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Policy Forum

Introduction: benefit–cost analysis and the environment in developing countries

In one sense, everyone making a decision of any consequence uses something very like benefit–cost analysis. That is, they weigh up the pros and cons of the options confronting them and decide between them accordingly. Benefit–cost analysis is merely one systematic way of evaluating the economically relevant pros and cons of various options. The authors of the project appraisal manuals of the early 1970s (Mishan, 1971; Dasgupta *et al*., 1972; Pearce, 1972; Little and Mirrlees, 1974) were interested in establishing a set of rules that might ensure that the results of distinct social investment decisions would be efficient (or at least consistent). On the surface, the paper by Arrow *et al.* (1996) that is the focus of this forum merely argues for an extension of benefit–cost rules to an area where, as David Pearce points out in his commentary, policy-making tends to be dominated by hasty, ill-conceived, *ad hoc* responses to the pressures of the moment. The paper argues that environmental, health and safety regulations in the US could and should be informed by an analysis of their economically relevant costs and benefits.

What makes the paper particularly interesting is its being written at a time when benefit–cost analysis is itself being re-evaluated—not least because application of the 1970s rules to transboundary problems such as climate change produces some very uncomfortable results. It is not at all clear, as a number of commentators point out, that we are in a very good position to estimate the value of many environmental impacts of economic activity or to deal with differences in valuation deriving from differences in income. Nor is it clear, as Graciela Chichilnisky argues in her commentary, that all future costs and benefits should be discounted at a constant rate, or even that they should be discounted at all.

The authors of the commentaries in this forum were invited to consider the implications of the Arrow *et al.* paper for the formation of environmental policy and environmental regulation in the developing countries. All have a strong professional concern with the environmental consequences of economic activity, and a deep understanding of the process of economic development. But the basis for their professional concern differs, and this is reflected in the commentaries. Together, they offer a very thought-provoking and sobering review of one of the key problems in the economics of the global environment.

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References
Arrow, K.J. *et al.* (1996), 'Is there a role for benefit–cost analysis in environmental, health, and safety regulation?' *Science* **272**: 221–222.
Dasgupta, P., S. Marglin and A.K. Sen (1972), *Guidelines for Project Evaluation*, Vienna: UNIDO.
Little, I. and J. Mirrlees (1974), *Project Appraisal and Planning for Developing Countries*, London: Heinemann.
Mishan, E. (1971), *Cost–Benefit Analysis*, London: Allen and Unwin.
Pearce, D.W. (1972), *Cost Benefit Analysis*, London: Macmillan.

Is there a role for benefit–cost analysis in environmental, health, and safety regulation?*

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The growing impact of regulations on the economy has led both Congress and the Administration to search for new ways of reforming the regulatory process. Many of these initiatives call for greater reliance on the use of economic analysis in the development and evaluation of regulations. One specific approach being advocated is benefit–cost analysis, an economic tool for comparing the desirable and undesirable impacts of proposed policies.

For environmental, health, and safety regulation, benefits are typically defined in terms of the value of having a cleaner environment or a safer workplace. Ideally, costs should be measured in the same terms: the losses implied by the increased prices that result from the costs of meeting a regulatory objective. In practice, the costs tend to be measured on the basis of direct compliance costs, with secondary consideration given to indirect costs, such as the value of time spent waiting in a motor vehicle inspection line.

The direct costs of federal environmental, health, and safety regulation appear to be on the order of $200 billion annually, or about the size of all domestic nondefense discretionary spending.[1] The benefits of the regulations are less certain, but evidence suggests that some but not all recent regulations would pass a benefit–cost test.[2] Moreover, a reallocation of expenditures on environmental, health, and safety regulations has the potential to save significant numbers of lives while using fewer resources.[3] The estimated cost per statistical life saved has varied across regulations by a factor of more than $10 million,[4] ranging from an estimated cost of $200,000 per statistical life saved with the Environmental Protection Agency's (EPA's) 1979 trihalomethane drinking water standard to more

[1] T.D. Hopkins, 'Cost of Regulation: Filling in the Gaps' (report prepared for the Regulatory Information Service Center, Rochester, NY, 1992); Office of Management and Budget, *Budget of the United States Government, Fiscal Year 1996* (Government Printing Office, Washington, DC, 1995).

