "When you have the symptom of a cold, such as a temperature of 38 degrees, mucus, and a sore throat, and you think that you have caught a cold, what action do you decide to take?". The respondents have three choices: "visit a doctor right away", "take over-the-counter medicine", and "do nothing". They are asked to make a hypothetical choice under the hypothetical scenario of coinsurance rate such as 30%, 40%, 50%, 70%, 100% and under that of actual rate.

Researchers can analyze choice by reference to the scenarios and in principle design the questions such that statistical models fully control the effects arising from individual properties. Nonetheless, it still potentially suffers from bias arising from two sources: hypothetical choice and hypothetical scenarios.

APPENDIX 2
Discount Rate for Health Projects

There is considerable confusion in the general literature over the appropriate discount rate to use for the health sector. The problem with health and discounting arises because of the possibility of having non-monetary rather than monetary benefits. In principle, there are three possible approaches: a zero rate, a social time preference rate, or an opportunity cost rate.

Standard ADB practice, as stated in *Guidelines 1997*, is to apply 12 percent as a test discount rate (with 10 percent used in exceptional cases where there are some additional non-quantifiable benefits). In principle, this is to reflect the opportunity cost of the funds committed to a project. By assumption, funds can be used elsewhere with a national return of 12 percent. The same test rate is applied across countries, which implies that essentially, it is a rationing device to allocate ADB resources between borrowers in an efficient manner. If health benefits can be quantified and valued accurately, then in principle, health projects can be compared with projects from any other sector. Benefits will be equivalent to an income figure and like any other stream of income, future benefits will be worth less than benefits received today due to the opportunity cost principle. Hence, if health projects are subject to a full cost-benefit analysis, it is clear that they must be treated in the same way as projects from any other sector and discounted at ADB's standard 12 percent rate.

If, however, health benefits are treated as quantifiable but not amenable to monetary valuation, which in general is the assumption in this *Handbook*, the standard practice may not be appropriate. Cost-effectiveness rather than cost-benefit analysis will be the technique to apply; but nonetheless since future impacts will be involved, a discount rate will still be required. What is not correct is to combine monetary and non-monetary benefits in one project calculation and apply one single discount rate, since incomparable units are being compared.

One approach is to argue that cost-effectiveness indicators (ratios of costs to health outcomes) should have a zero discount rate because of the non-monetary nature of health impacts. This argument has several difficulties. At a practical level, if non-monetary health impacts are not discounted while project costs are, the cost-effectiveness of project interventions will increase over time, because costs fall with the application of discount factors while health impacts remain constant. This leads to the paradoxical conclusion that it will be cost-effective to continue to postpone

a project indefinitely since each year, the cost-health impact ratio will be lower than the following year. Hence, a project could never be justified on cost-effectiveness grounds. To make timing decisions sensibly requires that both sides of the cost-effectiveness ratio be discounted at the same rate. At a more conceptual level, the use of a zero discount rate for health effects implies complete indifference when such impacts arise. In other words, there is no cost of waiting and a year of good health today is no more desirable in welfare terms than a year of good health at some point in the future. Since we can assume that normally individuals and society in general do perceive a cost in waiting, this argues for some form of discounting of health impacts.

In theory, for non-monetary health benefits such as disability adjusted life years (DALY) or healthy years of life gained (HYLG), the appropriate discount rate should be based on a social time preference rate that reflects society's subjective view of the cost of waiting. The key difference between health impacts and goods and services with monetary values is that unlike the latter, health effects cannot be traded over time. The rationale for conventional discounting is that if use of a good is postponed, this can be compensated by setting aside a sum that will grow over time at the opportunity cost rate. Hence, if a good has a value equivalent to X dollars today, in three years time it will have a value of $X * (1+r)^3$, where r is the opportunity cost discount rate. Individuals are assumed to be indifferent about having this accumulated sum three years in the future or having the good today.

With health effects, however, this argument does not hold since neglect of health in the present may not be compensated by monetary expenditure in the future. If health effects can be thought of as creating utility, then in principle the discount rate should reflect the decline in this utility over time. The social rate of time preference defines society's view of this rate of decline. The conceptual basis for a social time preference rate of discount is discussed in texts like *UNIDO 1972*. Precise measures of this subjective parameter are not possible, but most empirical studies suggest that it is low in comparison with opportunity cost rates. *World Bank World Development Report 1993*, which uses a 3 percent rate to discount health effects, justifies this on grounds of social time preference. The same rate has been used in other applications of cost-effectiveness methodology, for example, P. Ha, et al, 1996 and D. Jamison, et al, 1993. A 3 percent rate is now used in most international DALY calculations, such as those reported in Table 6A.1 of ADB's Policy for the Health Sector and reproduced here in the main text as *Table 6*. Hence calculations of DALY for individual projects can only be compared with these international standards, if the same 3 percent rate is used.

It may be objected that despite this conceptual basis for a social time preference discount rate, opportunity costs must be considered whenever an investment decision is involved. However, in principle, if one takes the position that benefits from a

particular sector cannot be valued and that its projects do not compete for funds with other sectoral projects, then that sector will have a fixed budget that is given independently of marginal returns in the sector. A standard opportunity cost rate, such as 12 percent which is a national figure, will therefore not be applicable. With a constrained budget, the opportunity cost rate for a particular sector is the marginal return in the sector itself. However, if we assume benefits cannot be expressed in monetary terms, then the concept of a marginal sectoral rate of return is meaningless. There can, therefore, be no sectoral opportunity cost discount rate under these circumstances, which brings us back to the social time preference rate as the basis for discounting. It should be noted that similar arguments do not apply to sectors such as power and water where cost-benefit analysis is often used. In these sectors, it is common to put monetary values on benefits and thus, in principle, there will be a sector-specific marginal return which can be used as the discount rate in cost-effectiveness analysis. If the investment budget for these sectors is not fixed, then for these sectors use of the standard 12 percent rate can be justified on grounds of allocative efficiency.

Where alternative projects are similar in scale and timing, choice of discount rate may not alter ranking by a CEI. However, where scale and timing differ then the discount rate used may influence the decision on competing alternatives. The simplified numerical illustrations demonstrate this in *Table A2.1* (pp.99–101). Three simple cases of comparisons between two projects (A and B) are given. In case 1, the difference between the projects is simply one of scale. Project B has double the costs and double the health impact of project A, with timing of costs and impacts the same for both. Here, the choice of discount rate makes no difference to cost-effectiveness rankings. The ratio of $ per unit of impact (in this case, healthy years) is the same for both projects at all discount rates and rises with the rate of discount. In case 2, the total undiscounted costs and health impacts of the two projects are the same; however, the timing differs. Project A creates health impacts from years 3-10, while impacts from B are felt only in years 9 and 10. Because of this later arrival of health impacts, project B is the higher cost alternative at all positive discount rates. The gap between cost-effectiveness indicators for A and B widens as the discount rate increases, but B will always be the higher cost. Case 3 introduces the situation where the choice of discount rate alters the ranking of the two projects. Here, there is both a difference in costs between the two projects and in the scale and timing of the health impacts. Project B has the lower cost per year when no discounting is applied but its health impact arrives later than A's. Hence, at low discount rates such as 3 percent, B is the more cost-effective alternative. At a higher rate of 12 percent, however, the later impacts for B are sufficiently reduced, making A more cost-effective. There is a crossover discount rate of about 7 percent at which

the two alternatives are equally cost-effective. At rates below this, B is preferred while at rates above, A is superior. These cases illustrate the obvious point that higher discount rates discriminate against projects with impacts well into the future (for example, vaccines for children against hepatitis B whose effects may be felt in 30 years). Further, they show that for projects with different time profiles, there will be a cross-over rate that can be estimated. The key issue then becomes how the discount rate should be specified to reflect the decline in costs and impacts over time.

Use of a conventional rate of 12 percent as the discount rate in health cost-effectiveness calculations has the advantage of ensuring consistency in ADB practice across sectors; but theoretically, it has the disadvantage of being derived from the concept of opportunity cost. Hence, under certain circumstances, use of this rate will discriminate wrongly against projects with long-run effects. Use of a 3 percent discount rate has the advantage of being compatible with the practice in DALY calculations; and if ADB analyses of cost-effectiveness use DALY, then it would be incorrect to apply any rate other than 3 percent. However, although the 3 percent rate is based on the theoretically correct discounting concept for non-monetary health effects, social time preference, the true time-preference discount rate, is still a subjective parameter that cannot be known with accuracy. Hence, 3 percent is only a proxy for this concept rather than a precise value and cannot be defended too rigorously. Where the discount rate is important to a cost-effectiveness appraisal, a range of rates can be tested to see if within a reasonable range, the choice of preferred alternative alters.

It may also be noted that so far, in ADB-funded health sector projects where a cost-effectiveness analysis had been carried out, the 3 percent discount rate was used (e.g., Pakistan Women's Health, Philippines Early Childhood Development, Bangladesh Urban Primary Health). On the other hand, where benefits were measured in monetary values (e.g., Lao PDR Primary Health Care), the 12 percent was used.

Table A2.1
Cost-Effectiveness Illustrations

CASE 1
Discount rate makes no difference to ranking with identical timing.

Project A

Year	1	2	3	4	5	6	7	8	9	10
Costs $	100	100	5	5	5	5	5	5	5	5
Health yrs	0	0	20	20	20	20	20	20	20	20

Project B

Year	1	2	3	4	5	6	7	8	9	10
Costs $	200	200	10	10	10	10	10	10	10	10
Health yrs	0	0	40	40	40	40	40	40	40	40

Discount rate		**A**	**B**
0%	PVcosts	$240.00	$480.00
	PVHealth	$160.00	$320.00
	$/yr	$1.50	$1.50
3%	PVcosts	$224.43	$448.86
	PVHealth	$132.33	$264.67
	$/yr	$1.70	$1.70
12%	PVcosts	$188.81	$377.61
	PVHealth	$79.20	$158.41
	$/yr	$2.38	$2.38

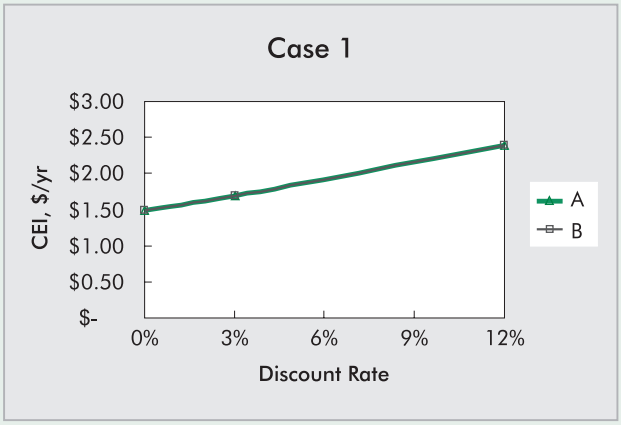


Table A2.1
Cost-Effectiveness Illustrations *(continued)*

CASE 2
Undiscounted cost effectiveness is equal but with a positive discount rate project B with later benefits is always inferior.

