# A Review of the Use of Contingent Valuation Methods in Project Analysis at the Inter-American Development Bank

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# Abstract

The elicitation of the values that individuals attach to various environmental improvements can be undertaken using either revealed or stated preference methods, the difference being that revealed methods use actual data observed in functioning markets while stated preference methods employ constructed markets in an experimental setting to elicit peoples' preferences. The most widely used stated preference method is contingent valuation (CV), which tries to get at willingness to pay in money terms for a posited change in environmental conditions. Recently, interest has grown in so called conjoint stated preference methods that do not ask about willingness to pay directly, but instead undertake experiments involving contingent ranking of, or contingent choice among, alternatives that provide different levels of non-marketed public goods or their multi-dimensional attributes.

This paper reviews the past ten years of the Inter-American Development Bank's experience with stated preference methods, concentrating on their use in the cost-benefit analysis of projects supplying sewer service and improving ambient water quality in Latin America and the Caribbean. It discusses the characteristics of nearly a score of projects, and the nature of the analysis undertaken to design and approve them. It reports the range of willingness to pay estimates involved, and comments on some of the most important economic analysis issues that appear to have arisen. Among these are the effect that alternative econometric specifications of the choice model can have on our estimates of average (or median) household willingness to pay derived from referendum CV surveys, the need to match what any investment project purports to achieve in a CV survey to what it will actually achieve in practice, and the role of sensitivity analysis in portraying the distribution of expected gross and net project benefits.

In the main we find that the revealed preference method of hedonic analysis has rapidly given way to contingent valuation as an approach to environmental benefit estimation in project analysis, but few, if any, "non-traditional" conjoint applications have been undertaken. Some promising areas for the IDB's future application of these new, less familiar methods are suggested, as are some more "conventional" needs.

# Contents

# Introduction

The Inter-American Development Bank is a multilateral financial institution that has long had a general operating policy on the preparation and analysis of the projects it finances in Latin America and the Caribbean (Operational Policy 302, September 1980). Broadly, that policy requires, whenever possible, a cost-benefit analysis of project feasibility, where all inputs and outputs must be valued in opportunity cost or economic efficiency terms. Acceptable projects must have an economic internal rate of return above 12 percent, or a positive net present value, using a 12 percent discount rate as a measure of the social opportunity cost of capital. The Operational Policy requires a full analysis, not just an economic justification of a single proposal, by saying "The analysis compares different alternatives of design, scale, location and timing so as to maximize the net present value, and thus contribute as efficiently as possible to economic growth" (p.OP-302-3). It also acknowledges that, in situations where the value of economic benefits cannot be reliably estimated, a comparison of the costs of alternative projects can be made to select the one(s) which attain a given set of objectives at the lowest cost (referred to interchangeably in the policy as " least cost" and "cost-effectiveness" analysis).

Depending on the nature of the project, Bank analysts chose among a battery of benefit estimation techniques to apply in project analysis. Contingent valuation has been prominent among them for roughly ten years. It began as an experimental technique that was first used in ex-post evaluation of completed projects and was soon adopted for the ex-ante analysis of investment project proposals. Eleven IDB studies are included in the 1994 compendium prepared by Carson et al., and several more have been undertaken since, especially in urban sanitation projects having sewer components that provide better neighborhood environmental quality and reduce health risks or wastewater treatment projects that improve the quality of rivers, lakes and coastal/estuarine waters. Because of the frequent use of the method in the urban sanitation sector, the remainder of this paper concentrates its attention there.

### A Review of Water Quality Improvement (Urban Sanitation) Projects Financed Since 1989

A desk review was undertaken of 18 specific investment loans and 9 global multiple works loans approved since 1989 that had ambient water quality improvement as an explicit objective.[1] The specific projects had water and/or wastewater treatment components, in a well-defined area (e.g. most frequently a metropolitan area) within which all the investments and the relationships among them are fully identified before project approval.[2] The total

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[1] Candidate projects were identified by a computerized search of the Bank's data base, supplemented by a survey of staff economists, and later screened by inspection of the documents themselves. Given the large number of eligible projects having ambient water quality objectives (27) the desk review primarily consulted official IDB project documents (Loan Proposal, Project Report) and readily available published articles or World Bank reports. Recourse to the Environmental Summaries was taken only in cases when the environmental information in the main project documents was clearly unsatisfactory. Background technical and economic analysis feasibility studies were not consulted because the sheer volume of background information, and its uneven availability across various file locations in the Bank, made a more in-depth and thorough review impossible to justify.

[2] Global multiple works loans usually involve multiple investments in several different cities or basins, only a sample of which are identified and analyzed prior to loan approval. In the past, the Bank has required that a (continued...)

accumulated cost of the eighteen specific investment projects was nearly US$5 billion between 1989 and 1998, with four of them exceeding one-half billion US$ each. Annexes 1 and 2 summarize the general characteristics of the projects.

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[2](...continued)
representative sample of projects, sufficient to cover thirty percent of total program cost, must be exposed to ex-ante feasibility analysis. This requirement often imposes a serious analysis and reporting burden (see Vaughan 1994). Global multiple works project documents therefore do not contain much useful technical and economic information, but below we do include their benefit estimates, when available.

# A Synthesis of the Overall Results of the Review

### Type of Economic Analysis

Annex 3 indicates that two-thirds of the projects reviewed represent just one stage in a multi-stage program, which raises difficult analysis issues with respect to the time-phasing of investments and, in any given time period, over space within a basin. While dynamic programming has not been used, some analyses have considered alternative investment configurations in more approximate way. For instance, Project No. 5 used a regional least-cost mixed integer programming analysis to minimize the sum of treatment plant investment, operation and maintenance costs, allowing construction to begin in either of two time periods (1992 or 1996 so operation comes on line in 1995 and 2000) subject to plant flow capacity constraints. Up to four plant locations were possible, and two alternative flow capacities at three of the locations (1.5 or 3 $m^3$/sec) and three capacities at the fourth location (2.5, 4.75 or 9 $m^3$/sec.). Each plant could be built in either the first or second stage subject to BOD concentration constraint imposed at three critical river reaches.

Time-phasing raises additional problems when cost/benefit analysis is undertaken instead of (or in addition to) regional least cost analysis. The heart of the issue is that the program overall may produce a positive net present value, but the initial phase, as designed, may not. Or, even if it does when population is held constant, additional population growth may, by increasing wasteloads, erode the AEQ gains the initial stage achieves. Project No. 9 is an example of the first issue, where the benefits of the project, taken in isolation from subsequent stages, were on the narrow margin between acceptance and rejection, depending on the assumptions underlying the analysis (e.g. the size of the benefitting population, the legitimacy of stemming or multiplier-induced benefits, etc.). In Project No. 16, the question of future growth was handled by adding additional costs mid-way through the project's lifetime to preserve the level of benefits initially achieved.

Regional least cost optimization models have been used infrequently (3 of 18 cases). More common is a narrower cost-effectiveness analysis that seeks the least expensive wastewater treatment equipment design to achieve a prespecified set of percentage pollutant removal targets. This exercise is usually a precursor to cost/benefit analysis, but hardly ever is explained in much detail

Cost-benefit analysis was commonly applied in a majority of the projects reviewed. In fact, only two (Project Nos. 1 and 2) did not appear to attempt it. Usually, projects with both sewer and wastewater treatment components report a separate analysis for each, consistent with good practice, rather than lumping both sets of investments together in a combined analysis which potentially might disguise economically unattractive components. The preferred benefit estimation approach for both sewer and treatment project components has overwhelmingly been contingent valuation. Although Annex 3 does not show it, in most cases where multiple methods were applied, the bulk of the benefits were obtained by CV, leaving the other methods to fill in the smaller gaps.[3]

Economic sensitivity analysis was missing in four of the fifteen projects where cost/benefit analysis was applied, in apparent disregard of standard Bank requirements. Where it was done, sensitivity was generally a pro-forma exercise, with three notable exceptions (Project Nos. 3, 4,and 7). The next section summarizes the magnitude of benefits estimated for IDB projects, followed by a discussion

[3] On occasion, some double counting may have arisen through the use of multiple methods.

of some interesting applications, as well as other innovations that are particularly worth noting.

