# 3 A Summary of Development Agency Experience in Applying Risk Analysis

## Introduction

This Part of the Handbook reviews ADB's and other agencies' actual experience with risk analysis in recent years.

The review of ADB experience is based on a review of some 50 recent RRPs covering projects in all sectors of lending operations to identify what risk analysis practices have been employed by ADB in practice (see list in Appendix 1). In addition, various project performance appraisal reports, impact evaluation studies (covering the late 1980s and 1990s), special studies, and sector syntheses (from 1994 to 2000)

were reviewed to find out to what extent those variables which were thought to have affected project impact during implementation were in fact those which had been identified as sources of risk or uncertainty at the time of project preparation and (if they had been so identified) to what extent any attempts had been made to model them as "risky".

The experience of the World Bank is also considered in this regard, and a number of projects were briefly reviewed which are propounded (e.g., in Belli et al. 2001) as examples of "good practice" of risk analysis. It will be seen that the actual practice of risk analysis falls somewhat short of what may appear to be advocated in its official publications.

The experience of some other agencies with approaches to risk analysis is also considered, notably that of the UK's Department for International Development (DFID 2001) and also the UK Treasury (2000). DFID's experience is notable for the purpose of the current study because that agency previously adopted a quite traditional approach to project economic analysis (including its technical approaches to risk analysis) but has now (along with most bilateral development agencies) shifted its analytical focus away from quantitative cost-benefit techniques and towards a more participant-centered and "pro-poor" driven "livelihoods" approach (within the context of pursuing poverty reduction as its overall objective). However, within this "livelihoods" framework (which is also increasingly being favored by World Bank) the need to assess vulnerability of target groups has actually increased the attention devoted to risk assessment, although not in a quantitative sense. DFID's experience and practice is also noted for the rigor of the application of the logical framework technique and the explicit attention to identification of sources of risk within this framework.

Actual experience with the use of risk analysis by major agencies is then considered within the context of a recent critique of project economic analysis by Harberger (1998). It is suggested, *inter alia*, that various biases are routinely introduced into estimation of project costs and benefits, and that among the ways of dealing with such unknowns greater attention should be paid to risk analysis (through the application of simplified simulation techniques).

## ADB Experience With Risk Analysis

With the notable exception of a port project, an agriculture project, and the few power sector projects described below, ADB's experience with quantitative risk analysis has been very limited, although the existence of risk as affecting project

outcomes is indeed very well-recognized. A review of some recent RRPs, and which cover all sectors of ADB project and policy lending operations, suggest the following main points:

- the standard format of an RRP invariably includes a section (usually within the 'Financial and Economic Analysis', but sometimes presented separately and called variously 'Risks', 'Risks and Safeguards', 'Risks and Assurances', etc.) describing qualitatively the risks which a project is expected to face
- this text usually (but not always) includes descriptions of the measures which have already been incorporated to mitigate such risks. Typical risk-mitigation measures include the provision of technical assistance to strengthen institutions, the provision of counterpart funding, and also the inclusion of a number of different components being included within the project ambit. Sometimes such identified risks are called 'micro' or 'project' risks (i.e., they are risks over which the project has some control), and are distinguished from 'macro' or 'sector' risks (over which the project has no, or very limited, control but which are not regarded as being significant enough to jeopardize project success)
- this is often followed by a section called 'Assurances' which contains statements/letters to ADB from the borrower regarding operations during project implementation, often designed to formalize and support the proposed mitigating measures which have been agreed upon
- Appendix 1 of the RRP is invariably the 'Project Framework', which identifies and summarizes the risks as previously discussed, and places them in the context of the project's hierarchy of objectives. There is no separate discussion here of risks' likelihood and seriousness, however
- the 'Financial and Economic Analysis' section of an RRP often argues that 'conservative' or 'pessimistic' estimates have been used for forecasts of (for example) shipping, road and rail traffic volumes, crop prices, yields and production, fisheries catches, etc., upon which benefits have been estimated
- in addition, often the fact that certain benefits are identified but not quantified and valued in EIRR calculations is used to argue that the 'base case' EIRR is 'conservative' or 'understates' real returns. There is thus a 'cushion' which supports the likely acceptability of project returns
- the 'Financial and Economic Analysis' section usually contains a fairly standardized approach to sensitivity testing, in which project aggregate 'base case' costs and benefits streams are changed by 10% or 20% each

and benefits are delayed by one or two years, and the effects of these on the project 'base case' EIRR are considered (both in isolation and in combination with one another). Some studies are now more detailed, and calculate switching values and sensitivity indicators