Project A

Year	1	2	3	4	5	6	7	8	9	10
Costs $	100	100	5	5	5	5	5	5	5	5
Health yrs	0	0	20	20	20	20	20	20	20	20

Project B

Year	1	2	3	4	5	6	7	8	9	10
Costs $	200	200	10	10	10	10	10	10	10	10
Health yrs	0	0	0	0	0	0	0	0	160	160

Discount rate		**A**	**B**
0%	PVcosts	$240.00	$480.00
	PVHealth	$160.00	$320.00
	$/yr	$1.50	$1.50
3%	PVcosts	$224.43	$448.86
	PVHealth	$132.33	$241.68
	$/yr	$1.70	$1.86
12%	PVcosts	$188.81	$377.61
	PVHealth	$79.20	$109.21
	$/yr	$2.38	$3.46

Table A2.1
Cost-Effectiveness Illustrations *(continued)*

CASE 3
Timing and undiscounted figures differ, so that cross-over discount rate can be calculated at about 7%.

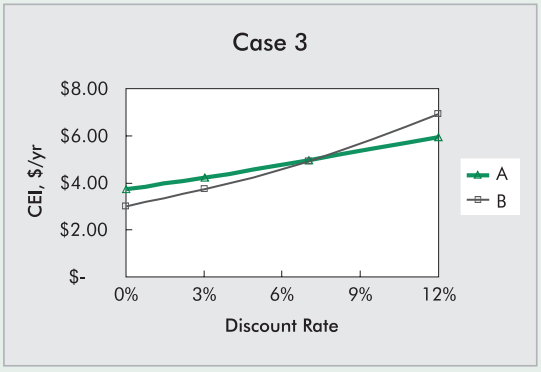
Project A

Year	1	2	3	4	5	6	7	8	9	10
Costs $	100	100	5	5	5	5	5	5	5	5
Health yrs	0	0	8	8	8	8	8	8	8	8

Project B

Year	1	2	3	4	5	6	7	8	9	10
Costs $	200	200	10	10	10	10	10	10	10	10
Health yrs	0	0	0	0	0	0	0	0	80	80

Discount rate		**A**	**B**
0%	PVcosts	$240.00	$480.00
	PVHealth	$64.00	$160.00
	$/yr	$3.75	$3.00
3%	PVcosts	$224.43	$448.86
	PVHealth	$52.93	$120.84
	$/yr	$4.24	$3.71
7%	PVcosts	$206.88	$413.76
	PVHealth	$41.72	$84.18
	$/yr	$4.96	$4.92
12%	PVcosts	$188.81	$377.61
	PVHealth	$31.68	$54.61
	$/yr	$5.96	$6.92



APPENDIX 3
Life Tables for Use in Health Project Analysis

A life table is essential for assessing the impact of a project on mortality, since it gives the probability of surviving between different age groups for a sample of the population. If this normal pattern is known, then it can be compared with the impact of a project; and the difference between these gives the incremental project impact on mortality. Normally, life tables are presented separately for both males and females and are often given in an abridged form covering age groups of five years rather single years. *Table A4.1* gives a section of the life table for males in the Philippines for 1990.

The key data in a life table from which all other parameters in the table are derived are the age-specific death rates for different age groups. The probability of dying between age group x (say 11 years) and group x + 1 (say 12 years) is

q_x = deaths during year of population aged x at start of year/ population aged x at start of year.

This is difficult to calculate since population estimates are normally for the mid-point of a year. Hence, q has to be derived normally from the simple death rate M where

M_x = deaths during year of population aged x at start of year/ population aged x at middle of year.

The link between the two expressions is as follows (see Newell 1988:69 or any similar text for a formal derivation):

$$q_x = M_x / (1 + [1 - ax] * M_x)$$

where ax is the fraction of the year lived by those who die during the year.

Normally, ax is taken as 0.5; but for poor countries, values lower than this (such as 0.3 or 0.4) are sometimes used for the first two years of life.

When the age group covers five years rather than a single year (so that x may be years 11-15 and x + 1, years 16-20), a similar approach is used except that Mx and qx will refer to a longer time interval. Now, the link between qx and Mx is slightly different since

$$q_x = n * M_x / (1 + n * [1 - a_x] * M_x)$$

where n is the length of time interval; and

a_x now refers to the fraction of the interval lived by those who die during that period (again see Newell 1988:71 or any similar text for a formal derivation).

Once the age group specific death rates have been estimated, these other columns in the life table can be calculated: the probability of surviving between ages x and x + 1; the numbers surviving between age groups out of the original population; the numbers dying between age groups out of the original population; the number of future person years to be lived at different points; and critically, the expectation of life at different age groups. Implicit in these calculations are assumptions about ax for different age groups.

Table A4.1 for the Philippines shows the life expectancy for a cohort of 100,000. Column 2, the number of survivors for different age groups, is derived from data on age-specific death rates. If qx is the probability of dying between age x-n and x, then

$P_x = (1-q_x)$ is the probability of surviving.

Hence, column 2 is derived from the expression

$$l_x = (l_x - n) * P_x$$

so that survivors at age x are the population at age x-n multiplied by the probability of survival between age x-n and x.

Column 3 is the number of person years to be lived beyond age x by those of the original cohort who reach x; in other words, this is the sum of person years lived between x and the death of the last member of the cohort. Column 4 is the survival ratio or probability of survival between age x-n and x. As has been noted, it is derived from age-specific death rate estimates. Finally, column 5 is life expectancy or average numbers of years left to live by surviving members of the cohort. Column 5 is derived by dividing column 3 (person years to be lived) by column 2 (the number of survivors in each age group).

Life tables can be calculated from actual data from the country concerned although often, in low income countries, there will be problems with data quality particularly with under-reporting of deaths and age misstatement among the elderly. As an alternative to the compilation of tables for individual countries, there are various models available to simulate life tables under different conditions. Hence, if it is judged impractical to derive a new table for a particular country, a new health project in that country could be assessed drawing on life expectancy data derived from a model specified to fit the type of country concerned. The Philippines table cited in Appendix 4 is based on the 1990 Population Census and adjustments to the figures for registered deaths published annually by the National Statistics Office. The model used for this adjustment drew on the mortality pattern from an earlier UN model for Latin America.

APPENDIX 4
Illustration of Calculation of YLG and HYLG

Years of Life Gained (YLG)

Here is a YLG calculation using assumed data on meningitis and the 1990 life tables for the Philippines. Life expectancy data for males is also used. Data from the life tables are in *Table A4.1* and the meningitis assumptions are in *Table A4.2*.

Table A4.1
Philippines Life Table

age	lx	Tx	nSx	life expectancy
0	100,000	6,220,178	0.93164	62.20178
1	94,014	6,124,880	0.98218	65.14859
5	91,824	5,754,357	0.99406	62.66724
10	91,184	5,296,836	0.99396	58.08953
15	90,738	4,842,030	0.98922	53.36276
20	90,024	4,389,970	0.98395	48.76444
25	88,767	3,942,783	0.98032	44.41722
30	87,183	3,502,775	0.97702	40.17727
35	85,311	3,071,426	0.97198	36.0027
40	83,200	2,649,992	0.9622	31.85087
45	80,533	2,240,364	0.94766	27.8192
50	76,954	1,846,221	0.92908	23.99123
55	72,252	1,472,706	0.90052	20.38291
60	66,300	1,125,679	0.86528	16.97857
65	58,435	813,175	0.81787	13.91589
70	49,479	542,770	0.73584	10.9697
75	38,667	321,614	0.5955	8.31753
80	26,170	158,878	0.44497	6.07099
85	13,092	61,969	0.33939	4.733349
90	5,012	18,848	0.22353	3.76057
95	1,402	4,213		3.004993

where: lx - number of survivors to age x from cohort of 100,000
Tx - number of years to be lived beyond age x by those of original cohort reaching x
nSx - survival ratio or proportion of people surviving from age group x to age group x+n

Source: Flieger, W. and J. Cabigon. 1994. *Life Table Estimates for the Philippines, its Regions and Provinces.* HFDP Monograph no. 5. Health Finance and Development Project. Department of Health, Government of the Philippines.

Table A4.2
Meningitis Data

• Incidence cases per 1000 persons at risk (IN)	8.00
• Fatality rate per case in percent (CF)	20%
• Average age at onset of disease (ao)	10.00
• Average age of death with disease (ad)	10.00
• Further years of life at age ad without disease	58.00
• Expected age of death without disease (ar)	68.00
• Probability of survival between ao and ad without the disease (SR)	1.00

A project to remove meningitis will create benefits in terms of years of life that are gained as a result of the removal of the disease. With reference to the main text, YLG can be calculated from equation (2) as follows:

$$\mathbf{YLG = IN * CF * SR * PV(ad..ar)}$$

where
- YLG is years of life gained;
- IN is the incidence of a disease (new cases per 1000 of the population);
- CF is the case fatality rate (percent);
- SR is the probability of survival without the disease between years ao and ad,
  where ao and ad are average age at onset of disease and average age at death with the disease, respectively;
- ad and ar are average age at death with the disease and average age at death without the disease, respectively; and
- PV(ad..ar) is discounted present value of expected years survived between ad and ar.

The probability of survival between onset of the disease (ao) and premature death (ad) can be calculated by the product of the survival ratios from the life tables for each age class covered. For example, if ao is 5 and ad is 15, two age classes of five years given in the life tables will be covered as an individual moves from ao to ad. The survival ratio for age class 5 is 0.99406, and for class 10 is 0.99396. The probability of someone starting in age class 5 reaching age class 15 is thus (0.99406 x 0.99396=0.98805). In the meningitis illustration, ao=ad so that it is assumed that

without the disease, there would be a probability of 1.0 that a person would reach year ad from year ao.

The present value of life years between the ages of 10 (ad) and 68 (ar) is 20.95 (at a 3 percent discount rate). This gives the loss of years for one person due to premature death at the age of 10 as compared with an expected life up to age 68. This figure must then be weighted by the incidence of the disease, the fatality rate per case, and the probability of survival between ao and ad (IN * CF * SR) to give a loss per 1,000 of the population. For our data, the YLG is 33.52 per 1,000 of population.

$$\mathbf{YLG = (8 * 0.2 * 1.0) * (20.95) = 33.52}$$

Healthy Years of Life Gained (HYLG)

Here is a HYLG calculation for schistosomiasis using the following assumed data and the same life tables.

Table A4.3
Schistosomiasis Data

• Incidence cases per 1,000 persons at risk (IN)	15.00
• Fatality rate per case in percent (CF)	4%
• Average age at onset of disease (ao)	5.00
• Average age of death with disease (ad)	30.00
• Further years of life at age ad (30) without disease	40.00
• Further years of life at age ao(5) without disease	62.00
• Expected age of death without disease at year ad (30) (ar)	70.00
• Expected age of death without disease at year ao (5) (ar)	67.00
• Probability of survival between ao and ad without the disease (SR)	0.9428
• Percentage of those affected by disease who do not die but are permanently disabled (PD)	0.90
• Percentage of those affected by disease who neither die nor are permanently disabled, but are affected temporarily	0.06
• Disability weight for year of morbidity from onset of disease to premature death (w_1)	0.40
• Disability weight for year of morbidity from onset of disease to death at normal expected age (w_2)	0.20
• Disability weight for year of temporary disability (w_3)	0.10
• Proportion of year for which temporary disability applies (t)	0.20

The onset of the disease occurs on average at year 5 (ao) with death occurring on average at year 30 (ad). Without the disease, the probability of survival between 5 and 30 is given by the product of the survival ratios for age classes 5-25 from the life tables; that is, (0.99406 x 0.99396 x 0.98922 x 0.98395 x 0.98032)= 0.9428. Once someone has reached age 30, life expectancy is a further 40 years, so ar is 70.