### Benefit Estimates

The review of twenty-seven IDB sanitation operations approved since 1989 having water quality improvement as an explicit goal uncovered useful benefits estimates in eighteen cases, almost all of which involved contingent valuation (CV) estimates of national resident willingness to pay.[4] With only a few exceptions, a referendum question format was employed by Bank analysts instead of direct revelation, consistent with the NOAA Panel's recommendations on CV protocols. The projects being financed usually include potable water supply, household sewer connections and drainage via collector and interceptor sewers; followed by wastewater treatment, or some subset of these components.[5] Given the design characteristics of the projects, two categories of benefit predominate, sewerage and more general ambient water quality improvement.

It was once common IDB practice to narrowly measure the benefits of household sewer connections solely in terms of direct use value by statistically determining the shift in the demand curve for potable water enabled by having a connection, and counting as the sewer connection benefit the difference between the integrals of the demand functions with and without sewer (the difference in total willingness to pay for potable water in the two situations). However, that approach leaves out many other types of benefits which potentially can be captured by contingent valuation, as pointed out a decade ago by former Bank economist Jorge Ducci in describing the IDB's first application of contingent valuation for the economic analysis of an urban sanitation project in Uruguay (Project Report: Montevideo City Sanitation Project, Second Stage (UR-0023), October 1989. Also see McConnell and Ducci 1989.)

Construction of a sanitary sewer system (household connections with storm drainage) produces a cost savings for connected residents who no longer have to maintain and eventually replace more expensive individual wastewater disposal solutions like cesspools and septic tanks. Moreover, it provides a greater level of what Ducci calls "desirability" attached to the absence of clogged piping and foul smells in the vicinity of the home, the avoidance of flood damage to personal property and the alleviation of transportation delays in rainy periods. Other benefits Ducci does not mention include the reduction of health risks through the elimination of pools of stagnant standing water in the neighborhood, and even some localized improvements in the quality of watercourses (creeks, ravines) that formerly received polluted domestic, commercial, and industrial discharges and storm runoff flows that sanitary sewer projects collect and channel elsewhere, usually to a consolidated downstream outfall. Contingent valuation estimates of the willingness to pay for sewer connections (sanitation and, on occasion, storm drainage, usually in separate systems) undertaken since Ducci's innovative effort appear in Table 1 below.

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[4] In two or three cases, producers surplus estimates were produced for tourism affected by improvement in marine coastal waters, but they were not firmly grounded in survey data, and are not discussed. Similarly, estimates of medical costs avoided were undertaken a few times, but they too do not appear reliable. One hedonic analysis was done; and it is included in Table 2 below.

[5] Potable water supply benefits are obtained by integrating under statistically estimated demand functions, and are not of direct concern here.

**Table 1 IDB Contingent Valuation Estimates of Willingness to Pay for Local Sewer and Drainage**

| Country-Project | Mean WTP | Income |
|---|---|---|
| | *(1996 US$/household/month)*[4] | |
| AR-0130 | $21.01 | $721 |
| AR-0130 | $47.27 | $1,471 |
| BA-0036[1] | $16.82 | NA |
| BR-0067 | $28.96 | $1,094 |
| BR-0073 | $15.95 | $399 |
| BR-0186[2] | $12.70 | $343 |
| BR-0186[3] | $16.36 | $343 |
| BR-0190 | $16.75 | $558 |
| CO-0082 | $2.32 | NA |
| CO-0227 | $15.60 | $233 |
| EC-0025 | $12.15 | NA |
| UR-0023 | $26.69 | $348 |
| UR-0089 | $21.50 | NA |
| *Average:* | $19.54 | $612 |
| *Standard Deviation* | $10.67 | $416 |
| *Median* | $16.75 | $399 |

Notes
1. Includes sewer benefits plus benefits of ensuring water at beaches is safe for contact recreation.
2. Excludes drainage
3. Sewer plus drainage
4. Converted to US$ using the exchange rate of the period and re-expressed in constant 1996 US$ by application of the US BLS Implicit Price Deflator.

On average, households in this small sample of projects are willing to pay three percent of their income each month (a recurrent, not a one-time, charge) to have a sewer connection and drainage services. The not inconsiderable sample average willingness to pay of almost US$20 per month ($240 per year) is influenced by the underlying distribution of income levels across the project sample.

A log-log regression of willingness to pay against income produces a positive and highly significant income elasticity of WTP of 0.54.[6] While one should not make too much of the magnitude of the elasticity,

[6] The regression model including an intercept produced an adjusted $R^2$ of 0.58 and the following parameter estimates (absolute value of *t* statistic in parentheses):

$$\ln WTP = -0.33 + 0.54 \ln INC$$
$$(0.34) \quad (3.49)$$

The intercept term is statistically insignificant, which is reassuring since households with no income cannot make a positive payment.

the fact that it is positive and significant across a sample of independently produced expectations of willingness to pay in different projects provides at least a consistency check on the pattern in the data generated via CV, since the existence of no relationship whatsoever between willingness to pay and income might be cause for serious concern about the plausibility of the method.

The income levels in the sample are generally low, since IDB projects are often focused on low income beneficiaries in the client countries, so the WTP elasticity is not a global estimate across all income levels in all countries. The result does suggest, however, that simple WTP averages are not particularly useful for benefits transfer.[7] Moreover, if the value of the income elasticity is truly less than one, transfer exercises that arbitrarily assume a value of one for convenience may seriously overstate or understate the magnitude of the transferred benefits, depending on whether income in the target area lies above or below income in the reference area. At least one IDB project analysis has explicitly recognized the dangers in the average benefits or unitary elasticity transfer assumptions and apparently tried to correct for it (Loan Proposal: Metropolitan Montevideo Sanitation Program Stage III (UR-0089), July 1996).

Contingent valuation estimates of willingness to pay for ambient water quality (AEQ) improvement are even more of a mixed bag than sewer benefits, mainly because the no-project AEQ baseline and the extent of AEQ improvement being valued and/or provided by the project is often unclear in the official IDB documents reviewed.[8] Table 2 provides fifteen estimates culled from eleven different project documents.

Very few of the documents clearly report the average income of the beneficiary population, so Table 2 does not risk stating an income level, [9] implying no income elasticity estimate for the value of ambient water quality improvements is possible with this data. It does hazzard a guess about what level of improvement is being valued.

Based on the current AEQ status reported, it is safe to assume a very poor initial level of water quality, with only a few exceptions (e.g. BA-0036). Ignoring differentiated levels of AEQ achievement and taking a crude sample average in Table 2 suggests that, in contrast with Table 1, households assign only about one-fourth the value to the more amorphous and distant (in both time and space) AEQ improvements in major watercourses ($5.78) than they do to the more concrete and immediate utility gains from having sewers. It does not seem at all implausible to find this relationship among respondents of limited means, who of necessity perhaps give greater weight to interventions providing a higher relative portion of use to non-use values.[10]

[7] Note that we pool all the sewer valuation information, since the extent of drainage provision is often not clear from the documents, which do not provide the wording of the contingent valuation questions used to elicit willingness to pay.

[8] This information is often available from the economic analysis feasibility studies, which were not reviewed because of time and budget constraints. The objective of this study is not the meta-analysis of benefit estimates.

[9] It is dangerous to presume that the expected value for general AEQ improvement reported in Bank documents is independent of income, or that the same average income applies that was used for sewerage (if both elements are present). The scope of beneficiary population for AEQ benefit evaluation is often the population of the entire city, not just a neighborhood. Usually no details are provided about the Logit specification of the probability of acceptance function estimated from the referendum bid data (no income effects or income effects) or the way the function was evaluated (truncated mean over bids yielding a positive estimated probability of acceptance versus untruncated expected value).