- the project is then usually described in terms of its 'robustness', i.e., in the 'worst case' scenario (when cost changes are highest, benefits most reduced and/or delayed, etc.) its EIRR is still above 12%; sometimes, the statement is (improbably) made that, given its ability to survive such adverse circumstances, 'the project faces no risk'.

This format is remarkably similar across projects in all sectors. In the case of program loans, qualitative discussions of risk are included in the text, and the policy matrix will usually contain a column describing 'actions planned', many of which deal with management of identified risks.

ADB practice recognizes that risks exist at different levels of objectives achievement. It also tends to closely link identified specific risks with those mitigating measures which are already included in project or program design. Moreover, it routinely exploits sensitivity testing to demonstrate 'robustness'. While ADB's practice could be argued to be very strong, it could not be said to incorporate quantitative risk analysis practice in any form.

The apparent exceptions to this conclusion are the Bintulu port project, an agriculture project, and several very recent power projects. The Bintulu port project was cited and extensively described in Johnson (1985). The analysis of this project involved the estimation of probability distributions of several types (triangular, trapezoidal, uniform) for different elements of the costs and benefits streams and the construction of a probability distribution of the EIRR based on 300 samplings/ replications. The output of the analysis is described in terms of the probability of the EIRR being more than acceptable (i.e., in excess of 12%) in 97% of samplings. What is perhaps interesting to ask, is why such a probability-based analysis was undertaken in 1979 (when presumably access to computational resources was far more restricted than is the case in recent years) for a ports project and yet was not for later similar ports projects (e.g., the Xiamen Port Project in 1997, the Belawan, Banjarmasin and Balikpapan Project, also in 1997). In both these later cases, references to 'conservative' traffic forecasts are combined with extensive sensitivity testing as ways of dealing with unknown future values.

Recent preparation of power projects in ADB have systematically employed risk analysis, and, interestingly, this has been very much along the lines suggested by Harberger's 1998 argument and in a similar fashion to the World Bank Mexican irrigation and power project examples (see below). In the cases of two ADB power

projects[1] for example, discrete probability distributions containing between three and five possible values (based on PPTA mission estimates) for five to six variables in each case (covering capital and other cost elements, commissioning delays, willingness-to-pay (WTP) estimates, foreign exchange, as well as aggregate financial costs and benefits) were used to run a Monte Carlo simulation which generated expected values for project EIRR, together with estimates of standard deviation (i.e., the square root of variance), minimum and maximum values. A cumulative distribution function was also plotted in each case, indicating the probability of negative or less than acceptable (i.e., below 10-12%) economic rates of return. Each simulation was run 3,000 times using "Risk Master" software. The models also incorporated estimations of correlation between variables. In addition, the most recently-prepared of these projects (the Shen Da project) included a risk analysis following on from the calculation of the PIR, and a cumulative distribution function (CDF) was estimated for the PIR itself (see discussion in Part IV of the utility of this exercise).

This approach to risk analysis is certainly pioneering within ADB at present (and in fact relies upon the use of a personal, rather than institutional, copy of '"Risk Master" software). It is suggested by staff working in the power sector that it has been very useful during project design (typically at the fact-finding stage rather than at PPTA) to investigate concerns connected with one or two 'key variables' (typically elements of input or output prices). The main effort in terms of additional work lies in selecting key variables, ensuring there is no correlation between them (or that its extent is fully understood), and designing a 'best guess' distribution for each variable. With familiarity of the sector and/or local conditions this exercise may be completed over the course of a few days, and running a simulation based on several thousand samplings will take only a few hours. The result is certainly a presentational improvement, and usually argued to be an increase in 'peace of mind' regarding project robustness.