A project that removes schistosomiasis creates benefits through savings in years of life lost to both mortality and morbidity. HYLG can be obtained by calculating YLG, YD, YCD, and YT from equations (2), (4), (5) and (6) of the main text where

YLG is as defined on page 108. (2)

$$\mathbf{YD = IN * CF * SR * w_1 * PV(ao..ad)} \quad (4)$$

where
- YD is years of life affected by disability before premature death;
- IN and CF are as defined on page 108;
- ao and ad are average age at onset of the disease and average age of death with the disease, respectively;
- SR is the probability of survival between ao and ad without the disease;
- w_1 is the disability weight attached to a year of morbidity from the onset of the disease to premature death; and
- PV is the value of the expected years survived between ao and ad discounted to the present.

$$\mathbf{YCD = IN * PD * w_2 * PV(ao..ar)} \quad (5)$$

where
- YCD is years of chronic disability;
- IN is as defined on page 108;
- PD is the percentage of those affected by the disease who do not die but are permanently disabled;
- w_2 is the disability weight attached to a year of morbidity from the onset of the disease to death at the normal expected age; and
- PV is the value of the expected years survived between ao and ar discounted to the present.

$$\mathbf{YT = PV(IN * [1\text{-}CF\text{-}PD] * t * w_3)} \quad (6)$$

where YT is years of temporary disability;
IN,CF, and PD are as defined on pages 108 and 110;
t is the proportion of year for which temporary disability applies;
w_3 is the disability weight for a year of temporary disability; and
PV is the present value of years lost to temporary disability.

The present value of life years between the ages of 30 (ad) and 70 (ar) is 9.81 (at a 3 percent discount rate). This gives the loss of years for one person due to premature death at the age of 30 as compared with an expected death at age 70 without the disease. This figure must then be weighted by the incidence of the disease, the fatality rate per case and the probability of survival between ao and ad (IN * CF * SR) to give a loss per 1,000 of the population. For our data, the YLG is 5.55 per 1,000 of population.

$$\mathbf{YLG = (15 * .04 * 0.9428) * (9.81) = 5.55}$$

YD is the equivalent of healthy years of life lost due to morbidity before premature death. To calculate years of life lost to morbidity between the onset of the disease (ao) and premature death (ad), discount life years between years 5 and 30. This gives a present value at 3 percent of 15.47. This figure must then be weighted by the incidence of the disease, the fatality rate per case, the probability of survival without the disease, and the disability weight (w_1) that converts a year of morbidity over this period into the equivalent of a healthy year lost. The full weight is thus (IN * CF * SR * w_1). When this is applied, a YD of 3.50 per 1,000 of population is obtained.

$$\mathbf{YD = (15 * 0.04 * 0.9428 * 0.40) * (15.47) = 3.50}$$

YCD is the equivalent of healthy years lost due to chronic morbidity among survivors of the disease. To obtain YCD requires that calculation of the years of life lost to morbidity between the onset of the disease (ao) and death at the expected normal age (ar), that is between years 5 and 67. This places the present value at 3 percent of 24.88. This figure must then be weighted by the incidence of the disease, the non-fatality rate per case, and the disability weight (w_2) that converts a year of morbidity over this period into the equivalent of a healthy year lost. The probability data on survival is not required here since it is already implicit in the estimation of normal expected age at death (ar). The full weight is thus (IN * PD * w_2). When this is applied, a YCD of 67.18 per 1,000 of population is obtained.

$$\mathbf{YCD = (15 * 0.90 * 0.20) * 24.88 = 67.18}$$

YT is the equivalent of healthy years lost due to temporary disability. All such years are assumed to arise in the year of onset of the disease (ao). YT is found by multiplying incidence by the proportion of those affected who suffer only a temporary disability, the proportion of a year that they are disabled, and the weight (w_3) placed on their temporary disability. The loss in year ao is then discounted to the present. Here, YT is (15 * 0.06 * 0.20 * 0.10) discounted from year 5 to the present or

$$\mathbf{YT = 0.018/(1.03)^5 = 0.0155}.$$

Total healthy years gained from removal of the disease (HYLG) are, therefore, the sum of YLG, YD, YCD, and YT or 76.24 per 1000 of affected population. In this case, the majority of healthy years gained arise from the savings in disability affected years during the period from the onset of the disease until death at the expected age of 67. This is because we use a very low fatality rate of 4 percent, so that 90 percent of those affected suffer from chronic but non-life threatening disability and 6 percent from temporary disability. Hence, savings in years of chronic disability (YCD) are 88 percent of total years of healthy life gained.

Project comparisons using discounted costs per YLG or HYLG can be made either for different versions of the same project (different meningitis or schistosomiasis projects) or for choices between projects (a meningitis project versus a schistosomiasis project). Where different versions of the same project are compared differences can arise through scale (so that costs and population affected may differ) and through effectiveness (so there may be differences between projects in the reduction of the incidence of the disease). These will be reflected in the YLG and HYLG indicators and the cost-effectiveness ratios derived from them.

Cost-Effectiveness Illustrations

A cost-effectiveness comparison using either a YLG or HYLG indicator requires that annual project costs be compared with annual impacts in terms of YLG or HYLG, with both cost and impact streams discounted to the present. Setting out the cost data annually should be relatively straightforward. *Table A4.4* presents cost data for two projects: one to remove meningitis, the other to remove schistosomiasis. In both cases, a 10-year project life with most costs in the early years is used. For discussions, cost can be treated as economic costs following the principles of economic valuation set out in *Guidelines 1997*.

Table A4.4
Project Costs (US$ million)

Year	MENINGITIS project			SCHISTOSOMIASIS project		
	Capital	Operating	Total	Capital	Operating	Total
1	30	80	100	250	60	310
2		80	80	305	65	370
3		75	75		65	65
4		75	75		65	65
5		75	75		65	65
6		3	3		8	8
7		3	3		8	8
8		3	3		8	8
9		3	3		8	8
10		3	3		8	8
Present value of total cost			394.0			854.6

Note: Here and elsewhere, all discounting calculations discount back to year 1.

Total health impact requires an assessment of the population that will be reached. It is assumed that the target population for both projects is 500,000. The aim is to reach this target gradually so that in the first five years of each project, 20 percent of the target population can be reached. In the remaining five years, the projects will only serve the increased population in the area calculated at a 3 percent annual growth rate. To allow for undercoverage, assume that annually, only 95 percent of targets are achieved. Total population reached and total health impact in each year are given for both projects in *Table A4.5*.

Table A4.5
Health Impact

Year	MENINGITIS project		SCHISTOSOMIASIS project		
	Population reached[a] (thousands)	YLG[b]	Population reached (thousands)	HYLG[c]	YLG[d]
1	95	3183	95	7241	527
2	95	3183	95	7241	527
3	95	3183	95	7241	527
4	95	3183	95	7241	527
5	95	3183	95	7241	527
6	16	553	16	1259	92
7	17	570	17	1296	94
8	17	587	17	1335	97
9	18	60	18	1375	100
10	18	623	18	1417	103
Present value at 3%		**16,900**		**38,433**	**2,798**

[a] Population reached in the first five years is (0.5 x .20) x 0.95 = 0.095 million. Population reached after year five is calculated from the formula (0.5 x [1.03]^t) x 0.03 x 0.95, where t+1 is the year concerned. 3% is taken as population growth. Values differ between years but in some years identical figures are shown due to rounding in presentation.

[b] YLG is population reached multiplied by 33.52 as calculated in previous section.

[c] HYLG is population reached multiplied by 76.24 as calculated in previous section.

[d] YLG is population reached multiplied by 5.55 as calculated in previous section.

The data on costs from *Table A4.4* can be combined with that on health impact from *Table A4.5* to derive CEI. *Table A4.6* presents the relevant indicators:

Table A4.6
Results of CEI Calculations

	MENINGITIS project	SCHISTOSOMIASIS project
PV of Costs *(US$ thousand)*	394,023	$854,641
Health Impact *(years thousand)*		
YLG	16,900	2,798
HYLG	16,900	38,433
CEI		
US$/YLG	23.32	305.5
US$/HYLG	23.32	22.23

The meningitis project only affects mortality; hence its YLG and HYLG impacts are equal. However, the schistosomiasis project mainly affects morbidity so that its cost per HYLG is much below its cost per unadjusted year of life saved. By the HYLG criteria that combines mortality and morbidity effects, the schistosomiasis project is marginally more cost-effective by around 5 percent. However, if one only considers lives saved as a health impact, the meningitis project is significantly the more cost-effective.

Sensitivity Analysis

For the sensitivity analysis, examine the impact on the respective CEI by changing

- discount rate (using alternative rates of 5 percent and 0 percent);
- effectiveness of the projects in reaching target population (assuming 85 percent instead of 95 percent);
- disability weight for chronic illness from schistosomiasis (using w2 = 0.15 rather than 0.20); and
- incidence of the two diseases per 1000 population (reducing incidence figures by 25 percent).

The relevant results are given for the HYLG indicator in *Table A4.7*.

Table A4.7
Sensitivity Analysis: Summary Results

	Meningitis Project		Schistosomiasis Project		% difference[b]
Base case	US$/HYLG	23.32	US$/HYLG	22.23	4.9
Discount Rate at 5%	US$/HYLG	40.81	US$/HYLG	36.81	10.9
Discount Rate at 0%	US$/HYLG	8.23	US$/HYLG	8.31	-0.9
Effectiveness 85%	US$/HYLG	26.06	US$/HYLG	24.85	4.9
Disability weight w2= 0.15	US$/HYLG	23.32[a]	US$/HYLG	28.52	-18.2
Incidence 25% reduction	US$/HYLG	31.09	US$/HYLG	29.65	4.9

[a] Analysis is the same as for base case since disability effects are not relevant.
[b] Difference between CEI for meningitis and schistosomiasis projects, as a percentage of the latter.

APPENDIX 5
Disability and Age Weights Used for DALY

Disability and Age Weights

Table A5.1 gives the disability classification and weights used in the original disability adjusted life years (DALY) study.[1] These weights are based on expert opinion. Age weights can be derived for each year from the formula $C_x e^{-bx}$ or, rewritten, C_x/e^{bx}. Use of the formula requires identification of the constant C which is specified so that the total burden of disease in healthy years is the same with and without age weights. This necessitates that some weights for some ages be below 1.0 (for ages 0 to 9 and 54 upwards) and all others above 1.0. The parameter b is required to derive a function of this form and is chosen in the original DALY study on the basis of expert opinion. Within a reasonable range, the weights are not sensitive to b. If b is changed to derive new weights, C must change also.

The calculation can be illustrated for ages 10 and 50. Using C_x/e^{bx}

for x = 10 we have $(0.1624*10)/(2.7314^{0.04*10})$
which reduces to 1.624/1.4947 = 1.086.
Similarly for x = 50 we have $(0.1624*50)/(2.7314^{0.04*50})$
which reduces to 8.12/7.46 = 1.088.