[10] It would probably be a stretch to try to read anything more out of the limited information in Tables 1 and 2. Therefore we resist the temptation to statistically test for the significance of the roughly $14/household/month difference between average willingness to pay for sewerage instead of better ambient water quality, or to try to sort the AEQ values by level of achievement (odor reduction, swimmable, etc.) in order to see if within-group average values are significantly and positively related to ascending levels of improvement

**Table 2. IDB Project Estimates of Willingness to Pay for General Ambient Water Quality Improvements in Rivers, Lakes and Coastal Waters**

| Country-Project | Method | AEQ Target | Mean WTP (*1996 US$/household/month*) |
|---|---|---|---|
| BA-0036 | CV | Beaches-swimmable water | $1.04 |
| BR-0072 | CV | River pollution control-no specifics | $7.85 |
| BR-0072 | CV | Beaches-swimmable water | $7.74 |
| BR-0073 | CV | Beaches-swimmable water | $5.40 |
| BR-0073 | CV | Beaches-swimmable water | $7.28 |
| CO-0082 | CV | Odor elimination | $3.24 |
| CO-0208 | CV (direct) | Odor elimination | $3.28 |
| CO-0208 | CV (direct) | Odor elimination & aesthetics | $7.14 |
| CO-0208 | CV (direct) | Swimmable water | $11.34 |
| CO-0227 | CV | Swimmable water | $3.72 |
| EC-0161 | Hedonic | Property "affected" by pollution | $4.20 |
| ME-0056 | CV | Clean River-no specifics | $6.30 |
| NI-0027 | CV | Odor elimination & aesthetics | $4.00 |
| PR-0064 | CV | Improvement in Water Quality | $13.38 |
| UR-0023 | CV | Beaches-swimmable water | $0.74 |
| | | *Average:* | $5.78 |
| | | *Standard Deviation* | $3.50 |
| | | *Median* | $5.40 |

Note: WTP expressed in constant 1996 US$ by application of the US BLS Implicit Price Deflator. CV means referendum question format unless otherwise noted.

# Economic Analysis Issues Arising from the Projects

General benefit estimation issues and the sensitivity of net present value to variability and uncertainty in benefit and cost streams have been, as might be expected, the major areas of concern.

## Contingent Valuation

As late as the mid 1980s, institutions like the IDB continued to be reluctant to employ CVM, regarding it as a frontier, non-operational technique of questionable accuracy, particularly when applied in developing country contexts where respondents may be unaware of or uninterested in the state of the ambient environment or its improvement, rendering the CV exercise totally hypothetical. However, at about the same time the ability of the traditionally favored hedonic pricing method to generate reliable estimates of willingness to pay for non-marketed environmental attributes came under scrutiny (Vaughan 1987, 1988), and some pilot CV studies had been tried in ex-post analysis (Vaughan 1987, Nicol 1988).

### CVM Innovators: Ducci and McConnell

The Bank began to entertain the use of CVM in place of hedonics or travel cost models in ex-ante project analysis when circumstances warranted. As noted above, former Bank economist Jorge Ducci, in collaboration with Kenneth McConnell of the University of Maryland,[11] was the first to successfully implement the method ex-ante in the 1988 economic analysis of the second stage of Uruguay's Urban Sanitation Project for the City of Montevideo (Ducci 1988; McConnell and Ducci 1989 and McConnell 1995). Their analysis paved the way for future applications, and effectively sounded the death knell for estimates of water quality improvement benefits based solely on hedonic analysis.

### Negative Expected Willingness to Pay: Ducci, McConnell and Rodriguez

Of the three basic survey designs[12] most IDB applications since 1989 have been of the single or double-bounded referendum sort,[13] following the protocols recommended by the NOAA Panel of Experts. With conventional Logit or Probit random utility models fit to referendum CV data, when over half of the fitted cumulative density function relating bid price to the probability of acceptance of an offer to improve environmental quality lies in the negative price quadrant the expected value of willingness to pay will be negative. This means that on average respondents would require a subsidy to persuade them to enjoy the utility improvement, rather than be willing to pay a positive amount for it, a result that is totally inconsistent with economic theory. This nasty surprise is always possible with referendum data, and a whole literature has evolved on how to confront the problem (see Haab and McConnell 1997, 1998).

Disturbingly, the possibility of a negative gross project benefit arose in the very first IDB application of the referendum CVM by Ducci and McConnell noted above, nearly dooming a novel experiment

[11] Terry Powers directed this effort; Pablo Gottret and William J. Vaughan also collaborated.

[12] The options referred to are (a) open-ended surveys where individuals are asked to state a willingness to pay; (b) closed-end referendums where individuals are presented with a bid and respond yes/no binary decision (single-response referendum); and (c) closed-end double referendums where individuals are presented with a sequence of two payments to obtain binary decisions (double-response referendum).

[13] This method is also known as dichotomous choice or discrete choice contingent valuation.

before it started. At the time, this outcome was wholly unexpected, given our limited experience with the approach. Fortunately, a fix was found by confining the evaluation of the fitted density function to only positive prices, ignoring the part lying in the negative price quadrant, to produce a truncated expected value of willingness to pay (Ducci 1998). McConnell mentioned the experience in passing several years later (McConnell 1995) and used the data set in some recent articles (Haab and McConnell 1997, 1998) to illustrate the problem and suggest how a negative expected value of willingness to pay can be overcome.

Rodriguez (1998) recovered the original referendum CV data used by Ducci and McConnell and re-estimated the probability of acceptance function. His objective was to explore the sensitivity of expected willingness to pay estimated from referendum data to the hypothesized form of the distribution function (linear or logit) and its arguments, other than price. Although the linear model is hardly ever used in practice, because it suffers from several econometric deficiencies and rigidly imposes a simplistic uniform probability density,[14] it was chosen to provide maximum contrast with the logit, which seems to be, perhaps by default, the most frequently used specification in the literature and IDB analysis.

Rodriguez found that the specification of the relevant independent variables other than price had little effect on mean (truncated or untruncated) or median willingness to pay, but sizeable differences between the linear probability and logit models existed across each measure. Table 3 compares his measures of central tendency for WTP with estimates by McConnell and Ducci (1989) and by McConnell (1995).[15]

The table reveals that to produce a positive WTP, a truncated mean must be used, illustrating the risks inherent in the referendum technique. Unlike open-ended CV, the dichotomous choice approach does not provide a benefit measure that can be drawn directly and easily from the data. Rather, it requires some facility with qualitative independent variable econometric estimation and a fairly thorough understanding of the mechanics of alternative interpretations to back out the number of interest – some central tendency measure of per household willingness to pay.[16]

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[14] Some of the major flaws of the linear probability model used in the 1960s and 70s (Amemiya 1981) are nonnormality and heteroskedasticity of the disturbances $e_i$ and the failure to confine the expected probability between zero and one. One way around the latter problem is to truncate the predictions (i.e. estimate y using OLS and if some estimated $\hat{y}_i$ are less than 0, $\hat{y}_i$ is assumed 0. Identically, if the estimated $\hat{y}_i$ are greater than 1, $\hat{y}_i$ is assumed to be 1).

[15] McConnell and Ducci (1989) estimated the mean willingness to pay using the augmented intercept model. McConnell (1995) estimated the willingness to pay using the same model but assuming that all explanatory variables other than price (ylevel, dwest, dbeach, and age) are all equal to zero. Therefore, the expected value was calculated by the ratio of the intercept to the price parameter (i.e. $a_0$/ßw).

[16] Haab and McConnell (1998) use the same Uruguay data to demonstrate the effects on WTP measures of a broader range of probability models than Rodriguez used, and produce an even broader range for mean WTP. Converting their results back to pesos for comparability:

| Model | Mean WTP (1988 Pesos) |
|---|---|
| I. Theoretically Consistent | |
| Beta | 75,240 |
| Pinched Logit | 55,110 |
| Truncated Logprobit | 53,790 |
| II. Theoretically Inconsistent | |
| Standard Logit | (8,250) |
| Truncated Logit | 30,360 |
| Loglogit | 641,520 |
| Pogprobit | 1,468,830 |

Serious project analysis issues clearly arise when the project approval decision hinges so critically on the analyst's choice of econometric approach, which in this example provides average per household benefit estimates ranging from negatives around $N 10,000 to positives as high as $N 1.5 million (or, in 1988 $US, from negative $30 to positive $4,500).

| Table 3. Alternative Estimates of WTP from Uruguay Referendum Data | | | | |
|---|---|---|---|---|
| **Estimate of WTP per Family per Year [a] (1988 Pesos)** | **Rodriguez Specification[b] Linear Probability (1998)** | **Rodriguez Specification[b] Logit (1998)** | **McConnell and Ducci Specification [c] Logit (1989)** | **McConnell Logit [d] (1995)** |
| C+ (Mean) | ($N11,260) | ($N6,986) | ($N6,180)[e] | ($N37,360) |
| C*(Median) | ($N11,260) | ($N6,986) | ($N6,180) | ($N37,360) |
| C'(Truncated Mean) | $N34,930 | $N16,973 | $N16,335 | NA |