Another exception concerns the Infrastructure for Rural Productivity Enhancement Sector project in the Philippines which used the @Risk software to simulate the impact of changes in the values of key variables on the feasibility of proposed investments in rural roads and irrigation development. The analysis applied triangular distributions constructed around the mean for key variables, whose upper and lower values were apparently based on subjective estimates of project designers. The results of the analysis presented features of a distribution of the expected values for the EIRRs of each of two project components (i.e., rural roads, irrigation), but did not present the probability of the overall EIRR being less than the opportunity cost of capital.

1 People's Republic of China's Windpower Development Project, and People's Republic of China's Shen Da Power Transmission and Grid Rehabilitation Project.

Given that the estimation of risk in this way relies only upon a few estimates of likely values of several key variables and also some estimate of correlation among those variables, there would seem little reason as to why its use should be restricted mainly to ADB power projects. Power projects may be typically relatively large investments, but they are not necessarily more prone to risk from exogenous or endogenous sources than (for example) transport or irrigation projects, and technical staff involved in preparing such projects are likely to have just as much basis (deriving from both historical data and informed projections of the future) for estimation of probable outcomes as do ADB energy staff.

Indeed, a review of ADB project performance across all sectors (based on sector synthesis reports) suggests that many events occur to project environments during implementation which are responsible for divergences between estimated economic outcomes (i.e., EIRR, ENPV) as anticipated at appraisal and those estimated at post-evaluation and which in fact could have been subject to risk analysis at the time of project preparation. Table 3 summarizes (by sector) what were the main technical factors causing differences between anticipated and actual outcomes. What is immediately clear is that most of the factors which have been so identified could have been subjected to some form of risk analysis, and perhaps better project (re-) design may have resulted if risk analysis techniques had been applied.

What also emerges from the table is that other factors which cause differences in economic returns as estimated prior to and post-project implementation (typically depending upon how benefits—especially environmental ones or those based on willingness-to-pay – have been approached) could have been subject to greater variation quantification as well. Overall, the evidence suggests that there is a strong prima facie case for more rigorous risk analysis in ADB project economic analysis.

Adding to such findings, a 'Special Evaluation Study' (1998) of factors affecting project performance in agriculture and social projects between 1991 and 1997 suggested that 'greater realism' was required at PPTA stage in estimating project costs and benefits so as not to consistently over-estimate EIRRs, and that particular attention should be paid to dealing with aspects of local government performance in project preparation. Again, these considerations could at least in part be tackled through greater application of risk analysis. Similarly, the special evaluation study on involuntary resettlement (2000) concluded that social investigations at the PPTA stage had often been weak and/or hurried in preparation, and that greater attention to project participants' risks (e.g., of impoverishment) was warranted.

In addition to sector-based work, a 1997 special study of the macroeconomic environment and project performance (across all sectors and from 1980 to 1997) in Sri Lanka found that numerous variables such as world market prices, the nominal exchange rate, scale of duties and tariffs, shipping costs, various government controls,

Table 3
**Sources of Differences Between Estimates of Economic Benefits, Pre- and Post-Implementation, by Sector**

| OED Sector Synthesis | Factors Affecting Estimates of Economic Outcomes | Comments |
|---|---|---|
| **Irrigation and rural development** | Cost overruns; implementation delays; untested technologies; cropping intensities; poor water management | All conceptually subject to risk analysis |
| **Rural and agricultural credit** | Repayment rates; debt amnesties; rates of interest; government commitment | Many (if not most) conceptually subject to risk analysis |
| **Fisheries** | Price trends; numbers of vessels; fish stock composition | All conceptually subject to risk analysis |
| **Forestry** | Benefit estimations and valuations | Difficulties in estimating non-direct use values; could have been approached using sensitivity analysis, and/or "with or without" inclusion, and perhaps risk analysis |
| **Industrial crops** | Yields and prices; cost overruns; mills capacity and throughput | All conceptually subject to risk analysis |
| **Health and education** | Institutional performance; health, morbidity and mortality levels; cost of services (participation rates and demand) | Many conceptually subject to risk analysis |
| **Urban development and housing** | Land values; benefit valuation methods | Some conceptually subject to risk analysis, and land valuation could have been approached using sensitivity analysis, and/or "with or without" inclusion, and perhaps risk analysis |
| **Water supply and sanitation** | Cost overruns; WTP estimation | Some conceptually subject to risk analysis; WTP estimates could have been approached using sensitivity analysis, and/or "with or without" inclusion, and perhaps risk analysis |
| **Power** | Cost overruns; capacity and generation/transmission losses; WTP/resource cost savings estimates | All conceptually subject to risk analysis |
| **Roads and transport** | Implementation delays; cost overruns; traffic flows; vehicle operating cost (VOC) savings | All conceptually subject to risk analysis |
| **Ports and shipping** | Implementation delays; cost overruns; traffic volumes; benefit estimation methodologies | All conceptually subject to risk analysis |