Hence, DALY calculations require two sets of weights: first by extent of disability and second, by age for premature death and disability effects. For example, with a serious disability in class 6 of *Table A5.1* suffered at the age of 10, the first healthy year of life lost will be the disability weight (0.92) multiplied by the age weight (1.09) to give a weight of 1.00. At age 11, the healthy year of life lost will differ because of the higher age weight at 11 (1.15) to give a healthy year of life lost of 1.06. A project which removes this serious disability will be credited with 1.0 DALY in year 10 of the patient's life and 1.06 in year 11, and so forth over the lifetime of the individual.

[1] C.J.L. Murray. 1994. Quantifying the Burden of Disease: The Technical Basis for Disability-Adjusted Life Years. In *Global Comparative Assessments in the Health Sector,* edited by C. Murray and A. Lopez. Geneva: WHO.

Table A5.1
Disability Weights

Class	Description	Weight
1	Limited ability to perform at least one activity in one of following areas: recreation, education, procreation, occupation	0.096
2	Limited ability to perform most activities in one of following areas: recreation, education, procreation, occupation.	0.220
3	Limited ability to perform most activities in two or more of following areas: recreation, education, procreation, occupation.	0.400
4	Limited ability to perform most activities in all of following areas: recreation, education, procreation, occupation.	0.600
5	Needs assistance with instrumental activities of daily living such as meal preparation, shopping or housework.	0.810
6	Needs assistance with activities of daily living such as eating, personal hygiene or toilet use.	0.920

Note: Limited ability is defined as a 50% reduction in normal ability.

Meningitis and Schistosomiasis Illustration using DALYs

For simplicity, we keep the same disability weights of w_1, w_2, and w_3 as used above. The only difference from the previous calculations is that with the years of life gained (YLG) and healthy years of life gained (HYLG) analyses, each year saved is given a weight of 1.0 while with the DALY calculations, mid-life years have a weight of greater than 1.0 and years in childhood and old-age have weights of below 1.0. Using the original DALY formula described above gives a series of years weighted by age as in Table A5.2.

In Appendix 3 for the meningitis project, YLG is originally calculated from equation (2), as in the main text as

$$\mathbf{YLG = IN * CF * SR * PV(ad..ar)}.$$

The present value of years at 3 percent between year 10 (ad) and 68 (ar) is 20.95, when each year has a weight of unity. With IN = 8, CF = 0.20 and SR = 1.0, the resulting figure for years of life gained in DALYs (YLG_d) is 33.52. This is the loss of life years per 1000 of population.

The same procedure is used in the DALY calculation except that age weights are used for each year so that

$$\mathbf{YLG_d = IN * CF * SR * PV(wa[ad..ar])}$$

where wa is the set of age weights used for each year. Introducing age weights gives a higher present value of life years between ad and ar of 26.88. Multiplication by IN * CF * SR gives a DALY of 43.02 per 1000 of population.

The DALY per thousand of population must now be multiplied by the population reached by the project to give the total health impact. In present value terms at 3 percent this is 21,696 DALYs.

Table A5.2
Age Weights

Age	Age-Weight	Age	Age-Weight	Age	Age-Weight	Age	Age-Weight	Age	Age-Weight
1	0.156002	16	1.365902	31	1.448205	46	1.175966	61	0.853367
2	0.299713	17	1.394097	32	1.436028	47	1.154196	62	0.833186
3	0.431858	18	1.417951	33	1.422563	48	1.132316	63	0.813272
4	0.553126	19	1.437761	34	1.40793	49	1.110368	64	0.793633
5	0.66417	20	1.45381	35	1.392242	50	1.088392	65	0.774279
6	0.765605	21	1.466364	36	1.375605	51	1.066425	66	0.755219
7	0.858018	22	1.475671	37	1.358118	52	1.044499	67	0.736458
8	0.941961	23	1.48197	38	1.339874	53	1.022645	68	0.718004
9	1.017958	24	1.485482	39	1.32096	54	1.000893	69	0.699861
10	1.086505	25	1.486417	40	1.301456	55	0.979267	70	0.682033
11	1.148072	26	1.484973	41	1.281439	56	0.957791	71	0.664523
12	1.203102	27	1.481336	42	1.260979	57	0.936488	72	0.647335
13	1.252014	28	1.475681	43	1.240143	58	0.915377	73	0.630469
14	1.295204	29	1.468172	44	1.218991	59	0.894476	74	0.613928
15	1.333049	30	1.458965	45	1.197581	60	0.873801	75	0.597711

Note: Age weights are calculated from the formula $C_x e^{-bx}$
where C is a constant 0.1624,
x is the age concerned,
b is 0.04,
and e is 2.7314.

Source: C.J.L. Murray. 1994. Quantifying the Burden of Disease: The Technical Basis for Disability-Adjusted Life Years. In *Global Comparative Assessments in the Health Sector,* edited by C. Murray and A. Lopez. Geneva: WHO.

Table A5.3
Meningitis Project: DALY Impact

Year	Population reached[a] (thousands)	DALY[b]
1	95	4,087
2	95	4,087
3	95	4,087
4	95	4,087
5	95	4,087
6	16	711
7	17	732
8	17	754
9	18	774
10	18	800
Present value at 3%		21,696

[a] As calculated in Table A3.5. Population figures presented above are rounded.
[b] DALY is population reached multiplied by 43.02.

As calculated in Appendix 3, the present value of costs of the meningitis project is US$394 million (see *Table A5.4*). Hence, the CEI or cost per DALY is US$18.16 (394,023/21,696 = 18.16).

For the schistosomiasis project, there are morbidity as well as mortality effects to include, covering years of life lost to morbidity before premature death in DALYs (YD_d), years lost to chronic morbidity among survivors in DALYS (YCD_d), and years lost to temporary disability in DALYs (YT_d), as well as years of life lost due to premature death in DALYs (YLG_d). In each case in the DALY calculations, the years involved must be adjusted by age-weights. Following equation (9) in the main text, YLG in terms of DALYs is

$$\mathbf{YLG_d = IN * CF * SR * PV(wa[ad..ar])}.$$

The present value of years at 3 percent between year 30 (ad) and 70 (ar) is 9.81, when each year has a weight of unity. When age weights are used, this value rises to 11.32. With IN = 15, CF = 0.04, and SR = 0.9428, the resulting figure for YLG in DALYs is 6.40.

From equation (10), YD in terms of DALYs is

$$\mathbf{YD_d = IN * CF * SR * w_1 * PV(wa[ad..ar])}$$

The present value of years at 3 percent between the onset of the disease in year 5 (ao) and premature death at 30 (ad) is 15.47, when each year has a weight of unity. When age weights are used, this value rises to 19.01. With IN = 15, CF = 0.04, SR = 0.9428, and w_1 = 0.40, the resulting figure for YD in DALYs is 4.30.

From equation (11), YCD in terms of DALYs is

$$\mathbf{YCD_d = IN * PD * w_2 * PV(wa[ad..ar])}$$

The present value of years at 3 percent between the onset of the disease in year 5 (ao) and death at the expected normal age 67 (ar) is 24.88, when each year has a weight of unity. When age weights are used, this value rises to 30.23. With IN = 15, PD =0.90, and w_2 = 0.20, the resulting figure for YCD in DALYs is 81.61.

From equation (12), YT in terms of DALYs is

$$\mathbf{YT_d = PV_{ao}(IN * [1\text{-}CF\text{-}PD] * t * w_3 * wa)}$$

The present value of year 5 (ao) at 3 percent is 0.8626, when each year has a weight of unity. When age weights are used, this value falls to 0.5729. With IN = 15, CF = 0.04,PD =0.90, t = 0.20 and w_3 = 0.10 , the resulting figure for YT in DALYs is 0.01.

The total loss of DALYs per 1000 of population is the sum of YLG_d, YD_d, YCD_d, and YT_d, which comes to 92.32. (6.40 + 4.30 + 81.61 + 0.01 = 92.32).

Table A5.4
Schistosomiasis Project: DALY Impact

Year	Population reached [a] (thousands)	DALY [b]
1	95	8,770
2	95	8,770
3	95	8,770
4	95	8,770
5	95	8,770
6	16	1,525
7	17	1,569
8	17	1,618
9	18	1,666
10	18	1,717
Present value at 3%		46,554

[a] As calculated in Table A3.5. Population figures presented above are rounded.
[b] DALY is population reached multiplied by 92.32.

As calculated in Appendix 3, the present value of costs of the schistosomiasis project is $854 million (see *Table A5.4*). Hence, the CEI or cost per DALY is $18.36 (854,641/46,554 = 18.36).

By introducing age weights in this case, the ranking of the two projects was changed. The meningitis is the less cost-effective using $/HYLG as the criterion (23.32 as compared with 22.23 for the schistosomiasis project). However, using $/DALY, we find that the choice has switched (18.16 for the meningitis project as compared with 18.36 for the schistosomiasis project). The main reason for this is that meningitis is assumed to have an average age of onset of 10 years and schistosomiasis an earlier age of onset of 5 years. The latter project will thus proportionately save more early years of life, which have a weight of below unity in the DALY age-weighting system. This illustrates the potential impact of using age weights.

APPENDIX 6

Cost-Effectiveness Analysis: Pakistan Women's Health Project

This illustration reworks the basic data from the original feasibility study and report and recommendation of the President (RRP) to illustrate how a cost-effectiveness indicator like cost per disability adjusted life year (DALY) can be calculated. The DALY is the most complex of the range of possible health indicators because it combines both mortality and morbidity effects through a set of disability weights and age weights for health impacts at different stages of an individual's life (see Appendix 5). The project analysis illustrates that DALY calculations can be applied to general health improvement projects, as well as to specific interventions such as immunization programs with well defined impacts.

This is a multi-purpose project designed to affect women's health through a variety of interventions. There are three components: (i) expansion of community-based health care and family planning involving the recruitment and training of 32,000 lady health workers, and the expansion of immunization services and education relating to safe deliveries; (ii) development of 20 women-friendly district health systems to provide essential health care at community, primary and first-referral levels; and (iii) institutional and human resource development to strengthen the capacity to deliver good quality health care to rural women.

The investment cost of the project is approximately $80 million divided between the provincial governments and the Federal government of Pakistan and spread over a five-year implementation period. This cost includes price contingencies and taxes and duties, which are not relevant for economic calculations. For this exercise, these latter items are deducted from the cost figures in the feasibility study to give the relevant economic costs. Allocations between years are based on the proportions given in the feasibility study. In addition, there is an annual operating cost which is not included in the cost per DALY calculations in the feasibility study (presumably, these are to be paid by the Federal government not the project). As an approximation, this is taken as the annual wage bill for lady health workers of $10 million, referred to in the RRP. Any costs on the female beneficiaries of the project (for example, in travel time or cost of waiting) are not identified in the feasibility study and are assumed here to be sufficiently small to be ignored. It is also assumed that this operational cost of

$10 million will be incurred annually form the second year to the end of the project life.

The life of the project is uncertain, since it is expected that over time, private sector and NGO suppliers will replace local government community initiatives. For the calculations, a project life of 10 years is assumed, so that the full institutional framework is established by the end of year 5 and the project continues to function for another five years. The project is designed to serve target populations in different parts of the country. However the speed at which these groups are reached is not specified. Given the difficulty attached to achieving full access, a phased build-up is assumed here as follows (where the percentages refer to proportions of the target populations reached by the project): year 1 = 0 percent, year 2 = 20 percent, year 3 = 40 percent, year 4 = 60 percent, year 5 = 80 percent, and year 6 onwards = 90 percent.