Notes:

a. The exchange rate in 1988 was $N330/US$. Parentheses denote negative amounts.

b. Explanatory variables other than intercept and price were a binary variable indicating whether a municipal beach in the city was the principal recreation spot or not; age of the head of household (continuous); and a binary variable indicating whether the respondent used the beach to be improved by the project (Playa Ramirez) or not.

c. Explanatory variables other than intercept and price were all binary indicating if the household (i) was above the low income level; (ii) planned to use western area beaches in the future; (iii) was beach-going; (iv) age of head less than 60.

d. Evaluation of the model in note c above with all explanatory variables set to zero.

e. Ducci (1988) reports a negative expected value (equal to the median) of $N -6,196. But McConnell and Ducci (1989), using the same specification of explanatory variables and the same parameter estimates as Ducci (1988) report a mean willingness to pay of $N +4,707, without explaining how it was calculated. In a personal communication with the authors, Ducci (1998) cleared up this apparent inconsistency. The $N+4707 represents a truncated mean constructed by calculating WTP for each observation in the sample, assigning a zero WTP to all negative predictions, and then averaging over the whole sample. For the cost-benefit analysis of the project, Ducci actually used a more conservative WTP per household of $N2309 produced by estimating a log price Logit model (not shown above) and evaluating it at the sample means of the explanatory variables to get a "typical" WTP. If the same log price model is evaluated at each observation and then the average of WTP is taken over the entire sample (rather than evaluating WTP at the sample means of the independent variables), an average WTP of $N4624 results, which is close to the truncated estimate of $N+4707from the Logit model in untransformed price.

While academic or research applications usually provide a thorough account of what was done, in commercial applications such as those done by or for the Bank the several steps (survey instrument design and administration, model estimation, function evaluation) required in the referendum approach can pose difficulties and open the door for ambiguities, especially if no reporting is expected from the analyst on exactly how the benefits estimates were derived. The instability of benefits estimated from referendum data, stemming from their sensitivity to econometric specification issues (Halvorsen and Sœlensminde 1998) is worrisome, and can easily lead to relentless exploration of the data and alternative formulas for expected value of WTP until a benefit level that manages to justify the project is uncovered. The negative expected willingness to pay phenomenon, while perhaps rare,[17] only illustrates the more general issue of potentially biased analyst values being imposed via econometric artistry on top of the values expressed by respondents to referendum CV surveys.

[17] Ducci (1998) suggests that low acceptance rates at low bid levels, which leads to negative expected WTP values in some model specifications, is a questionnaire design problem that can be detected and corrected in the early stages of survey design by "testing very low and very high prices during focus groups and pilots to make sure the acceptance curve is well centered on prices." Nevertheless, it remains generally true that alternative probability model specifications can produce a wide range of central tendency measures of WTP, even if the negative WTP problem is not present.

This suggests that the desirability of the open ended method, whose use was discouraged by the NOAA panel, should perhaps be reassessed (McFadden 1994), especially in light of the institutional context of project evaluation as done by the Bank and its borrowers (Rodriguez 1998). Alternatively, more thought might be given in the future to non-parametric methods for extracting expected values from referendum data (McConnell 1995, Haab and McConnell 1997), or to estimation approaches that eschew the standard random utility difference model (Hanemann 1984) in favor of an approach that in application is more consistent with theory, particularly that willingness to pay should have a non-negative lower bound and an upper bound no greater than income (Haab and McConnell 1998).[18]

**Double-Bounded Referendum: Ardila**

In 1993, in the analysis of the Guaiba Watershed management Program (Project No. 7) Ardila (1993) introduced Hanemann et al's (1991) application of the double-bounded variant of referendum CVM. Rather than just asking respondents whether they would or would not be willing to pay a stipulated amount for a proposed water quality improvement, the double-bounded approach adds a follow-up question, which raises the payment amount for those who accepted the initial proposal and lowers it for those who did not, and asks a follow-up accept/reject question. The advantage of the approach is that at a given sample size it yields a more precise estimate (reduces the variance) of the expected value of WTP. Put otherwise, the sample size (and hence survey cost) needed to achieve a given degree of precision can be lowered by using two plays of the referendum game rather than one.

This approach has occasionally been used since, but it is not possible to determine how often because the descriptions of methods used are very terse in most official project documents. Apparently, however, it has not always met with success, because respondents, who put full faith in the realism of the initial play of the game, become confused and suspicious when the initial offer is altered in the second play (Quiroga, Personal Communication). For this reason, in Project 16 (Lake Managua) only a single-bounded model was fit although double-bounded data were collected.[19]

**Valuing Alternative States of the World: Ardila**

One of the major analysis issues revealed by our discussions with Bank staff is that of maintaining consistency between the actual effect of the project on water quality and the outcome that is described and valued in a CVM experiment used to generate project benefits. Obviously, if CVM survey respondents think they are paying for a greater degree of water quality improvement than the project will actually be able to supply, a form of benefits inflation sets in that makes economic justification pro-forma. This can be a "trick" if it is premeditated, or a "trap" if it is the inadvertent result of poor communication between the project economist and the environmental engineers in charge of modeling the project's effect on water quality.

A mismatch between benefits and achievements can also arise from a last-minute scaling back of project objectives because of, say, financial constraints, after the CVM exercise had already been conducted for the original, more ambitious, design. It can also be a product of CVM benefit estimation for the

[18] Creel (1998) sounds a more optimistic note by demonstrating that the marginal expected value of willingness to pay, truncated from below at zero and from above at a maximum that drives the probability of acceptance to zero can be consistently estimated from the simplest possible logit model (intercept and price parameters only) providing the bids are spread uniformly between the upper and lower bounds, the upper bound is known a-priori, and the acceptance probability is integrated only up to the upper bound in calculating the mean.

[19] Alberini et al. (1997) present modeling strategies to detect the possibilities of random response shocks, structural shifts in WTP, and heteroskedasticity between and within the responses to dichotomous choice CV surveys with follow-up questions. The final WTP result will depend on the analyst's acumen, since "Ultimately, the decision as to which model specification is most appropriate should be based on the *researcher's judgement* about the possible incentives generated by the particular CV survey instrument being analyzed" (p. 323, emphasis added).

ultimate outcome of a long-term, multi-stage program, of which the IDB-financed project is just a part or a first stage.

One way to deal with this potential problem is to anticipate it by conducting several independent CVM surveys to value alternative "states of the natural world" to rough-out a step-wise approximation to benefits as a function of varying levels of AEQ. The analyses for the Rio Bogota Wastewater Treatment Plant and the Basic Sanitation Program for the Guanabara Bay Basin projects in Colombia (Ardila, personal communication) attempted this. Another route is to conduct contingent choice experiments to produce continuous value functions for the various water quality attributes the project effects (an approach described in the literature by Mazotta et al. 1998, and Adamowicz et al. 1998, but never employed by the IDB in project analysis).[20]

When the analyst must improvise to correct for a mismatch, Ardila's analysis of the Guiaba Watershed Management Program suggests a quick and dirty way out. Figure 1 below displays the calculation done for two treatment plants that will be built to improve the quality of the Gravati river in Brazil. The CV benefits are associated with a state of the world (Level II quality designation which basically amounts to water fit for contact recreation–e.g. swimmable quality) the project will not attain overall, but only for a few hundred meters along selected stretches.