etc. had all affected project outcomes. An explicit conclusion of the study was that greater attention to analysis of these variables at project design might have improved project effectiveness. An implicit conclusion may also be that quantitative and/or qualitative risk analysis techniques could have been employed to consider such variables more carefully.

## World Bank Experience With Risk Analysis

The World Bank devotes relatively more of its basic publication on project economic analysis (Belli et al. 2001) to the analysis of risk than does ADB in its comparable documentation (i.e., ADB 1997a). In this publication, a discussion of sensitivity analysis and its shortcomings is followed by a presentation of the principles of calculations based on mean-based expected values and the use of Monte Carlo simulation (including a hypothetical example). The problems of developing probability distributions for variables are discussed, and there is some description of judgmental methods applied to derive distributions in the absence of complete data sets. There is also a discussion of the implications for decision-making of risk analysis, concluding that (risk analysis is perhaps of limited use in decision-making terms due to governments' supposed risk-neutrality) the techniques are more likely to be of use in the processes of project design and redesign, rather than in decision-making per se.

Overall, the presentation of the material is relatively thorough, if somewhat traditional —being oriented mainly around the use of Monte Carlo techniques, and specifically recognizes the fact that the kind of analysis and presentation of issues associated with risk which are advocated are "extremely rare in existing documents". World Bank accepts that in situations when projects are large with respect to a particular region or group of people the ENPV criterion alone (i.e., without any associated measure of risk) is an inadequate measure of investment acceptability—but does not pursue the consequences of this thinking towards (for example) pro-poor project lending.

Two projects with risk analysis are given as examples of somewhat different types of "good practice". The first, from an irrigation project in Mexico, identifies three sources of risk (inadequate government counterpart funding, delays in surveys and studies, and unwillingness to invest/ problems with access to credit) which (collectively) have two sorts of impacts—implementation delays and low adoption rates. These two impacts are each then divided into three scenarios ("optimistic", "modal", "pessimistic" in the case of adoption rates, and delays of 0, 1, and 2 years in the case of implementation) with estimated probabilities of occurrence (0.1, 0.5,

0.4, 0.35, 0.4, 0.25, respectively), and EIRRs calculated for the resulting nine (i.e., 3*3) possible different scenarios. The result of this approach is a table of events (i.e., combinations of adoption rates and delays) with their associated probabilities and EIRRs. It is shown that even under the most pessimistic of assumptions (in this example this results from pessimistic adoption rates and a 2-year delay in implementation), which has a probability of occurrence of 0.1 (calculated from the multiplication of the likelihood of 0.25*0.4) the calculated EIRR (of 12.7%) is still in excess of the opportunity cost of capital (assumed to be 12%). A cumulative distribution function for the range of EIRRs is shown in tabular form, and could have been presented graphically as well.

This sort of approach is very similar to that advocated by Harberger (1998), which is discussed below. It is simple, clear and can be undertaken with only very limited suppositions about the probability of certain states occurring. Arithmetic calculations are trivial, project designers' or participants' ability to identify a few possible states for individual variables is likely to be plausible, and the resulting combinations of possible states is quite likely to be representative of the range of situations.

The other quoted example ("the most transparent and complete economic and risk analysis") is from a technical and higher education project in Mauritius (prepared in 1995). This project was clearly innovative from the World Bank's point of view as regards its economic analysis, and appears to be the first World Bank education project for which a measure of net worth (as opposed to a cost-effectiveness approach) was used.