The DALY calculations are applied only to the main illnesses that the project is expected to address. The illnesses and the relevant target populations are given below:

Table A6.1
Population and Illnesses Targeted by the Project

Target Groups	Conditions
Rural pregnant women (15-49 age group)	hemorrhage, sepsis, abortion, pregnancy complications and maternal mortality
Rural children (0-1 year)	perinatal complications and mortality
All rural women (15-49 age group)	anemia, iodine and vitamin A deficiency

Insofar as there are unquantified impacts on other health conditions not covered in the calculations, health effects will be understated. Population data and assumptions about growth rates are used to determine the size of the target groups. It is assumed that population growth is 3 percent annually and that each year, each target group grows by this rate.

To derive estimates of the impact of the project on the conditions specified above requires three additional sets of data:

(i) the incidence of the illnesses concerned in the target population (for example, the proportion of the population that would suffer from vitamin A deficiency or maternal mortality without the project);

(ii) the DALYs lost per person affected by the illnesses;

(iii) the degree to which the project averts the different conditions in the target population (for example, the proportionate decline in the numbers suffering from vitamin A deficiency or maternal mortality with the project as compared to the without project situation).

The incidence of illness data in the regions served by the project come from the National Health Survey of Pakistan, with adjustments made for a higher incidence in rural areas as compared with the national average. The feasibility study calculations use figures for DALY losses per person taken from a World Bank paper on the health sector in Pakistan, again adjusted for a difference between rural and national figures. Therefore, the DALY figures are derived from national data rather than the short-cut approach of using approximations based on international figures illustrated in Appendix 7. Finally, assumptions are made for the degree to which the project succeeds in averting the onset of different conditions. In each of these three areas, the original assumptions used in the feasibility study are applied in these recalculations. The data used are given in *Table A6.2*.

By the time the project is in full operation, its main impact will be in averting loss of DALYs from perinatal mortality among children below one year of age (0.223

Table A6.2
Health Impact of the Project

	Incidence of Illnesses in Affected Pop, %[a]	Adjusted DALY[b]	Project Effect[c]	DALY Gained per Person in Target Group
Hemorrhage	0.0815	0.4182	30	0.0102
Sepsis	0.2038	0.1572	30	0.0096
Abortion	0.4077	0.1398	30	0.0171
Pregnancy complications	0.2202	0.3211	30	0.0212
Maternal mortality	0.0086	35.2571	30	0.0905
Anemia	0.3004	0.1695	50	0.0255
Iodine deficiency	0.2787	0.1692	50	0.0236
Vitamin A Deficiency	0.0094	0.7013	50	0.0033
Prenatal mortality	0.0154	8.7648	30	0.0404
Perinatal mortality	0.0141	36.8909	30	0.1565

[a] Proportion of relevant group subject to illness without the project. Estimates are derived from national data escalated by 12.5 percent to establish rural figures.

[b] DALYs lost from onset of different illnesses. National DALY data estimated by World Bank are escalated by 20 percent to give rural figures.

[c] Percentage reduction in incidence of disease as a result of the project.

million DALYs in the final year), from anemia in pregnant mothers (0.091 million DALYs in the final year), from iodine deficiency in pregnant mothers (0.084 million DALYs in the final year), and from prenatal mortality among children below one year in age (0.057 million DALYs in the final year). Discounting calculations are done at 3 percent

Table A6.3
Cost-Effectiveness Analysis

	1	2	3	4
Investment Costs ($M)				
Investment costs	16.429	24.34	17.153	11.874
Taxes/duties	1.727	2.4	1.594	1.04
Price contingency	0	1.518	2.027	2.044
Net Investment Costs	14.702	20.422	13.532	8.79
Wages	0	10	10	10
Total Costs	14.70	30.422	23.532	18.79
DALY saved				
Hemorrhage	0	0.0010	0.0020	0.0031
Sepsis	0	0.0009	0.0019	0.0029
Abortion	0	0.0016	0.0033	0.0051
Pregnancy complications	0	0.0020	0.0041	0.0064
Maternal mortality	0	0.0085	0.0176	0.0271
Anemia	0	0.0161	0.0331	0.0511
Iodine deficiency	0	0.0149	0.0307	0.0473
Vitamin A deficiency	0	0.0021	0.0043	0.0066
Prenatal mortality	0	0.0101	0.0208	0.0321
Perinatal mortality	0	0.0391	0.0805	0.1245
Total DALY saved	**0**	**0.0963**	**0.1983**	**0.3062**
Targets Reached	90%	100%		
PV, Cost ($M)	$136.03	$136.03		
PV, DALY saved	2.94	3.165572		
Cost per DALY ($M)	$46.27	$42.97		

and the discounted total stream of DALYs from all conditions saved over the life of the project is 2.94 million. This must be compared with the total cost of the project discounted at 3 percent of $136.03 million. The cost per DALY saved is therefore $46.27 (136.03/2.9 = 46.27). Full details of the calculations are in *Tables A6.3* to *A6.4*.

5	6	7	8	9	10
11.197					
0.921					
2.49					
7.786	0	0	0	0	0
10	10	10	10	10	10
17.786	10	10	10	10	10
0.0042	0.0049	0.0050	0.0051	0.0053	0.0055
0.0039	0.0046	0.0047	0.0048	0.0050	0.0051
0.0070	0.0081	0.0084	0.0086	0.0089	0.0091
0.0087	0.0101	0.0104	0.0107	0.0110	0.0113
0.0372	0.0430	0.0442	0.0456	0.0469	0.0484
0.0700	0.0808	0.0832	0.0857	0.0883	0.0910
0.0648	0.0748	0.0771	0.0794	0.0818	0.0842
0.0090	0.0104	0.0108	0.0111	0.0114	0.0118
0.0441	0.0511	0.0526	0.0542	0.0558	0.0575
0.1710	0.1978	0.2038	0.2099	0.2162	0.2226
0.4200	**0.4855**	**0.5001**	**0.5151**	**0.5305**	**0.5465**

Discount rate: **3%**

The result derived here is well above the original cost per DALY of around $22 in the feasibility study. This stems principally from the fact that the latter calculations assume immediate 100 percent coverage rather than a phased build-up, do not include salaries and wages of health workers, and do not discount DALYs and costs over the life of the project. However, the result here is equal to the upper end of the possible range of costs per DALY referred to in the RRP (although no derivation of this figure is given there). The feasibility study compares cost per DALY from the project with

Table A6.4
Targets and Targets Reached

	1	2	3	4
Targets				
Rural women	15.1409	15.5750	16.0226	16.4843
Married women, 15–49	2.2927	2.3589	2.4272	2.4976
Pregnant women	0.4585	0.4718	0.4854	0.4995
Children<1	1.2114	1.2485	1.2868	1.3263
All women, 15–49	3.0741	3.1615	3.2517	3.3446
Targets Reached	0%	20%	40%	60%
Married women, 15–49	0	0.4718	0.9709	1.4986
Pregnant women	0	0.0944	0.1942	0.2997
Children<1	0	0.2497	0.5147	0.7958
All women, 15–49	0	0.6323	1.3007	2.0068

Assumed average annual increase in targets, from year 6: 3%

Assumed share of pregnant women from married women, 15–49: 20%

international estimates of costs. For prenatal and delivery care for women in low-income economies, comparative data suggests costs in the $30–$50 per DALY range in 1990 prices. From this comparison, this project (which is probably based at 1996/97 prices) is at the top end of the range. Such comparisons cannot be definitive and since there are almost certainly other unquantified health impacts from the project that will also save DALYs, the project is probably acceptable. However, the recalculations suggest that it is not as cost-effective as the original feasibility study suggests.

5	6	7	8	9	10
16.9408	17.3907	17.9125	18.4498	19.0033	19.5734
2.5673	2.6360	2.7151	2.7966	2.8805	2.9669
0.5135	0.5272	0.5430	0.5593	0.5761	0.5934
1.3656	1.4045	1.4467	1.4901	1.5348	1.5808
3.4364	3.5269	3.6327	3.7417	3.8539	3.9695
80%	90%	90%	90%	90%	90%
2.0538	2.3724	2.4436	2.5169	2.5924	2.6702
0.4108	0.4745	0.4887	0.5034	0.5185	0.5340
1.0925	1.2641	1.3020	1.3411	1.3813	1.4227
2.7491	3.1742	3.2694	3.3675	3.4685	3.5726

APPENDIX 7

Country DALY Estimates: A Second-Best Approach

For accuracy, disability adjusted life years (DALY) figures should be calculated from data specific to the country concerned. However, a large international database has been built up by C. Murray and A. Lopez (1996. *The Global Burden of Disease*. New York: WHO) for different regions and two large countries, India and People's Republic of China. These data give total DALY lost for the regions concerned for a large number of medical conditions. DALYs are given both in total and for different age groups. If one makes the assumption that an individual DMC has similar epidemiological conditions to one of the regions or large countries studied, then a simple adjustment for population size of the DMC relative to the comparator region will give a country figure for DALY by age group and by condition. In general, for country j, condition or illness x, and age group y, the country figure will be given by the expression

DALYjxy = DALY for condition x in age group y in comparator x (population in country j in age group y / population in comparator in age group y).

The global figures are given for 1990 and projected for the year 2000 and beyond. Here is the derived country data for 1990 and an estimate for the year 2000, which will be relevant if the assumptions underlying the projection are accurate. To illustrate the general procedure, here is a specimen calculation for one condition (iron-deficiency anaemia) in one DMC (Pakistan). India is used as a comparator (see *Tables A7.1* and *A7.2*).

DALY output is shown in two ways:

- DALY per age group
- Total DALY per thousand of total population.

The second of these two figures can be derived from the first and both may be used in the context of individual projects. For example, there may be a project serving 5,000 people and from the national data of incidence and age structure, condition x causes a loss of 10 DALYs per 1,000 of the general population per year.