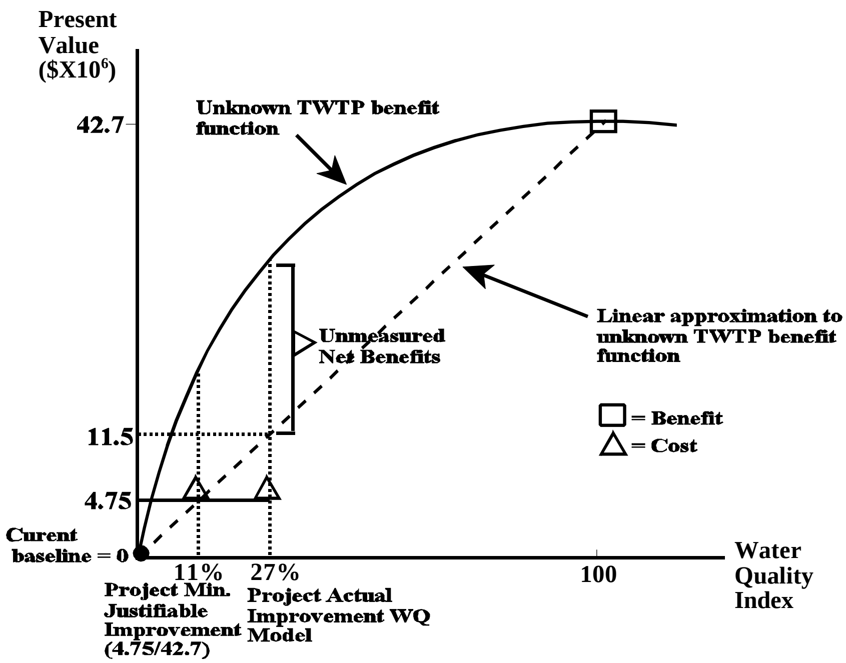
To reconcile the project's limited achievements in the first stage with the ultimate Level II goal of a multi-stage program, the benefits of the entire program were scaled back using a linear approximation to the concave, unknown total willingness to pay function for water quality, indexing Level II as 100% improvement. This linearization by definition understates benefits, assuming diminishing marginal willingness to pay. As shown in the Figure, the PV of known costs ($4.75 million) would just offset benefits if water quality improved from the baseline polluted condition by 11%. However, water quality model runs forecast a weighted average quality improvement of 27% could be achieved by the project, which suggests gross discounted benefits of at least $11.5 million, or net benefits greater than $6.75 million (US$11.5 million minus US$4.75 million).

**Combined Methods: Niklitschek and Leon**

The work of IDB economists Niklitschek and Leon (1996) shows how to obtain an estimate of the total value of rehabilitating a recreational resource by combining hypothetical market and observed direct recreational use information. The authors demonstrate the approach by estimating an econometric model from survey data on value and use of ocean and bay beaches in a major metropolitan area in Latin America. Their technique allows use and non-use values to be distinguished. The integrated econometric model can be evaluated to compute the effects of a beach carrying capacity constraint in terms of the equilibrium entry fee it implies, the reduction in household benefits it imposes, and the potential revenue that can be collected under a fee regime rather than unrestricted access. It should be acknowledged that much simpler routes to benefits were actually taken in analyzing the project for which the data were collected; Niklitschek and Leon's published article went far beyond what normally can be expected or is found in applied project analysis.

[20] Malarin and Vaughan (1998) illustrate how it *might* be applied to assess environmental damages of solid waste landfills using a didactic integer programming model for optimal site selection.

**Figure 1**




**Introducing Hypothetical Choice Questions to Augment Information: Ardila and Provencher**

The analysis of two projects (recreation in Mexico City and potable water in the Family Islands of the Bahamas) required the introduction of contingent choice (rather than value) questions to generate the information required to estimate willingness to pay.

In the case of Mexico City, the problem was framed as a contingent travel cost model in which respondents were asked the number of trips they would take to new proposed parks, given the availability of existing alternatives. Hypothetical entrance fees to the new park were varied to identify price effects. Estimation was done following conventional practice for travel cost surveys conducted at the point of origin (i.e. many respondents do not intend to visit so Tobit estimation is required) and willingness to pay was estimated following procedures suggested by Hellerstein (1992).

In the case of the Family Islands, the proposed project would improve the quality of potable water being provided to households by reducing salinity and increasing pressure. Most households currently receive poor service but their consumption is metered and they pay the same increasing block rate tariff. To avoid problems created by small price variability and to obtain information on the impact of higher quality water, Ardila and William Provencher of the University of Wisconsin designed a survey asking a hypothetical question: *If water of a particular quality (i.e. salinity and/or system pressure) were provided at a given average price would the household consume more water than it currently does?*

A maximum likelihood formulation for demand estimation combined information from actual consumption (i.e. household price/quantity pairs and socioeconomic characteristics) and the yes/no answer to the hypothetical quality question. Although the small size of the survey precluded obtaining statistically significant results in this application, it is believed that some variant of this approach could render positive results in the future.

## Sensitivity Analysis

Most of the sensitivity exercises conducted have been of the standard decision reversal type, taking key variables like investment cost, operation and maintenance cost, benefits en toto or by category, rate of population growth, postponement, etc. and asking what percentage changes in baseline costs and benefits would drive the economic rate of return (EIRR) below 12% (or make net present value negative at a 12% discount rate). Along a similar line, sometimes arbitrary changes in the same variables have been posited and their effect on EIRR reported. These approaches give a rough, subjective impression of whether the project's economic viability is robust to "small" changes in cost and benefit streams or the variables underlying them, taken one at a time. It does not define what "small" is, nor does it consider the possibility of the joint occurrence of several unfavorable events.

In our water project sample, there are three innovative analyses that go beyond this conventional sensitivity approach; two that explicitly incorporate the variance in statistically estimated benefits to construct a probabilistic statement about the magnitude of the benefit streams, and one that undertakes a full Monte Carlo risk analysis.[21]

[21] While risk analysis was performed for in the economic feasibility analysis of at least two other projects in our sample (Project Nos. 2 and 10 in the Annexes), it was not discussed or referenced in the official project documents we used to characterize the technical and economic project appraisals (see footnote 1 above). The omission of any systematic discussion of project risk suggests that there may be some difficulties in communicating Monte Carlo results to decision makers who are not familiar with the technique, or, more speculatively, that some decision makers prefer unqualified "bottom line" answers unencumbered by subjective probabilistic assessments of the likelihood that expectations will, in fact, be realized.

### The Distribution of Benefits: Ardila and Savedoff

In the economic analysis of the Guaiba Watershed Management Program, a sensitivity analysis was performed using the empirical distribution function of expected benefits. As explained in Ardila 1993, this distribution was generated from the econometric estimate of a logistic probability of acceptance function estimated from survey data positing a referendum offer to supply improved environmental quality over a range of payments. The probability of acceptance function can be transformed into an expression for the expected value of willingness to pay, which depends on the parameter estimates of the logistic that are random variables. Repeated evaluation of this expected willingness to pay function over a large number of draws from the distributions of the parameter estimates (holding the explanatory variables fixed at representative levels) produces a bootstrap estimate of the empirical distribution function of expected benefits per household. With this empirical household benefits distribution in hand, sensitivity-type statements can be made about the probability of aggregate benefits being above the critical value required for project acceptance.

The report on the Basic Infrastructure and Sanitation Program in Fortaleza also contains information on the EIRR under reductions in per household benefits of one and two standard deviations. Unlike the Ardila (1993) bootstrap approach, the variance of willingness in this case was approximated with a first order Taylor series expansion (Savedoff, personal communication and Savedoff 1992). Although this innovation antedated the Ardila application, which was undertaken independently, the 1992 Fortaleza economic analysis background paper was not widely distributed, and did not elaborate on how to derive and apply the technique. Analytical and programming details on both the delta (Taylor series) and bootstrap methods for generating the empirical distribution of willingness to pay are carefully elaborated in Hazilla (forthcoming).

**Risk Analysis: Darling, Gomez and Niklitschek**

Monte Carlo risk analysis was creatively employed by Darling et al. (1993) to assess the net benefits of a Barbados South Coast Sewerage Project. While willingness to pay estimates for a public sewer system were available from a contingent valuation exercise, they alone were insufficient to justify the project. Other important categories of benefit involving losses in producer surplus in tourism and fisheries that would be avoided through the project's beneficial effects on coastal water quality and coral reef condition were more difficult to quantify precisely with the data available. Therefore risk analysis was used to generate EIRR and NPV distributions due to lack of information on the empirical relations between water pollution control/coastal water quality and reef condition; fisheries productivity, beach erosion and tourism visits.