In the project's economic analysis as presented in Belli et al. (2001), three variables which affect returns (income differentials between graduates and non-graduates, employment rates of graduates, enrolment rates) were identified, and each assigned probability distributions (log-normal, and two different triangular forms, respectively). A resulting probability distribution of project benefits is shown in graphical form. In the actual Staff Appraisal Report (SAR—and available on *www.worldbank.org*) for the same project, different variables appear to have been analyzed (major cost and benefit items) using different sorts of distributions—truncated and non-truncated normal distributions and one uniform distribution. A full Monte Carlo simulation—using 3000 replications, with and without correlation assumed between different variables—was ran at appraisal, and a probability distribution of net benefits was produced.

When considering this particular project material and the general nature of this type of approach (in contrast to the Mexico irrigation project, for example), it should perhaps be noted that the risk analysis as described in project documentation involves considerable technical discussion of the nature of variables' distributions, and the appropriateness of the particular techniques applied. It is also the case that the risk

analysis of the Mauritius project itself apparently took four weeks of staff time (on the part of one summer intern, presumably with a strong statistics background) to complete.

Other, arguably much more typical, examples of risk analysis from World Bank practice include (firstly) the $350 million Ghazi Barotha Hydropower Project in Pakistan (SAR, 1995), where least-cost and economic net worth analysis was conducted, and then a sensitivity analysis (for delays and cost overruns) was supplemented by a risk analysis of the type used in the Mexico irrigation example, i.e., four factors affecting project returns were modeled as having three possible states each, and EIRRs were calculated for each. (This process was undertaken for the project in the context of the power sector as a whole and for its own stand-alone operations). As for the Mexican example, a cumulative probability distribution of outcomes was constructed, so that it could be said (for example) that "the probability of the project's rate of return being less than the opportunity cost of capital is 8 percent." Another project example is the Xiaolangdi Multipurpose Project (Stage II) in China (SAR, 1995)—a $430 million loan, where probabilities of river flow volumes are discussed, although only appear to be modeled in terms of sensitivity analysis.

Other examples of World Bank practice in dealing with risk in various ways include the projects shown in the following table. What is clearly similar to the experience within ADB is that it is projects in the power sector which are analyzed most fully in quantitative risk terms.

## Other Agency Experience With Risk Analysis

A scrutiny of recent literature published by bilateral agencies such as Danish International Development Assistance (DANIDA), Danish Cooperation on Environment and Development (DANCED), AUSAid (Australian), GTZ (German), and FINNIDA (Finland) regarding preparation of project or sector loans reveals very little about general guidelines for economic analysis (in the sense of quantitative cost-benefit techniques), or risk analysis in particular. One reason for this is obviously that such agencies are (by and large) disbursing grant or extremely soft funds, often in relatively small amounts and do not have the same fiduciary accountability requirements as a bank such as ADB. It is also the case that operations by such agencies are increasingly in sectors where monetized costs and benefits are less obvious than historically may have been the case.

The prevailing view among bilateral grant-based aid agencies, as reflected in the available documented techniques for project preparation is that projects are assessed primarily in qualitative terms, with a focus on institutional and sustainability issues, rather than on estimation of economic returns per se. Exceptions (and

Table 4
**Examples of Risk Analysis from Recent World Bank Projects**

| Project Title and Date | Features of Risk Analysis |
|---|---|
| **Arun III Hydroelectric Project** (India, 1994) | Four factors affecting performance, with 2 or 3 states each, were used to generate probability distribution of EIRR; 'sensitivity testing' of basic assumed probabilities was also undertaken for several variables |
| **Waigaoqiao Thermal Power Project** (China, 1997) | 5 'risk variables' with 5–6 states each used to generate table describing expected EIRR with standard deviation, minimum/maximum values, probability of negative outcomes, etc. (uses 1000 simulations in Risk Master software) |
| **National Drainage Program Project** (Pakistan, 1997) | Includes quantitative assessment of political-economy risk regarding implementation and impact of various reforms, but not measured probabilistically in terms of EIRR distribution |
| **Third Andhra Pradesh Irrigation Project** India, 1997) | Combinations of variables' values used to estimate range of EIRRs; 'risk analysis' is really extended sensitivity testing |
| **Yunnan Environment Project** (China, 1996) | Wide range of technical, financial, institutional and policy risks, classified as short-term/medium and long-term/strategic; these are described qualitatively, and presented in matrix format with identified mitigating measures and parties responsible |
| **Shandong Environment Project** (China, 1997) | Wide range of technical, financial, institutional and policy risks, classified as short-term/medium and long-term/strategic; these are described qualitatively, and presented in matrix format with identified mitigating measures and parties responsible |