Table A7.1
DALY Calculations—Pakistan

Comparator: India
Condition: Iron-Deficiency Anemia

pop structure: 1996 most recent year

IND		*939408 thousands*							
total		0..4	5..9	10..14	15..19	20..24	25..29	30..34	35..39
487417	M	61330	64330	58245	48252	41896	37992	33917	30152
451991	F	58881	60043	51908	42972	40570	38210	32550	27161
1	M	0.12583	0.13198	0.11950	0.09900	0.08596	0.07795	0.06959	0.06186
1	F	0.13027	0.13284	0.11484	0.09507	0.08976	0.08454	0.07201	0.06009

pop structure: 1981 most recent year

PAK		*84251 thousands*							
total		0..4	5..9	10..14	15..19	20..24	25..29	30..34	35..39
44231	M	6334	7003	6054	4328	3358	2970	2449	2173
40020	F	6614	6482	5029	3619	3202	2635	2282	2128
1	M	0.1432	0.1583	0.1369	0.0978	0.0759	0.0671	0.0554	0.0491
1	F	0.1653	0.1620	0.1257	0.0904	0.0800	0.0658	0.0570	0.0532

pop structure: 1990 estimated

IND		*834700 thousands*							
433088.7	M	54494.05	57159.67	51752.91	42873.75	37226.20	33757.35	30136.55	26791.21
401611.3	F	52318.02	53350.51	46122.25	38182.27	36048.00	33951.05	28921.92	24133.59

pop structure: 1990 estimated

PAK		*112400 thousands*							
59008.97	M	8450.25	9342.76	8076.69	5774.02	4479.94	3962.30	3267.23	2899.02
53391.03	F	8823.80	8647.69	6709.23	4828.14	4271.82	3515.38	3044.44	2838.98

Pop PAK/Pop IND 1990

total		0..4	5..14	15..44	45..59	60..
0.134659	M	0.1551	0.1599	0.1190	0.1186	0.1559
	F	0.1687	0.1544	0.1166	0.1153	0.1217

40..44	45..49	50..54	55..59	60..64	65..69	70..77	75..79	80..
25603	21601	17698	13907	11640	8528	6225	2364	3737
22476	18938	15463	12651	10906	7973	5600	2281	3408
0.05253	0.04432	0.03631	0.02853	0.02388	0.01750	0.01277	0.00485	0.00767
0.04973	0.04190	0.03421	0.02799	0.02413	0.01764	0.01239	0.00505	0.00754

40..44	45..49	50..54	55..59	60..64	65..69	70..74	75..79	80..
1986	1650	1674	879	1326	567	688	792	
1972	1496	1354	762	929	437	487	592	
0.0449	0.0373	0.0378	0.0199	0.0300	0.0128	0.0156	0.0179	
0.0493	0.0374	0.0338	0.0190	0.0232	0.0109	0.0122	0.0148	

22749.25	19193.32	15725.35	12356.90	10342.59	7577.45	5531.15	2100.50	3320.47
19970.79	16827.14	13739.47	11240.90	9690.40	7084.32	4975.81	2026.76	3028.14

2649.54	2201.28	2233.30	1172.68	1769.03	756.44	917.87	1056.61	0
2630.86	1995.83	1806.38	1016.59	1239.39	583.01	649.71	789.79	0

Table A7.2
DALY Calculations—Pakistan

Comparator: India
Condition: Iron-Deficiency Anemia

DALY thousands

IND		1990				
total		0..4	5..14	15..44	45..59	60..
2812	M	854	689	832	200	237
3533	F	826	656	1437	376	238

DALY thousands

total		0..4	5..14	15..44	45..59	60..
402.3002	M	132.43	110.20	99.01	23.72	36.94
480.4467	F	139.31	101.28	167.56	43.34	28.96

DALY/thousand of general population

total		0..4	5..14	15..44	45..59	60..
3.5792	M	1.18	0.98	0.88	0.21	0.33
4.2744	F	1.24	0.90	1.49	0.39	0.26

Projected Population 2000 **agr**

IND	1095831.97 thousand			1996	939.42	0.026			
PAK	150987.01 thousand			1996	134.15	0.03			
IND		0..4	5..9	10..14	15..19	20..24	25..29	30..34	35..39
568578.4	M	71542.26	75041.80	67943.57	56286.60	48872.24	44318.18	39564.63	35172.71
527253.5	F	68685.47	70040.96	60551.37	50127.41	47325.45	44572.47	37970.01	31683.67
PAK		0..4	5..9	10..14	15..19	20..24	25..29	30..34	35..39
79266.79	M	11351.22	12550.14	10849.43	7756.25	6017.90	5322.56	4388.88	3894.25
71720.22	F	11853.01	11616.45	9012.52	6485.64	5738.33	4722.21	4089.59	3813.61

Pop PAK/Pop IND 2000

total		0..4	5..14	15..44	45..59	60..
	M	0.16	0.16	0.12	0.12	0.16
	F	0.17	0.16	0.12	0.12	0.12

DALY thousands

IND	2000					
total		0..4	5..14	15..44	45..59	60..
1622	M	273	428	664	127	130
2050	F	254	398	1030	231	137

DALY thousands

PAK	2000	estimated				
total		0..4	5..14	15..44	45..59	60..
230.356	M	43.32	70.04	80.85	15.41	20.73
273.8924	F	43.83	62.87	122.89	27.24	17.06

DALY/thousand of general population

total		0..4	5..14	15..44	45..59	60..
1.5257	M	0.29	0.46	0.54	0.10	0.14
1.8140	F	0.29	0.42	0.81	0.18	0.11

	40..44	45..49	50..54	55..59	60..64	65..69	70..74	75..79	80..
	29866.24	25197.85	20644.95	16222.70	13578.22	9948.03	7261.55	2757.64	4359.26
	26218.55	22091.43	18037.80	14757.56	12721.99	9300.61	6532.47	2660.82	3975.48
	40..44	45..49	50..54	55..59	60..64	65..69	70..74	75..79	80..
	3559.13	2956.98	2999.99	1575.26	2376.34	1016.13	1232.97	1419.35	0.00
	3534.04	2681.00	2426.52	1365.59	1664.87	783.15	872.76	1060.93	0.00

Data Sources: Murray, C.J.L., and A.D. Lopez, eds. 1996. *The Global Burden of Disease.* Boston, MA: Harvard School of Public Health.

UN Economic and Social Commission for Asia and the Pacific. 1997. *Statistical Yearbook for Asia and the Pacific.* Bangkok: ESCAP Secretariat.

Using the national figures and assuming 50 percent effectiveness in removing condition x means a saving of 25 DALYs annually.

ADB's Economic and Development Research Center (EDRC) has derived a full set of DALY estimates for Pakistan by condition and age group following this methodology.

In deriving the country figures for a selected DMC, it is necessary to identify the appropriate comparator region or large country. A possible set for each DMC is given below.

Table A7.3
Possible Comparators in Deriving DALYs

Comparator	DMC
India	South Asia (India, Pakistan, Bangladesh, Sri Lanka, Bhutan, Nepal)
China	P.R. China plus some Central Asian Republics
Other Asia and Islands[a]	East Asia (Thailand, Cambodia, Vietnam, Lao, Indonesia)
Former Socialist E. Europe[a]	Central Asian Republics

[a] List of countries in regional groupings is in Murray, C.J.L., and A.D. Lopez, eds. 1996. *The Global Burden of Disease.* Annex Table 1. Boston, MA: Harvard School of Public Health.

APPENDIX 8

Benefit Valuation by Future Earnings: LAO Primary Health Care Project

A simple means of measuring the benefits of health projects is to value years of life saved by future lifetime earnings of the individuals involved. This, however, provides an under-estimate of health benefits since human life has an intrinsic worth that cannot be captured by future earnings. This also suffers from an obvious non-egalitarian bias that is contrary to poverty alleviation objectives because it values lives in rich countries or regions more highly than those in poorer areas. Nonetheless, it is often rationalized on the grounds that it provides a minimum estimate and that if a project can be justified in rate of return terms using this minimum figure, then it would clearly be acceptable if the "true" value of life were known. The illustration using the data from the Lao Primary Health Care project presents this approach. The data have been modified in a few places to clarify the approach.

The Project aims to improve the health of those in rural areas by establishing primary health services at the village level, by improving the supply of drugs, by training health workers, and by providing information to households on good health practices. Although a number of benefits are expected to follow from the provision of these services and drugs, the key quantitative target for health impact (as set out in the Project Framework) is a reduction in the under-five mortality rate in the areas of the Project by 15 percent-from 182 per 1,000 population to 155 per 1,000. This reduction in infant deaths provides an indicator of the health benefits of the Project. To establish the number of lives saved annually, if this target is achieved, first identify the under-five population in the Project area.

The Project serves two provinces in Lao: Xiengkhuang and Oudomxay. Their populations and the numbers under five are given in *Table A8.1*.

To calculate lives saved, assume that the under-five population in the two provinces will grow annually at the existing rate of population growth in these two areas of 2.7 percent (which is slightly above the national figure of 2.6 percent). This allows a projection into the future of the under-five population. Once the Project is fully effective in reducing the mortality rate by 15 percent, the number of lives saved will be given by the expression

Table A8.1
Population Data

	Population	Under-Five Population[a]	Growth
Xiengkhuang	198,268	31,128	2.7%
Oudomxay	207,744	32,616	2.7%

[a] Taken as the national proportion of 15.7 percent.

Source: Lao Results from the Population Census 1995, State Planning Committee, Vientiane 1997.

$$(1–0.155)x – (1–0.182)x \quad \text{or} \quad (0.182 – 0.155)x$$

where x is the size of the under five population,
(1–0.182) is the probability of survival without the Project, and
(1–0.155) is the probability of survival with the Project, as indicated in para. 2 above.

This reduces to 0.027x so that annually, if the target is reached, 2.7 percent of the under-five population would not be alive without the Project.

To allow for a build-up in Project effectiveness, it is assumed that in the first three years, there will be no impact on mortality rates. In year 4, however, 40 percent effectiveness will be achieved. In year 5, 70 percent effectiveness. Finally by year 6, it is assumed that 100 percent effectiveness, that is a full 15 percent reduction in the infant mortality rate, is achieved and maintained over the remaining project life.

This allows an estimate of annual lives saved. The more controversial step is in valuing these. To illustrate the approach, use discounted lifetime earnings as a proxy for the value of life. To apply this approach, the following data for a representative individual are required:

- income in real terms in the base year;
- projected increase in real productivity and income over their lifetime;
- probability of survival at each age group (that is, the likelihood that an individual will live to pass into the next age category); and
- participation rate in the labor force at each age group (that is, likelihood that an individual will be in the labor market).

The real income figure used for an individual in the base year is $300. This is taken from the technical appendix of the report and recommendation of the President

(RRP). It is derived originally as a weighted average of incomes for households in the labor force for which the head of household is a farm worker. Recorded rural unemployment is low, but a minor adjustment is made in the original analysis for time spent out of work. The base year income figure of $300 is then adjusted to allow for productivity growth over time. In the absence of further data and to illustrate the procedure, assume a modest 1 percent real income increase over the working life of a representative individual. Each year therefore, the base figure of $300 grows by 1 percent.

Assume a working life from age 15 to 65. However, two further adjustments are required since not all individuals who survive up to age 5 will survive to complete their working lives, and equally in different age groups, not all individuals of working age will be in the labor market. At different ages, expected annual income (we) for a representative individual is given by the expression

$$we = (p * s * w)$$

where p is the participation rate in the labor force at the particular age;
s is the cumulative probability of an individual surviving to that age; and
w is annual income (allowing for productivity growth).

The data used for participation rates and survival probabilities are again taken from the RRP with a minor modification on the survival data to allow for the impact of the project. The data used are shown in *Table A8.2* for five-year age groups, although in the project calculations, each year within each age group is included individually.

The expected lifetime income figure derived by discounting the annual figures back to the present at a 12 percent discount rate is $383. This figure is low for a lifetime earning stream because it has been discounted back to the birth of the individual, not to the year the individual commences work. If the discounting starts at the time the individual reaches 15 and finds employment, the present value of earnings will be much higher. This latter procedure, however, is incorrect since what is needed is the figure to value lives saved in the year in which they are saved. When a life is saved in infancy, the individual will have to wait a number of years before entering the labor market; hence, discounting the income stream to the point at which the individual starts work will overstate the value of benefits in the year in which the life is saved.

The value of $383 is applied to the annual years saved in each year of project operations to derive annual monetary benefits (see *Table A8.3*).