Excluding benefits from avoiding tourism declines, but including cost savings from not having to invest in and operate private sewage disposal systems, domestic willingness to pay for cleaner coastal water, health costs avoided due to reduced exposure to contaminated coastal water, fishery benefits and prevention of beach erosion produced a range for the EIRR from -0.2% to 6.6%, and a modal value of about 4%. This range is below the Bank's 12% cutoff. The permanent decline in tourism avoided by maintaining coastal water quality required to raise the IRR to 12% and justify the project was then calculated in a second "what if" step. Without the project, tourism on the whole island would have to decline by 4% to 7% once and for all due to coastal pollution (or, alternatively 10% to 17% in the South Coast only) to raise the EIRR to 12%. The analysis concluded that, given the possibility that without the project the tourism decline could be even greater than 10%, the project's economic feasibility was highly probable.

# Broad Lessons Learned from the Review

In the project analysis context, it is important to recognize that benefits estimation is only one facet of project design; the Bank also has to assure the technical and financial integrity of its projects. Thus, economic benefit estimation methods cannot be viewed in isolation from their purpose–project analysis– nor can scarce project design and development resources be allocated to benefits estimation to the exclusion of all else. Staff economists have many other things to worry about besides benefits estimates (Vaughan et al. 1993). In fact their responsibilities include a host of other administrative and team management activities extending beyond economic analysis, which makes it difficult to stay abreast of cutting edge methodological developments. These realities may partly explain why no examples of the use of non-traditional stated preference methods were discovered in this review. Rather, two sorts of concerns fall out of the accumulated IDB experience with the economic analysis of water quality improvement investments; broad questions related to the definition of the problem setting and specific issues related to working within that setting, once it has been defined.

### Analysis Scope

Paramount among the broad questions is defining the scope of the analysis in the sense of going beyond the immediate project to incorporate the objectives and actions of the longer range program it fits into. Here, we run into the challenges raised by multi-stage programs, particularly whether they can be structured to optimally define the time-phasing for investments that improve AEQ. Temporal scope has an analogue in spatial scope; which involves representing the natural world and the discharge behavior of non-point and point (domestic, commercial and industrial) sources that affect natural world conditions in a basin, and choosing among many ways to improve AEQ, of which any particular project may be but a part. Setting the time dimension aside, that implies integrated empirical modeling strategies that consistently meld and mimic economic and natural world conditions to produce static recipes for the optimal (or efficient) allocation across space of discharge reductions and the public investment part of the total package. Combining the temporal and spatial dimensions to solve for the regional least-cost or net benefit maximizing investment packages over a long planning period of twenty years or more, given assumptions about growth and change (both economic and demographic), is the broadest, and most difficult, problem statement of all.

Most of the projects reviewed do not engage in such heroics, although some have tried to do static regional least cost analysis, a few have tried to explore alternative investment time phasing scenarios, and some have attempted to evaluate the net benefits of alternative levels of treatment, but not on a consistent basis. Usually, the focus of the rest has been much narrower, so the issues that arise pertain mainly to ways to work within that more restricted setting, which could be characterized as a "project-by-project" approach.

### Analysis Technique

Even within the ad-hoc single project approach, ambient environmental quality (AEQ) simulation modeling is critical for establishing the degree of ambient water quality improvement attributable to the project and identifying where the benefits will be registered. If the project treats only domestic wastewater, and industrial dischargers are not obliged to connect to the public sewer system, the project's effects must be separated out from what else is going on (in particular, the effects of other dischargers). To achieve a consistent match between physical project impacts and their valuation, AEQ models are an essential ingredient in project appraisal and a necessary condition for realistic economic analysis (either least cost or benefit-cost). One could easily argue that efforts in this area are as critical to good project design as reasonable benefits estimates produced via CVM, traditional or not.

The decision about which benefit estimation method to use in general seems to have come down pretty firmly on the side of stated, rather than revealed, preference approaches.[22] Having said that, however, it is still true that several specific issues remain. Most important, the predicted natural world effects of a water quality improvement project must be matched with the benefit scenario(s) portrayed in a CVM survey used to generate gross benefits. Many of the projects reviewed produce rather modest AEQ improvements because they work on a very degraded baseline under a hard budget constraint. While CVM may be able to accurately detect WTP for very modest improvements, very few "multiple states of the world" CVM exercises have been done by the Bank in order to verify that belief or help decide on the extent of treatment and AEQ improvement. Rather, benefits estimates for the program en toto sometimes have had to be scaled back to produce the benefits of less ambitious specific project components.

[22] In commenting on an earlier draft of this paper, Ducci (1998) succinctly put the Bank's experience with CV and hedonics in perspective: "Survey data for hedonics is much cheaper than CV as the latter requires focus groups, pilots, better trained interviewers, etc. We usually quote CV surveys at US$25 per questionnaire, while a comparable hedonic might be US$15 per questionnaire. It used to be, however, that the time spent in the econometrics of hedonic models was large (to be able to torture the data to provide a decent coefficient) while for the CV a simple logit was sufficient. Nowadays the econometrics of CV has also grown, with double bounded models, Monte Carlo simulations or bootstrapping for variances, and other novelties. In the end hedonics is much cheaper but more unreliable with respect to whether you will be able to get a usable result."

Benefits transfer based on CV results has been uncommon in Bank applications. But, some specific investment project analyses have used ad-hoc transfers to, for instance, apply WTP estimates based on surveys taken in one part of a metropolitan area to other non-surveyed neighborhoods. Global multiple works programs involving many investment projects in many cities have sometimes based benefits on a sample from a few cities, because the cost of doing valuation surveys in every metropolitan location would be prohibitive.

By beginning to systematically collect CVM benefit estimates in a data base the Bank could, after enough observations accumulate, undertake a statistical meta-analysis. It would relate benefits per household to the type of benefit (i.e. sewer connection, general ambient water quality improvement etc.), the magnitude of change being valued, the average income level and other socioeconomic characteristics of the respondents and the characteristics of the method used (e.g. open ended, single bounded or double bounded CV, hedonic analysis, etc.). The estimated benefit function could be used as a benefits transfer shortcut for pre-feasibility screening, environmental impact damage assessment, and global multiple works project valuation.

Finally, sensitivity analysis has been handled in routine fashion in most IDB water quality projects.[23] But, some of the innovative applications mentioned above suggest that these projects are inherently uncertain because the natural world is not deterministic and because benefits estimates are random variables rather than fixed values having zero variance. While perhaps out of fashion among practitioners of economic project analysis, risk analyses can be constructed that incorporate information on the distribution of benefits as well as historically derived information on cost and execution performance to show their separate and combined effects. Again, efforts along this line may improve decision-making in the Bank as much or more than an exclusive focus on CVM techniques

[23] This is true more generally across sectors. See Vaughan et al. 1993.

ever could. They can provide a more realistic view of project promise and risk than the traditional touting of a single (NPV or IRR) number, with its misleading aura of exactitude and the bottom line, take it or leave it attitude that a false sense of precision inspires.

# Concluding Observations

### The IDB Context

The IDB is a financial, not a research institution. While it does finance research activities undertaken in its borrowing member countries, the main use of CV for its own purposes is to establish the economic viability of the investment projects it approves for financing. Therefore, the Bank tends not to engage in very early testing of frontier, innovative techniques or in developing them on its own. Instead it adopts, adapts and disseminates new methods once it can be reasonably established that they are as good or better than the existing approaches it customarily uses. For example, even in the late 1980s CV was just moving from an experimental, prototype approach into an initial implementation stage (Mitchell and Carson 1987). But, at that time, after some trial experimentation with CV in ex-post analysis, the Bank moved fairly quickly to apply CV on a more routine basis in ex-ante analysis once its advantages over other approaches in project analysis (like hedonics) became clear.

If this paper had been prepared ten years ago, and had the topic been conventional CV, the Bank would not have had much to say. Now it does. Ten years hence, we may have acquired the experience with non-traditional CV methods that we currently lack. But for that to happen pressing needs or genuine opportunities for Bank applications must arise that cannot be satisfactorily handled using the more familiar "standard" methods. We can only speculate what these might be.

In the water quality context, a closer look at contingent choice (Mazotta et al. 1998), contingent ranking or multiple scenario methods (explored some years ago in Smith and Desvouges 1986) may be worth reconsidering in cases where an approximation to a benefits function rather than a benefits point or single state of the world is desired to sort out local from global project design optima. The valuation of public preferences regarding controversial IDB investments that may impose non-monetized damages on surrounding communities is another potentially important application area, as demonstrated in Malarin and Vaughan (1998), which draws on the innovative work of Swallow et al. (1992, 1994) and Opaluch et al. (1993). Other possibilities are less clear. Some may stem from IDB support for attempts to place values on interventions in multiple problem areas or media (air pollution, water pollution, solid waste disposal, protected area preservation) to facilitate environmental priority setting at the national and local levels in its borrowing member countries.