sometimes, additions) to this approach are circumstances where there may be financial impacts at individual or household levels, and then crop (or farm, household, enterprise, etc.) budgets may be modeled. In these situations it appears that some kinds of sensitivity testing (e.g., yields and prices up or down 20%, etc.) may be undertaken, but not quantitative risk analysis.

One agency which used to undertake comprehensive cost-benefit or (cost-effectiveness) analysis of most of its projects is the UK DFID (formerly ODA). Its publication *Project Appraisal of Projects In Developing Countries: A Guide for Economists* (various editions 1988–1995) was a standard source text for technicians. However, while sensitivity testing is described at some length in this publication, the agency's view was that

> "risk analysis (in the sense of probability-based techniques) is unlikely to be used often for economic appraisal except in the largest projects" (page 77, 1992 edition)

and its emphasis even in such circumstances seems to have been on the capital and financial aspects of dealing with risk. While some examples of the application of the techniques of risk analysis within DFID/ODA may be found, it certainly was a far from routinely-advocated practice. An unpublished technical paper prepared within DFID in 1995 reviewed the status of risk analysis, and advocated greater use of tools such as probability/impact matrices (see below), decision trees, and histograms to guide investment decision-making. This perhaps represents the last phase of thinking about quantitative cost-benefit techniques within the agency, as this work was abandoned in view of changed priorities.

There are nowadays two major aspects of DFID's approach to project preparation techniques that have direct bearing on the analysis of risk, although not in quantitative terms. Firstly, in recent years DFID (like ADB) has taken a very strong anti-poverty focus in its operations, and this has had major consequences for its approach to project appraisal. Since the publication of the 1997 "White Paper" on poverty, DFID's approach has been far less oriented around the formal techniques of cost-benefit analysis than previously, and more located within its "sustainable livelihoods" approach (see figure in Appendix 2). One aspect of the "livelihoods" approach to promoting sustainable development is that it involves explicit assessment of households' vulnerability to trends (e.g., in crop prices), shocks (e.g., natural disasters) and cultural factors (e.g., ethnicity). This is effectively equivalent to raising the profile of incorporation of risk in project preparation work by putting it at the heart of strategic thinking, compared to previous practice, where consideration of uncertainty and risk in DFID/ODA practice was essentially seen as supplementary aspects of a quantitative cost-benefit analysis.

Secondly, within the context of the application of the logical framework technique, DFID is very rigorous in

- identifying risks (right-hand column of the DFID format, and similar but not identical to that of ADB's "Project Framework") and specifying how they relate to relationships between different levels of the framework (i.e., "output-to-purpose", "purpose-to-goal")
- clearly specifying what mitigating measures have been already within project design to address or minimize these risks, and
- compiling a "risk matrix" which locates each identified risk within a matrix whose dimensions are "probability of occurrence" and "seriousness of impact" (i.e., if the event does occur).

DFID is also notable for the preparation of a "risk annex" in its supporting project documentation, which gives it a similar status to that of social appraisal, technical appraisal, economic and financial appraisal, etc. The risk annex and risk matrix are essentially used in a qualitative way to both promote dialogue between host governments and executing agencies and to ensure that appropriate mitigating measures are put in place.