[2] R.W. Hahn, in *Risks, Costs, and Lives Saved: Getting Better Results from Regulation*, R.W. Hahn, Ed. (Oxford Univ. Press, Oxford, and AEI Press, Washington, DC, in press).

[3] J.F. Morrall, *Regulation* **10**, 25 (November–December 1986).

[4] These figures represent the incremental direct cost of part or all of proposed regulations relative to specified baselines. For examinations of issues associated with estimating the full costs of environmental protection, see (16).

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than $6.3 trillion with EPA's 1990 hazardous waste listing for wood-preserving chemicals.[3,5] Thus, a reallocation of priorities among these same regulations could save many more lives at the given cost, or alternatively, save the same number of lives at a much lower cost.[6]

Most economists would argue that economic efficiency, measured as the difference between benefits and costs, ought to be one of the fundamental criteria for evaluating proposed environmental, health, and safety regulations. Because society has limited resources to spend on regulation, benefit–cost analysis can help illuminate the trade-offs involved in making different kinds of social investments. In this regard, it seems almost irresponsible to not conduct such analyses, because they can inform decisions about how scarce resources can be put to the greatest social good. Benefit–cost analysis can also help answer the question of how much regulation is enough. From an efficiency standpoint, the answer to this question is simple: regulate until the incremental benefits from regulation are just offset by the incremental costs. In practice, however, the problem is much more difficult, in large part because of inherent problems in measuring marginal benefits and costs. In addition, concerns about fairness and process may be important noneconomic factors that merit consideration. Regulatory policies inevitably involve winners and losers, even when aggregate benefits exceed aggregate costs.[7]

Over the years, policy-makers have sent mixed signals regarding the use of benefit–cost analysis in policy evaluation. Congress has passed several statutes to protect health, safety, and the environment that effectively preclude the consideration of benefits and costs in the development of certain regulations, even though other statutes actually require the use of benefit–cost analysis.[8] Meanwhile, former presidents Carter, Reagan, and Bush and President Clinton have all introduced formal processes for reviewing economic implications of major environmental, health, and safety

[5] Office of Management and Budget, *Regulatory Program of the United States Government: April 1, 1992–March 31, 1993* (Government Printing Office, Washington, DC, 1993).

[6] If the goals of a program or the level of a particular standard have been specified, economic analysis can still play an important role in evaluating the costs of various approaches for achieving these goals. Too frequently, regulation has used a one-size-fits-all or command-and-control approach to achieve specified goals. Cost-effectiveness analysis, which identifies the minimum-cost means to achieve a given goal, can aid in designing more flexible approaches such as using markets and performance standards that reward results.

[7] L. Lave, in (2).

[8] Several statutes have been interpreted to restrict the ability of regulators to consider benefits and costs. Examples include the Federal Food, Drug, and Cosmetic Act (Delaney Clause); health standards under the Occupational Safety and Health Act; safety regulations from the National Highway and Transportation Safety Agency; the Clean Air Act; the Clean Water Act; the Safe Drinking Water Act; and the Comprehensive Environmental Response, Compensation and Liability Act. On the other hand, the Consumer Product Safety Act, the Toxic Substances Control Act, and the Federal Insecticide, Fungicide, and Rodenticide Act explicitly allow regulators to consider benefits and costs.

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regulations. Apparently the Executive Branch, charged with designing and implementing regulations, has seen a need to develop a yardstick against which the efficiency of regulatory proposals can be assessed. Benefit–cost analysis has been the yardstick of choice.[9]

We suggest that benefit–cost analysis has a potentially important role to play in helping inform regulatory decision-making, although it should not be the sole basis for such decision-making. We offer the following eight principles on the appropriate use of benefit–cost analysis.[10]

(1) *Benefit–cost analysis is useful for comparing the favorable and unfavorable effects of policies.* Benefit–cost analysis can help decision-makers better understand the implications of decisions by identifying and, where appropriate, quantifying the favorable and unfavorable consequences of a proposed policy change, even when information on benefits and costs is highly uncertain. In some cases, however, benefit–cost analysis cannot be used to conclude that the economic benefits of a decision will exceed or fall short of its costs, because there is simply too much uncertainty.