Table A8.2
Participation, Survival, and Income Data

Age Group	Participation Rate	Cumulative Survival Rate[a]	Expected Income[b]
0–4	0.00	0.85	0.0
5–9	0.00	0.78	0.0
10–14	0.00	0.76	0.0
15–19	0.67	0.75	180.9
20–24	0.87	0.74	243.4
25–29	0.91	0.72	260.2
30–34	0.99	0.71	293.3
35–39	0.96	0.69	290.2
40–44	0.97	0.67	299.0
45–49	0.98	0.65	307.7
50–54	0.96	0.64	311.8
55–59	0.91	0.62	300.6

[a] Original survival probabilities have been adjusted upwards to reflect the impact of the project.
[b] Income figures change each year; values shown are for the mid-point years.

Table A8.3
Lifetime Earnings

Year A	Labor Partici-pation B	Survival Rate C	Probability D = B * C	Average Income E = D * Y	New Annual Income F = Y(1+P)[a]	Improved Survival Rate G = C(1+S)	New Probability H = B * G	NewAverage Income I = F * H
0	0	0.82	0	0	300	0.820	0	0
1	0	0.82	0	0	303.000	0.845	0	0
2	0	0.82	0	0	306.030	0.845	0	0
3	0	0.82	0	0	309.090	0.845	0	0
4	0	0.82	0	0	312.181	0.845	0	0
5	0	0.76	0	0	315.303	0.783	0	0
6	0	0.76	0	0	318.456	0.783	0	0
7	0	0.76	0	0	321.641	0.783	0	0
8	0	0.76	0	0	324.857	0.783	0	0
9	0	0.76	0	0	328.106	0.783	0	0
10	0	0.74	0	0	331.387	0.763	0	0
11	0	0.74	0	0	334.701	0.763	0	0
12	0	0.74	0	0	338.048	0.763	0	0
13	0	0.74	0	0	341.428	0.763	0	0
14	0	0.74	0	0	344.842	0.763	0	0
15	0.67	0.73	0.489	146.73	348.291	0.752	0.504	175.543
16	0.67	0.73	0.489	146.73	351.774	0.752	0.504	177.298
17	0.67	0.73	0.489	146.73	355.291	0.752	0.504	179.071
18	0.67	0.73	0.489	146.73	358.844	0.752	0.504	180.862
19	0.67	0.73	0.489	146.73	362.433	0.752	0.504	182.670
20	0.87	0.72	0.626	187.92	366.057	0.742	0.645	236.289
21	0.87	0.72	0.626	187.92	369.718	0.742	0.645	238.652

Table A8.3
Lifetime Earnings *(continued)*

Year A	Labor Participation B	Survival Rate C	Probability D = B * C	Average Income E = D * Y	New Annual Income F = Y(1+P)[a]	Improved Survival Rate G = C(1+S)	New Probability H = B * G	NewAverage Income I = F * H
22	0.87	0.72	0.626	187.92	373.415	0.742	0.645	241.038
23	0.87	0.72	0.626	187.92	377.149	0.742	0.645	243.449
24	0.87	0.72	0.626	187.92	380.920	0.742	0.645	245.883
25	0.91	0.70	0.637	191.10	384.730	0.721	0.656	252.544
26	0.91	0.70	0.637	191.10	388.577	0.721	0.656	255.070
27	0.91	0.70	0.637	191.10	392.463	0.721	0.656	257.621
28	0.91	0.70	0.637	191.10	396.387	0.721	0.656	260.197
29	0.91	0.70	0.637	191.10	400.351	0.721	0.656	262.799
30	0.99	0.69	0.683	204.93	404.355	0.711	0.704	284.636
31	0.99	0.69	0.683	204.93	408.398	0.711	0.704	287.482
32	0.99	0.69	0.683	204.93	412.482	0.711	0.704	290.357
33	0.99	0.69	0.683	204.93	416.607	0.711	0.704	293.261
34	0.99	0.69	0.683	204.93	420.773	0.711	0.704	296.193
35	0.96	0.67	0.643	192.96	424.981	0.690	0.663	281.681
36	0.96	0.67	0.643	192.96	429.231	0.690	0.663	284.498
37	0.96	0.67	0.643	192.96	433.523	0.690	0.663	287.343
38	0.96	0.67	0.643	192.96	437.858	0.690	0.663	290.217
39	0.96	0.67	0.643	192.96	442.237	0.690	0.663	293.119
40	0.97	0.65	0.631	189.15	446.659	0.670	0.650	290.205
41	0.97	0.65	0.631	189.15	451.126	0.670	0.650	293.107
42	0.97	0.65	0.631	189.15	455.637	0.670	0.650	296.038
43	0.97	0.65	0.631	189.15	460.193	0.670	0.650	298.998
44	0.97	0.65	0.631	189.15	464.795	0.670	0.650	301.988
45	0.98	0.63	0.617	185.22	469.443	0.649	0.636	298.671
46	0.98	0.63	0.617	185.22	474.138	0.649	0.636	301.657
47	0.98	0.63	0.617	185.22	478.879	0.649	0.636	304.674
48	0.98	0.63	0.617	185.22	483.668	0.649	0.636	307.721
49	0.98	0.63	0.617	185.22	488.505	0.649	0.636	310.798
50	0.96	0.62	0.595	178.56	493.390	0.639	0.613	302.619
51	0.96	0.62	0.595	178.56	498.323	0.639	0.613	305.645
52	0.96	0.62	0.595	178.56	503.307	0.639	0.613	308.701
53	0.96	0.62	0.595	178.56	508.340	0.639	0.613	311.788
54	0.96	0.62	0.595	178.56	513.423	0.639	0.613	314.906
55	0.91	0.60	0.546	163.80	518.557	0.618	0.563	291.764
56	0.91	0.60	0.546	163.80	523.743	0.618	0.563	294.682
57	0.91	0.60	0.546	163.80	528.980	0.618	0.563	297.629
58	0.91	0.60	0.546	163.80	534.270	0.618	0.563	300.605
59	0.91	0.60	0.546	163.80	539.613	0.618	0.563	303.611
60	0.76	0.58	0.441	132.24	545.009	0.598	0.454	247.564
61	0.76	0.58	0.441	132.24	550.459	0.598	0.454	250.040
62	0.76	0.58	0.441	132.24	555.964	0.598	0.454	252.540
63	0.76	0.58	0.441	132.24	561.523	0.598	0.454	255.066
64	0.76	0.58	0.441	132.24	567.139	0.598	0.454	257.616
NPV at 12%				$291.79				$382.58
NPV at 10%				$453.89				$603.94

Annual income, Y	300
Annual productivity growth, P	1%
Improved survival rate, S	3%

Table A8.4
Economic Cash Flow

Year A	Population <5 B = T(1+ R)[A]	Incremental Survivors C = B(W P)	Effective-ness D	Total Saved E = C * D	Income Discounted at 12% US$million F = E * Y/10[6]	Cost US$million G	Net Income US$million H = F G
0	63,743.884						
1	65,465.0	1,767.6	0.0	0.0	0.000	1.821	-1.821
2	67,232.5	1,815.3	0.0	0.0	0.000	1.821	-1.821
3	69,047.8	1,864.3	0.0	0.0	0.000	1.821	-1.821
4	70,912.1	1,914.6	0.4	765.9	0.293	0.3	-0.007
5	72,826.7	1,966.3	0.7	1,376.4	0.527	0.3	0.227
6	74,793.0	2,019.4	0.9	1,817.5	0.695	0.3	0.395
7	76,812.5	2,073.9	1.0	2,073.9	0.793	0.3	0.493
8	78,886.4	2,129.9	1.0	2,129.9	0.815	0.3	0.515
9	81,016.3	2,187.4	1.0	2,187.4	0.837	0.3	0.537
10	83,203.8	2,246.5	1.0	2,246.5	0.859	0.3	0.559
11	85,450.3	2,307.2	1.0	2,307.2	0.883	0.3	0.583
12	87,757.4	2,369.5	1.0	2,369.5	0.907	0.3	0.607
13	90,126.9	2,433.4	1.0	2,433.4	0.931	0.3	0.631
14	92,560.3	2,499.1	1.0	2,499.1	0.956	0.3	0.656
15	95,059.4	2,566.6	1.0	2,566.6	0.982	0.3	0.682
16	97,626.0	2,635.9	1.0	2,635.9	1.008	0.3	0.708
17	100,261.9	2,707.1	1.0	2,707.1	1.036	0.3	0.736
18	102,969.0	2,780.2	1.0	2,780.2	1.064	0.3	0.764
19	105,749.2	2,855.2	1.0	2,855.2	1.092	0.3	0.792
20	108,604.4	2,932.3	1.0	2,932.3	1.122	0.3	0.822
IRR							5%
NPV at12%							($2.02)
NPV at10%							($1.63)
NPV at 0%							$4.24

	Population	
	Total	**<5**
Oudomxay	207,744	32,615.808
Xiengkhuang	198,268	31,128.076
Total, project	406,012	63,743.884 (T)
Growth rate, R	2.7%	

Under five mortality:	
With Project, P	0.155
Without Project, W	0.182
PV Average Income, Y	$382.58

The Project is taken to have a three-year implementation period with investment costs divided equally between the three years. The costs from the feasibility study include taxes, price contingencies, and interest; these are netted out to give a total investment cost of $5.482 million. Operating cost is estimated at $0.3 million from year 4 onwards and a project life of 20 years is used (see *Table A8.4*).

When benefits (defined as the value of future income per life saved) are compared with costs, the result is an internal rate of return (IRR) of 5 percent. The implication of this is that even though a 15 percent reduction in under-five mortality is substantial, in a poor country where average earnings are low, it can still be very difficult to justify a health project on the basis of the future value of generated earnings. Sensitivity analysis shows that in valuing benefits in this way, it would take a reduction in under-five mortality of about 22 percent to generate an IRR of 12 percent valuing benefits in this way (see *Table A8.5*).

The sensitivity of the IRR to changes in the under-five mortality rate is shown below. For simplicity, any further impact of changes in the under-five mortality on chances of survival in later life (apart from those introduced initially for a 15 percent reduction) is not allowed.

Table A8.5
Sensitivity Analysis

Change in Under-Five Mortality	IRR
15%	5%
20%	10%
22%	12%
25%	14%
40%	22%

It can be seen that large mortality improvements (for example, a 40 percent reduction) are associated with high rates of return. This type of analysis can focus attention on the issue of what is a feasible and likely reduction in the mortality rate.

APPENDIX 9

Financial Sustainability: Philippines Early Childhood Development Project

Given the tight budget constraints that most governments now operate under, it is important to establish that any proposed health project is not only cost-effective but can also be sustained financially over its operating life. The Philippines Early Childhood Development Project provides a good illustration of how the issue can be assessed. The Project is to increase the coverage and improve the quality of a range of essential health, nutrition, psycho-social and early education services to children, and to develop the capacity to sustain such levels of coverage and quality.

The Project is to be run by a combination of central government departments and local government units. For the main health components of the Project, user charges are not envisaged on equity and externality grounds; while for other elements such as day care services, pilot testing of user fees will be tried. Capital costs of the Project will be covered by a combination of ADB, World Bank, and the national government funds, with local governments providing resources in kind in the form of personnel, vehicles, and other forms of support. Even if capital funds are committed to the Project, it is still necessary to establish whether the central government departments and the local government units are likely to have funds to recover the recurrent costs of operations. For national departments, annual recurrent costs are for materials, supplies, and operation and maintenance of equipment and are estimated at P2.6 million per year. At the local government level, annual recurrent costs are food supplements and care giver incentives which are estimated as P78.6 million in total spread over all participating units.