The following is an example of a DFID risk (or impact/probability) matrix from a recent project in China (Yunnan Environmental Development Programme, 2000). The numbers 1-10 refer to the 10 different sources of risk to the project, which were identified during preparation and discussed within the project's logical framework. The identified risks comprised the following

Risk 1: Chinese long term funding for poverty alleviation and environmental improvements in Yunnan is inadequate
Risk 2: Inadequate state:provincial link established
Risk 3: Economic development given higher political ranking than reduction of environmental degradation
Risk 4: Abnormal incidence of physical shocks, e.g., earthquakes
Risk 5: High staff turnover leads to skills dissipation
Risk 6: Sustainable development and the Agenda 21 process is not given sufficient priority by Yunnan Provincial Government
Risk 7: Institutional practices limit the adoption of an integrated approach and subsequent co-ordination of activities
Risk 8: Insufficient counterpart funding leads to sub-optimum choice of pilot projects
Risk 9: Greater priority given to environmental benefits than to poverty reduction
Risk 10: Institutional support for proposed gender improvements may not be adequate

One other point with respect to risk analysis in the context of logical frameworks is that some variants of that technique (e.g., that of the German agency GTZ) have used versions where the probability of a risk—as well as its existence—is indicated within the framework itself. If the probability of a situation occurring which would jeopardize the achievement of project objectives is thought to be sufficiently high, this may be regarded as a 'killer assumption', around which the project must either be scrapped or re-designed.

Another UK agency which has been active in extending its analysis of risk (and which is probably the original source of the DFID approach) is the UK Treasury, in the context of the Private Sector Finance programs (where the private sector is

Figure 8
Risk Matrix: Impact and Probability Analysis

| | Impact | | |
|---|---|---|---|
| Probability: | Low | Medium | High |
| *Low* | 4 | 6 | 1, 2, 5, 7, 9 |
| *Medium* | 8, 10 | 3 | |
| *High* | | | |

invited to participate in what are traditionally regarded as public projects). Within the Treasury's approach to PFI, considerable effort is devoted to

- identifying the full range of risks faced by a project (from planning, design and construction risks, through demand, occupancy and maintenance risks, to legislative, inflation and technology risks)
- quantifying the impact of risks (based on the Construction Industry Research and Information Association classifications of "catastrophic", "critical", "serious", "marginal", and "negligible")
- estimating the likelihood of risks (based on standard probability techniques), and
- allocating risks between different project participants, such that those who can best manage the sources of risk should bear the consequences (good or bad) of such management.

It is clearly the last of these functions which is the main purpose in the PFI context— i.e., making sure that (where possible) the ownership of risks and their consequences are transferred to the parties (public or private sector) most able to deal with them. It is then the responsibility of respective parties to take action to mitigate risk. Based on the construction of an extensive risk matrix in this way—with its emphasis clearly on allocating and transferring risks—negotiations about contracts for the private sector to be involved in public service delivery or procurement are much clearer, and the basis for the public sector comparator (i.e., the risk-adjusted cost estimate for the project to be entirely a public sector provision and against which any private bids must be compared) is entirely apparent.

Despite the innovativeness of these various techniques, it should still be noted that none of them deal with risk proper, in the sense of quantitative, probability-

based techniques, or (if they do include any probability-based constituents) they do not extend such techniques as already applied—at least on occasion—by (for example) World Bank or ADB.

## Risk, and the 'Harberger' Critique of Recent Applied Project Economic Analysis

While reviewing the experience of ADB and other major multilateral and bilateral development agencies with respect to the analysis of risk in the context of project economic analysis, it is impossible to avoid some of the major critiques of observed technical practices which have appeared in recent years. One of these, and one that has definite implications for practice with regard to risk analysis, is that of Harberger (1998).

One of Harberger's main points is that there has been a lack of account of risk taken in project economic work in recent years. This is partly because of the (perhaps unexpected) importance of large changes in relative prices over time (some being due to significant shocks, such as unpredictable changes in petroleum prices, and some due to longer-term trends, such as in the US$ appreciation of the late 1990s), and partly because of systematic "approval culture" which is endemic to most multilateral organizations (and which tends to consistently overstate benefits and to underestimate costs of projects in a climate of "appraisal optimism"). As a result, the relationship between what was expected at appraisal and what actually happened overall in development projects is relatively poor (the experience of the ADB projects reviewed in this Handbook largely confirms this view). Harberger also argues that because loans made by agencies such as ADB and World Bank are in effect subject to countries' sovereign guarantees and the banks' capital is not effectively at risk, these lending agencies tend to take a less serious view of risk than would, for example, private investors in similar circumstances.