(2) *Decision-makers should not be precluded from considering the economic costs and benefits of different policies in the development of regulations. Agencies should be allowed to use economic analysis to help set regulatory priorities.* Removing statutory prohibitions on the balancing of benefits and costs can help promote more efficient and effective regulation. Congress could further promote more effective use of resources by explicitly asking agencies to consider benefits and costs in formulating their regulatory priorities.

(3) *Benefit–cost analysis should be required for all major regulatory decisions.* Although the precise definition of 'major' requires judgment,[11] this general requirement should be applied to all government agencies. The scale of a benefit–cost analysis should depend on both the stakes involved and the likelihood that the resulting information will affect the ultimate decision. For example, benefit–cost analyses of policies intended to retard or halt depletion of stratospheric ozone were worthwhile because of the large stakes involved and the potential for influencing public policy.

(4) *Although agencies should be required to conduct benefit–cost analyses for major decisions and to explain why they have selected actions for which reliable evidence indicates that expected benefits are significantly less than expected costs, those agencies should not be bound by strict benefit–cost tests.* Factors other than aggregate economic benefits and costs, such as equity within and across generations, may be important in some decisions.

(5) *Benefits and costs of proposed policies should be quantified wherever possible. Best estimates should be presented along with a description of the uncertainties.* In most instances, it should be possible to describe the effects of proposed policy changes in quantitative terms; however, not all impacts

[9] In particular cases, such as the phasing out of lead in gasoline and the banning of certain asbestos products, benefit–cost analysis has played an important role in decision-making (17).

[10] For a more extended discussion, see (18).

[11] In this context, 'major' has traditionally been defined in terms of annual economic impacts on the cost side.

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can be quantified, let alone be given a monetary value. Therefore, care should be taken to assure that quantitative factors do not dominate important qualitative factors in decision-making. If an agency wishes to introduce a 'margin of safety' into a decision, it should do so explicitly.[12]

Whenever possible, values used to quantify benefits and costs in monetary terms should be based on trade-offs that individuals would make, either directly or, as is often the case, indirectly in labor, housing, or other markets.[13] Benefit–cost analysis is premised on the notion that the values to be assigned to program effects—favorable or unfavorable—should be those of the affected individuals, not the values held by economists, moral philosophers, environmentalists, or others.

(6) *The more external review that regulatory analyses receive, the better they are likely to be.* Historically, the U.S. Office of Management and Budget has played a key role in reviewing selected major regulations, particularly those aimed at protecting the environment, health, and safety. Peer review of economic analyses should be used for regulations with potentially large economic impacts.[14] Retrospective assessments of selected regulatory impact analyses should be carried out periodically.

(7) *A core set of economic assumptions should be used in calculating benefits and costs. Key variables include the social discount rate, the value of reducing risks of premature death and accidents, and the values associated with other improvements in health.* It is important to be able to compare results across analyses, and a common set of economic assumptions increases the feasibility of such comparisons. In addition, a common set of appropriate economic assumptions can improve the quality of individual analyses. A single agency should establish a set of default values for typical benefits and costs and should develop a standard format for presenting results.

Both economic efficiency and intergenerational equity require that benefits and costs experienced in future years be given less weight in decision-making than those experienced today. The rate at which future benefits and costs should be discounted to present values will generally not equal the rate of return in private investment. The discount rate should instead be based on how individuals trade off current for future consumption. Given uncertainties in identifying the correct discount rate, it is appropriate to use a range of rates. Ideally, the same range of discount rates should be used in all regulatory analyses.

(8) *Although benefit–cost analysis should focus primarily on the overall relation between benefits and costs, a good analysis will also identify important distributional consequences.* Available data often permit reliable estimation of major

[12] For example, potentially irreversible consequences are not outside the scope of benefit–cost analysis. The combination of irreversibilities and uncertainty can have significant effects on valuation.

[13] For a conceptual overview of methods of estimating the benefits of environmental regulation and a brief survey of empirical estimates, see (19). For examinations of regulatory costs, see (16).

[14] For a description of problems that arise when benefit–cost analysis is used in the absence of standardized peer review, see (20).

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policy impacts on important subgroups of the population.[15] On the other hand, environmental, health, and safety regulations are neither effective nor efficient tools for achieving redistributional goals.