Financing recurrent costs is judged to be unproblematic for the national departments. The three agencies involved are the Department of Social Welfare and Development (DSWD), the Department of Health (DOH), and the Department of Education, Culture and Sports (DECS). Of these, the main burden of recurrent costs falls on DSWD; but in each case, the costs involved are only a very small proportion of the projected departmental budgets. Even for DSWD, the recurrent costs are below 1 percent of the projected budget.

The issue of local government finance requires closer attention since local governments will have to cover the bulk of the recurrent costs. As part of the preparation of the Project, a study for a sample of 94 municipalities was carried out.

(viii) Compare the project's cost-effectiveness indicator with either that of other projects in the country concerned or with international norms for the same type of project.

(ix) Where benefits can be quantified, calculate an economic IRR and NPV for the project.

(x) Identify indicators of project impact that can be used for project monitoring. Working closely with the Mission Leader present these indicators together with other relevant information in a project or program framework.

(xi) See ADB Handbook on Economic Analysis of Health sector projects for definitions of terms and for recommended methods.

Table A9.1
Recurrent Cost by Department

	Expected Recurrent Cost	Expected Annual Budget	% of Budget
DSWD	1.4	1,777	0.08
DOH	0.7	10,851	0.006
DECS	0.5	70,213	0.0007

Source: Supplementary Appendix F of Loan 1607-PHI: *Early Childhood Development Project*, for $8.8 million, approved on January 1998.

The methodology used was the development of a financial model to predict local government units' expected revenue and to compare this with a forecast normal level of expenditure to meet existing service commitments. The difference between these two figures (expected revenue – normal expenditure) gives discretionary income which, in principle, is available for financing recurrent costs of the Project, as well as other new commitments. Project costs can then be compared with this discretionary income rather than with total income.

To apply this methodology, it is first necessary to require estimates of expected revenue for local government units. The two main sources of revenue are local sources, that is revenue from local charges, and transfers from the national Government. For the first, it is assumed that the local tax base grows at the same rate as the gross national product (GNP) with macro-economic projections used to establish the GNP growth rate. For transfers from the central government, income to each of the units studied is projected by a financial model that allows for macro-economic projections and forecasts of central government revenue. Expected revenue is assumed to be all spent and expenditure is assumed to grow at the same rate as revenue. Expenditures for future years are allocated between different headings (such as social service expenditure under which the Project expenditures will fall) in the same proportion as in the base year (1994). Hence, for each future year, there will be a projected social service expenditure, which can be compared with normal social service expenditure.

"Normal" expenditure levels are estimated by assuming that 1997 levels under each heading are maintained constant in real per capita terms. Hence, for each local government unit, normal expenditures under each heading are the amount that must be spent to maintain the real per capita 1997 level of service. Inflation projections and forecast population growth for each unit are needed for this calculation.

Discretionary income, defined as the difference between income and normal expenditure, can be viewed in two ways. First, if it is assumed that local government

units are willing to reallocate expenditure to the Project from other expenditure headings (and not just from social services expenditure), then discretionary income available for the Project will be total expenditure minus normal total expenditure. Second, if it is assumed that there will be no reallocation of expenditure between headings, then discretionary income available for the Project will be given as social service expenditure minus normal social service expenditure. This can be termed social service discretionary income. Whichever definition is used however, it appears that there will be sufficient discretionary funds for the Project. Analysis of the individual local government units reveals that, provided there is phasing of the Project and that poorer units get central funds for the capital costs, the funding of recurrent costs in the longer term should not be a problem. Data are only given on the comparison between annual recurrent expenditure at P7.5 per capita and average income per capita for the different units. Project recurrent expenditure is less, below 1 percent of total income, although the more useful comparison between recurrent expenditure per capita and per capita discretionary income or per capita social service discretionary income is not given. However, the report stresses that the Project appears affordable.

Establishing affordability by the local government units does not mean that as autonomous local bodies, they will actually choose to allocate their funds to the Project. Hence, the last stage in the sustainability analysis is to consider past local government decisions to establish whether it is likely that they will wish to use their funds for an early child-care project. In the Project, this was done by estimating the local government units' marginal propensity to spend on social services. The analysis was carried out by fitting a regression relationship across units between income per capita and different expenditure categories per capita (when a logarithmic relationship is used, the coefficient on the independent variable per capita income gives the proportion of additional expenditure going to the particular expenditure category under examination). Using this approach, it was found that in the recent past, approximately 23 percent of additional local government unit income has gone to social service expenditure and that within this general category, 14 percent of additional income has gone to health, nutrition, and population-related services. This is taken as a strong argument that local government units will be willing to commit a sufficient proportion of their discretionary income to cover the recurrent costs of the Project.

APPENDIX 10
Draft Terms of Reference for Project Economists/Consultants

Working closely with the Mission Leader and health specialist the project economist/consultant should undertake the following tasks:

(i) Show how the project relates to objectives for the health sector as a whole and the need for the services of the project. Assess the demand for and supply of project-related health services.

(ii) Consider alternative technical designs for the project and alternative institutional and management arrangements for meeting project objectives and identify the least-cost alternative. If the project is to be in the public sector is there scope for links with the private and NGO sectors through sub-contracting or other forms of collaboration?

(iii) Identify the main beneficiary groups affected by the project. Show how they relate to the Bank's health sector priorities, in particular, and its strategic objectives, in general.

(iv) Identify the main health impacts of the project and consider whether these can be expressed in monetary values.

(v) Establish the costs of the project, distinguishing between financial costs and economic costs.

(vi) Identify the financing arrangements for the project with a view to establishing a system that will be financially sustainable. Where user charges are to be applied show the implications of different levels of charge for both the financial sustainability of the project and affordability by project beneficiaries. If the project is not self-financing consider the scope for government funding, particularly of recurrent expenditure and provide an assessment of the budgetary implications of the project for the government, both central and local.

(vii) Where appropriate, justify the project using cost-effectiveness criteria. Identify a cost-effectiveness indicator that can be calculated for the project, either a process indicator or more complex indicators, such as Years of Life Gained, Healthy Years of Life Gained, or Disability Adjusted Life Years.

(viii) Compare the project's cost-effectiveness indicator with either that of other projects in the country concerned or with international norms for the same type of project.

(ix) Where benefits can be quantified, calculate an economic IRR and NPV for the project.

(x) Identify indicators of project impact that can be used for project monitoring. Working closely with the Mission Leader present these indicators together with other relevant information in a project or program framework.

(xi) See ADB Handbook on Economic Analysis of Health sector projects for definitions of terms and for recommended methods.

7 Sensitivity Analysis

Given the uncertainty that is attached to parameters of all projects, sensitivity analysis is a useful tool for the analysis of projects from all sectors. *Guidelines 1997* Appendix 21 provides a general discussion of the role of sensitivity analysis, pointing out that it involves recalculating project results for different values of major variables that should be varied one at a time. The key issue is to identify the variables to which a project is most sensitive and to take mitigating action to ensure, as much as possible, that unfavorable shifts in these variables do not occur. For health projects, key areas of uncertainty are likely to occur in relation to project costing (have capital and operating cost estimates been prepared accurately?), epidemiological data (what are incidence rates, duration of illness, and average ages

at onset of illness and premature death?), and project coverage (what proportion of the target population is the project able to reach?).

Guidelines 1997 identifies several procedures for sensitivity analysis which can be used, with minor modifications, for the health sector:

(i) list the variables to which the project is likely to be most sensitive and based on experience and past data, assume alternative values for these variables that differ from the value used in the original or base case project calculation;
(ii) recalculate the project analysis using the alternative values for the key variables, changing these independently of each other;
(iii) compare the percentage change in the measure of project worth with the percentage change in the key variables to give a sensitivity indicator;
(iv) for variables to which the project is sensitive, show the switching value (that is, the percentage change in a variable which is sufficient to alter the original decision on the project) to make it acceptable if it was previously unacceptable, or vice versa; and
(v) if it is judged likely that some variables may move together, the impact of a change in a combination of two or more variables on project worth can also be tested.

Productive sector projects are normally appraised using the net present value (NPV) and IRR indicators of project worth. The sensitivity indicator and switching value should be calculated using a change in a project's NPV measured either at financial or economic prices, or both. For health projects, however, it is unusual for benefits to be in a form that can be quantified and valued. Hence, the normal procedure is to apply cost-effectiveness rather than full cost-benefit analysis. Sensitivity analysis will thus have to be applied to a CEI. The sensitivity indicator and switching value must therefore be redefined to allow for this modification. The sensitivity indicator (SI) will show the ratio of the change in CEI to the change in the variable concerned. Thus

$$\mathbf{SI = ([CEI_s - CEI_b]/CEI_b) / ([V_s - V_b]/V_b)} \qquad (14)$$

where CEI is a cost-effectiveness indicator (for example, cost per patient or per YLG or per HYLG);
V is the variable tested;
s refers to the sensitivity test; and
b refers to the base case.

Similarly, the switching value (SV) in a comparison between health project alternatives will be the change in the value of the variable tested, which is sufficient to make the superior alternative in the base case cease to be the preferred choice. Thus

$$\mathbf{SV = (V_s - V_b)/V_b} \quad (15)$$

which, for two alternatives 1 and 2 leads to CEI1 = $CEI2_s$, and where $CEI2_s$ refers to the value of the cost-effectiveness indicator in the sensitivity test.

Once these calculations have been carried out, the results of the sensitivity analysis should be reviewed to establish:

(i) which are the sensitive variables with high SI ratios;
(ii) whether the sensitivity calculations have used a plausible range of values for the tested variables;
(iii) whether the switching values for key variables are likely to occur; and
(iv) what initiatives in terms of project design and management are necessary to ensure successful completion of the project in as cost-effective a manner as possible.

These general procedures are illustrated for the projects examined in Appendix 3 using the YLG and HYLG indicators of health impact. There the sensitivity of the CEI was tested for changes in:

(i) discount rate,
(ii) effectiveness of projects in reaching target population,
(iii) incidence rates for meningitis and schistosomiasis per 1000 of population, and
(iv) disability weight for chronic disability from schistosomiasis.

Both projects are sensitive to the assumption concerning the incidence of the respective diseases in the target population. A 25 percent fall in the incidence increases the CEI of both diseases by 33 percent (SI = 0.333/0.250 = 1.07). Given the uncertainty concerning basic epidemiological data, this is a cause for concern. However, both projects are affected equally since a 25 percent fall in incidence reduces both streams of health impacts by the same proportion. The project choice between the most cost-effective alternative is sensitive to the assumed parameters—the discount rate and the disability weight on chronic illness from schistosomiasis. If no discounting is used, then the choice of the more cost-effective alternative switches from the schistosomiasis project to the meningitis project. However, at any positive discount rate, the latter is still more cost-effective provided one uses the HYLG indicator that allows for morbidity effects. Use of the HYLG indicator requires three weights for

different states of disability so that these can be compared with healthy life years saved by the meningitis project. The base case uses weights of 0.4, 0.2, and 0.1 for disability before premature death, chronic disability, and temporary disability, respectively. Of these, the second is by far the most significant because of the number of cases where chronic effects occur. A very small 5 percent change in the weight w_2—from 0.20 to 0.19—is sufficient in the base case to give equal CEI for the two projects. Under these conditions, this high sensitivity to what is a subjective parameter would probably be sufficient to give preference to the meningitis project, if the two were competing for the same funds.

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