In sum, are opportunities for the application of non-traditional CVM techniques important to economists at the IDB? Certainly, but mainly in situations where tried and true methods, for whatever reason, can't be applied. Realistically, from the agency perspective, everyday practitioners tend to exercise caution when the academic literature provides no clear path.[24] Under these circumstances there is a serious downside risk to hasty innovation; using unproven techniques when millions of dollars are at stake can

[24] Adoption of innovations from the world of research is made more difficult for everyday practitioners when the alternative routes are many and the path through them unclear. However, we do not mean to suggest that *research* on stated valuation approaches should be bound by a straightjacket of rules and approved protocols that stifle innovation and progress. Randall (1997) forcefully argues that the NOAA panel guidelines for CV did not usher in a new era of standardization. Rather, he believes an era of experimentation and a proliferation of methods has begun which is likely to have more desirable consequences than a "narrowly standardized and stylized CV method". While standardization may not encourage creativity, it is comforting and even desirable in bureaucratic settings because, if it clearly defines what is minimally acceptable, in so doing it clarifies what is bogus and therefore cannot reasonably be believed, accepted or supported.

endanger the welfare of the client and the reputation of the analyst. However, there are several economic analysis challenges that have not yet been satisfactorily met, and some of the answers may come from newer or better methods.

### Emerging Needs

The successful incorporation of economic analysis criteria into the appraisal of environmental projects has in part been responsible for the emergence of new, more complex projects in this field. These new projects pose new challenges to project economists and, at the same time, they have revived some old controversies. Some of the main areas of concern are:

- Economic analysis deals not only with a yes/no decision on funding a particular project, but also with identifying the most desirable project scale and design features (e.g. for a wastewater treatment plant, how big the project should be in flow terms and what some of its main design characteristics should be in terms of the degree of residuals removal and the type of treatment). Our ability to provide better answers to some of these questions hinges on the possibility of having willingness to pay functions that are sensitive to varying levels of several quality attributes. Estimating these functions can be a more expensive and complex problem than obtaining a single value for a particular quality level.

- Closely related to the previous theme is the question of what is the best initial stage for a project that may be too expensive to be accomplished in a single step. This question is important not only in the time dimension (i.e. how big should the first stage be and when should it start) but also in the space dimension (i.e. where should we locate the first wastewater treatment plant for a large city?).

- As environmental projects have become more complex, it is understood that they must deal with the multiple dimensions of so called environmental goods, so economists at the Bank face the difficult tasks of valuing attributes and alternative combinations of attributes rather than single packages. For example, in the case of water pollution control, the typical question is how much money and effort should be devoted to solve pollution problems associated with dissolved oxygen deficits as opposed to problems posed by a number of toxic substances.

- Countries in the region have stepped up their efforts to solve environmental problems and have started using direct survey valuation techniques. But, the danger exists that the perceived simplicity of applying stated preference surveys and obtaining economic values from them could lead to casual use, or even significant misuse and misleading answers. Therefore, efforts to generate application guidelines (e.g. Ardila, 1993; Hazilla, forthcoming) and make them widely available are urgently needed.

## *Annex 1 : CHARACTERISTICS OF THE SPECIFIC INVESTMENT PROJECTS*

| **PROJECT #** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** | ***12*** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COUNTRY** | AR | AR | BA | BR | BR | BR | BR | CO | CO | CO | EC | EC |
| **APPROVAL YEAR** | 93 | 97 | 92 | 92 | 92 | 93 | 93 | 93 | 97 | 98 | 90 | 94 |
| ***TYPES OF WATER BODIES AFFECTED [a]*** | | | | | | | | | | | | |
| Freshwater Streams/Rivers | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| Lakes/Reservoirs | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Coastal Marine Waters/Bays/Estuaries | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| Groundwater | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***COMPONENTS [a,b,c]*** | | | | | | | | | | | | |
| Potable Water | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 |
| Flood Control | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sewer/Drainage | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| Deepwater Outfall | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Pretreatment | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| Primary Treatment | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| Secondary Treatment | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| **TOTAL NOMINAL ORIGINAL COST** (Million Nominal US$) | 280 | 500 | 73 | 266 | 900 | 793 | 220 | 232 | 125 | 40 | 57 | 170 |

**NOTES:**

a. 1= yes; 0=no or unclear

b. Highest level of treatment indicated as 1if all plants have the same technology (e.g. primary plus secondary is scored 0 for primary, 1 for secondary). If several treatment plants are built with different technologies, both primary and secondary are indicated as 1.

c. Projects 4, 10, 17 and 18 use an existing underwater outfall.

d. Total Project costs include components other than treatment costs

## *Annex 1 : CHARACTERISTICS OF THE SPECIFIC INVESTMENT PROJECTS* (Continued)

| PROJECT # | *13* | *14* | *15* | *16* | *17* | *18* | *TYPE I* |
|---|---|---|---|---|---|---|---|
| **COUNTRY** | GU | ME | ME | NI | UR | UR | ***TOTAL*** |
| **APPROVAL YEAR** | 96 | 90 | 94 | 96 | 89 | 96 | |
| ***TYPES OF WATER BODIES AFFECTED*** [a] | | | | | | | |
| Freshwater Streams/Rivers | 1 | 1 | 1 | 1 | 1 | 1 | 16 |
| Lakes/Reservoirs | 1 | 0 | 0 | 1 | 0 | 0 | 5 |
| Coastal Marine Waters/Bays/Estuaries | 0 | 0 | 0 | 0 | 1 | 1 | 7 |
| Groundwater | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| ***COMPONENTS*** [a,b,c] | | | | | | | |
| Potable Water | 0 | 1 | 1 | 0 | 0 | 0 | 6 |
| Flood Control | 0 | 0 | 0 | 0 | 1 | 1 | 4 |
| Sewer/Drainage | 1 | 1 | 1 | 1 | 1 | 1 | 16 |
| Deepwater Outfall | 0 | 0 | 0 | 0 | 1 | 1 | 6 |
| Pretreatment | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Primary Treatment | 1 | 0 | 0 | 0 | 0 | 0 | 5 |
| Secondary Treatment | 1 | 1 | 1 | 1 | 0 | 0 | 10 |
| **TOTAL NOMINAL ORIGINAL COST** (Million Nominal US$) | 35 | 650 | 282 | 47 | 33 | 219 | 4922 |

**NOTES:**

a. 1= yes; 0=no or unclear

b. Highest level of treatment indicated as 1if all plants have the same technology (e.g. primary plus secondary is scored 0 for primary, 1 for secondary). If several treatment plants are built with different technologies, both primary and secondary are indicated as 1.

c. Projects 4, 10, 17 and 18 use an existing underwater outfall.

d. Total Project costs include components other than treatment costs

## *Annex 2: BASELINE INFORMATION AND AEQ IMPACT FOR THE SPECIFIC INVESTMENT PROJECTS*

| **PROJECT #** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **COUNTRY** | AR | AR | BA | BR | BR | BR | BR | CO | CO | CO | EC |
| **APPROVAL YEAR** | 93 | 97 | 92 | 92 | 92 | 93 | 93 | 93 | 97 | 98 | 90 |
| ***BASELINE INFORMATION*** | | | | | | | | | | | |
| AEQ Monitoring Information (available or included in project) | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Industrial Discharge Inventory (available or included in project) | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| ***DISCHARGE REDUCTION TARGETS*** | | | | | | | | | | | |
| Industrial/Commercial Control (including any complementary programs, financed or not) | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Domestic Collection/Treatment | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| *Pollutants Targeted by Treatment* | | | | | | | | | | | |
| BOD | 1 | NA | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| COD | 0 | NA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fecal or Total Coliforms | 0 | NA | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| Nutrients (eg. nitrogen, phosphorus) | | NA | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Others (eg. suspended solids, oil, grease, heavy metals, etc) | 0 | NA | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| *% Removal of Pollutants Specified?* | | | | | | | | | | | |
| BOD % | 95 | | | | 38 | 40-90 | | | 40 | | |
| Coliforms % | | | | | 38 | 90-99 | | | | | |
| ***AEQ TARGETS*** | | | | | | | | | | | |
| AEQ Standards Specified? | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| Contribution of project to achieve standards (1=full; 0=partial; U=unclear) | 0 | U | 1 | U | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Use of water quality models to simulate AEQ impacts (1=yes; 0=no or unclear) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