As a result of what Harberger calls such "ambient pressures", a "comfortable scenario" (perhaps reinforced by organizational internal incentive structures) typically characterizes most project preparation environments, which causes a divergence between expected values at time of appraisal and ultimate project impacts. Harberger argues that better derivation of expected values at appraisal (i.e., estimation of ones more likely to represent real flows of costs and benefits) would be realized if more account were taken of risk—and in practice Harberger advocates the more widespread use of a simplified Monte Carlo simulation technique. The application of this technique would depend upon a few (he suggests four or five) values being chosen for the

"key (i.e., single) variable which is most critical to the project's outcome"

in most circumstances, and an expected value for NPV being calculated based on assigned probabilities for each of these states. This approach can also be extended, so that even two or three other variables can be identified (which are in practice quite independent of one another – e.g., weather, real wage growth, traded input price), and the simulations re-run on the basis of only a few values for variables. (This approach is therefore very similar to the World Bank's "On-Farm and Minor Irrigation" project example mentioned earlier in Part III).

Harberger offers no new techniques for risk analysis *per se*, but does make a strong case for greater application of probability-based techniques, albeit in a simplified form. This is in fact what is largely recommended to improve ADB practice. ADB experience as described in Part III appears to bear out at least some of Harberger's criticisms (e.g., as regards systematic underestimation of costs, overestimation of benefits, etc.).

## Summary of Risk Analysis Experience

What emerges from the review of ADB and other agency experience is that, despite the extensive academic literature describing the techniques for more quantitative approaches to risk analysis and the increasing availability of computers with which to run probability-based simulations for values of key variables, actual examples of such practice are very rare.

Within ADB, the overwhelming orientation of current practice has been towards a qualitative risk description linked to mitigating actions included in the project design. A reliance on this, plus fairly standardised sensitivity testing designed to demonstrate project robustness (survival in the 'worst case' scenario), is found across all sectors of operations.

Almost identical conclusions are drawn in relation to a review of recent World Bank practice (despite its much stronger emphasis on the utility of such techniques in its own published project economic analysis documentation), although the format and presentation of World Bank projects perhaps differ more across sectors (with a much larger number of projects being dealt with).

Within both institutions, almost the only exceptions to this situation appear to be found in the power sector, where simplified probability distributions for a few key variables are used to estimate expected returns plus estimated variability. The cited ADB port and agriculture projects, and the World Bank education

project are most notable for the rarity of the application of full-scale probability techniques.

Most bilateral agencies (such as UK DFID) are now undoubtedly moving away from quantitative cost-benefit analysis generally, although it is also clear that certain qualitative techniques for dealing with risk and more centrally incorporating it within a pro-poor lending environment are emerging at the same time. Greater consideration of the expected vulnerability of poor groups in terms of the risks they face while earning their livelihoods, and how they may best be planned for in such situations, are ongoing themes of research work. Similarly, other agencies (e.g., the UK Treasury) are moving consideration of risk more towards the center of project analysis in an attempt to more properly allocate costs and benefits from risk management. Although no new techniques for extending quantitative risk analysis are yet being proposed it is possible that existing techniques may be further extended in application.

Critiques of some of the project economic analysis practices of major multilateral development agencies (based on reviews of project outcomes) include arguments that risk has not been sufficiently well dealt with in the past, and that lenders have not been rigorous enough in considering unknown future outcomes from the point of view of their borrowers (who ultimately bear the financial and economic consequences of such outcomes).

In these circumstances, perhaps the future challenge for ADB as regards risk analysis is therefore two-fold:

- as a lending institution whose interest lies in seeing that its clients (i.e., borrowing governments) are not unduly exposed to economic risks, there is scope to strengthen project design through the fuller use of risk analysis so as to ensure greater sustainability (financial, environmental, and institutional) of project effects and likelihood of project success; this can include better identification and definition of risk, and its allocation among various project participants, and
- with the increasing emphasis on lending to reduce poverty, there is a need to put the circumstances (especially as regards their vulnerability) and attitudes of those affected and targeted by projects at the heart of project economic analysis.