



# Sensitivity Analysis

**G**iven 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

$$SI = [(CEI_s - CEI_b)/CEI_b] / [(V_s - V_b)/V_b] \quad (14)$$

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

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

which, for two alternatives 1 and 2 leads to  $CEI_1 = CEI_{2s}$ , and where  $CEI_{2s}$  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 HYLГ 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 HYLГ indicator that allows for morbidity effects. Use of the HYLГ 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.