NOTE: 1=yes; 0=no or unclear NA indicates projects without treatment plant components

## *Annex 2: BASELINE INFORMATION AND AEQ IMPACT FOR THE SPECIFIC INVESTMENT PROJECTS* **(Continued)**

| **PROJECT #** | ***12*** | ***13*** | ***14*** | ***15*** | ***16*** | ***17*** | ***18*** | ***TYPE I*** |
|---|---|---|---|---|---|---|---|---|
| **COUNTRY** | EC | GU | ME | ME | NI | UR | UR | ***TOTAL*** |
| **APPROVAL YEAR** | 94 | 96 | 90 | 94 | 96 | 89 | 96 | |
| ***BASELINE INFORMATION*** | | | | | | | | |
| AEQ Monitoring Information (available or included in project) | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 13 |
| Industrial Discharge Inventory (available or included in project) | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 12 |
| ***DISCHARGE REDUCTION TARGETS*** | | | | | | | | |
| Industrial/Commercial Control (including any complementary programs, financed or not) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 17 |
| Domestic Collection/Treatment | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 17 |
| *Pollutants Targeted by Treatment* | | | | | | | | |
| BOD | 0 | 1 | 0 | 1 | 1 | NA | NA | 10 |
| COD | 0 | 0 | 0 | 0 | 1 | NA | NA | 1 |
| Fecal or Total Coliforms | 0 | 1 | 0 | 0 | 1 | NA | NA | 10 |
| Nutrients (eg. nitrogen, phosphorus) | 0 | 0 | 0 | 1 | 0 | NA | NA | 5 |
| Others (eg. suspended solids, oil, grease, heavy metals, etc) | 0 | 0 | 0 | 0 | 1 | NA | NA | 4 |
| *% Removal of Pollutants Specified?* | | | | | | | | |
| BOD % | | | | 70 | 71 | | | |
| Coliforms % | | | | | 99.95 | | | |
| ***AEQ TARGETS*** | | | | | | | | 12 |
| AEQ Standards Specified? | 0 | 0 | 1 | 1 | 1 | 1 | 0 | |
| Contribution of project to achieve standards (1=full; 0=partial; U=unclear) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Use of water quality models to simulate AEQ impacts (1=yes; 0=no or unclear) | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 14 |

NOTE: 1=yes; 0=no or unclear NA indicates projects without treatment plant components

## *Annex 3 : ECONOMIC ANALYSIS FEATURES OF THE SPECIFIC INVESTMENT PROJECTS*

| **PROJECT #** | ***1*** | ***2*** | ***3*** | ***4*** | ***5*** | ***6*** | ***7*** | ***8*** | ***9*** | ***10*** | ***11*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **COUNTRY** | AR | AR | BA | BR | BR | BR | BR | CO | CO | CO | EC |
| **APPROVAL YEAR** | 93 | 97 | 92 | 92 | 92 | 93 | 93 | 93 | 97 | 98 | 90 |
| Single or Multi-Stage (0=single; 1=multi-stage; U = Unclear) | 1 | U | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ***TYPE OF ANALYSIS*** | | | | | | | | | | | |
| Regional AEQ Cost Minimization | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| Cost-Effectiveness/Technology Standard | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| *Cost/Benefit of* | | | | | | | | | | | |
| Sewer and/or Flood Control | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| Treatment | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| ***MAJOR TYPES OF BENEFIT AND METHODOLOGY*** | | | | | | | | | | | |
| Total Economic Value (Generic) of AEQ Improvement | 0 | 0 | 0 | 0 | 0 | CV-D | CV-D | CV-D | 0 | CV-D | H-D |
| Aesthetics and Odor Elimination/Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | CV-D | 0 | 0 |
| Sewer Connection/Method | 0 | 0 | CV-D | CV-D | CV-D | CV-A | CV-D | CV-D | 0 | CV-D | RP-D |
| Health/Method | 0 | 0 | CA-A | 0 | 0 | 0 | 0 | 0 | CV-D | 0 | 0 |
| Recreation/Method | 0 | 0 | CV-D | 0 | 0 | CV-D | 0 | 0 | 0 | 0 | 0 |
| Agriculture/Irrigation Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | PS-A | 0 | 0 |
| Tourism/Method | 0 | 0 | PS-A | 0 | 0 | PS-A | 0 | 0 | 0 | 0 | 0 |
| Systems Cost Savings | 0 | 0 | CA-D | 0 | 0 | 0 | 0 | CA-D | CA-D | 0 | 0 |
| Fishery/Method | 0 | 0 | PS-A | 0 | 0 | PS-A | 0 | 0 | 0 | 0 | 0 |
| Erosion or Property Damage/Method | | | CA-A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Sensitivity* | 0 | 0 | R | R | S | 0 | R | S | S | S | S |

NOTE : 1=yes; 0=no or unclear. Benefit Method type codes are: CV = Contingent Valuation; TC = Travel Cost or other participation models; H = Hedonics; PS = Producer Surplus; CA = Cost or Damage Avoided/Averting Expenditure; RP = Revealed Preference, Demand Function Estimation. Information codes are A = mainly by assumption or benefit transfer; D = based on project-specific data from surveys or other sources. Sensitivity method codes are R = risk-based and S = standard-either arbitrary % changes in cost and benefits flows or solution for % changes that make the project economically unviable

* Last in four stages of IDB projects, thus analytically similar to a single stage.

## *Annex 3 : ECONOMIC ANALYSIS FEATURES OF THE SPECIFIC INVESTMENT PROJECTS* **(Continued)**

| **PROJECT #** | ***12*** | ***13*** | ***14*** | ***15*** | ***16*** | ***17*** | ***18*** | |
|---|---|---|---|---|---|---|---|---|
| **COUNTRY** | EC | GU | ME | ME | NI | UR | UR | ***TOT.*** |
| **APPROVAL YEAR** | 94 | 96 | 90 | 94 | 96 | 89 | 96 | |
| Single or Multi-Stage (0=single; 1=multi-stage; U = Unclear) | 1 | 0 | 1* | 1 | 1 | 1 | 1 | 13 |
| ***TYPE OF ANALYSIS*** | | | | | | | 0 | |
| Regional AEQ Cost Minimization | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Cost-Effectiveness/Technology Standard | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 15 |
| *Cost/Benefit of* | | | | | | | | |
| Sewer and/or Flood Control | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 12 |
| Treatment | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 11 |
| ***MAJOR TYPES OF BENEFIT AND METHODOLOGY*** | | | | | | | | |
| Total Economic Value (Generic) of AEQ Improvement | 0 | 0 | 0 | CV-D | CV-D | CV-D | 0 | |
| Aesthetics and Odor Elimination/Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Sewer Connection/Method | CV-D | 0 | 0 | 0 | 0 | CV-D | CV-D | |
| Health/Method | 0 | 0 | 0 | 0 | CA-D | 0 | 0 | |
| Recreation/Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Agriculture/Irrigation Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Tourism/Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Systems Cost Savings | 0 | CA-D | 0 | CA-D | 0 | | 0 | |
| Fishery/Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Erosion or Property Damage/Method | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| *Sensitivity* | 0 | S | 0 | 0 | 0 | S | S | |

NOTE : 1=yes; 0=no or unclear. Benefit Method type codes are: CV = Contingent Valuation; TC = Travel Cost or other participation models; H = Hedonics; PS = Producer Surplus; CA = Cost or Damage Avoided/Averting Expenditure; RP = Revealed Preference, Demand Function Estimation. Information codes are A = mainly by assumption or benefit transfer; D = based on project-specific data from surveys or other sources. Sensitivity method codes are R = risk-based and S = standard-either arbitrary % changes in cost and benefits flows or solution for % changes that make the project economically unviable

* Last in four stages of IDB projects, thus analytically similar to a single stage.

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