Conclusion. Benefit–cost analysis can play an important role in legislative and regulatory policy debates on protecting and improving health, safety, and the natural environment. Although formal benefit–cost analysis should not be viewed as either necessary or sufficient for designing sensible public policy, it can provide an exceptionally useful framework for consistently organizing disparate information, and in this way, it can greatly improve the process and, hence, the outcome of policy analysis. If properly done, benefit–cost analysis can be of great help to agencies participating in the development of environmental, health, and safety regulations, and it can likewise be useful in evaluating agency decision-making and in shaping statutes.

[15] G.B. Christiansen and T.H. Tietenberg, in *Handbook of Natural Resource and Energy Economics*, A.V. Kneese and J.L. Sweeney, eds. (North-Holland, Amsterdam, 1985), vol. 1, pp. 345–393.

[16] R. Schmalense, *Environmental Goals*, M.B. Kotowski, ed. (American Council for Capital Formation, Center for Policy Research, Washington, DC, 1994), pp. 55–75; A.B. Jaffe, S.R. Peterson, P.R. Portney, R.N. Stavins, *J. Econ. Lit.* **33**, 132 (1995).

[17] A. Fraas, *Law Contemp. Probl.* **54**, 113 (1991).

[18] K.J. Arrow *et al.*, *Benefit–Cost Analysis in Environmental, Health, and Safety Regulation* (AEI Press, Washington, DC, 1996).

[19] M.L. Cropper and W.E. Oates, *J. Econ. Lit.* **30**, 67 (1992); A.M. Freeman, *The Measurement of Environmental and Resource Values* (Resources for the Future, Washington, DC, 1993).

[20] W.N. Grubb, D. Whittington, M. Humphries, in *Environmental Policy Under Reagan's Executive Order. The Role of Benefit–Cost Analysis*, V.K. Smith, ed. (Univ. of North Carolina Press, Chapel Hill, 1984), pp. 121–164.

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The costs and benefits of benefit–cost analysis

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Among the tools of the economic trade, cost–benefit analysis is the most widely used in policy circles. Asking whether there is a role for cost–benefit analysis is like asking whether there is a role for the weatherman. Of course there is.

The analogy is not idle. We need to know the weather, for it causes some of the worst uncertainties known to humans. But it is at least as important to know that the weather service makes errors. We need to know its limitations to take precautions. Errors can be costly. Think of cyclones, droughts and floods. Few of us would fly an airplane in possibly dangerous weather conditions if we did not know the margin of error.

Like weather prediction, cost–benefit analysis can be useful but it can also go wrong. Erroneous cost–benefit analysis can be as damaging as erroneous weather prediction. Both fail when concerned with larger issues. Weather predictions for large areas and for large timescales are unreliable and could be dangerous if taken too seriously. The same holds true with cost–benefit analysis. Climate change is a global version of this problem, and illustrates it well. I come back to this example below.

The article by Arrow *et al.* does a good job of pointing out the uses and limitations of cost–benefit analysis in the small. But it could be strengthened in regard to one of the largest pitfalls of all. Cost–benefit analysis can be dangerous if taken literally on large issues, and on large timescales. Why? Because some of the largest items, such as water resources and their services, are difficult to price. And cost–benefit analysis is based on *pricing* of costs and *pricing* of benefits: each is given a dollar value, and the two numbers are compared. If the number for costs is larger than the number for benefits, then one turns the project down. Otherwise one accepts it. The numbers that weight the different factors entering into costs and benefits are *prices.*

But where do these prices come from? How reliable are they? And how much do they influence the outcome of the cost–benefit analysis?

The prices usually come from markets.[1] However, some of the most important environmental assets have no market prices (see Chichilnisky, 1996b). Think of water across the world, such as the watersheds serving our cities: for example, Chesapeake Bay. Or water-based systems such as

[1] Prices are sometimes obtained through other means, but none is as trustworthy as markets.

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the Everglades. How to price their services? Generally we do not know how. We cannot use market prices, because water is not traded in markets. To give a stark example, if all the water of the US was to dry up next year, using standard cost–benefit tools one may only register a 2 per cent drop in national income, and this would only be because we would account for the fact that plants need water. We do not generally account for the fact that humans need water.

The problem is serious because an error in prices can radically change the results: a project can turn from positive to negative when the wrong prices are applied. When property rights are ill defined, as they are for the most important environmental assets such as water and the atmosphere, prices can be highly inaccurate. International markets in resources do not improve the problem; they can make it worse (see, e.g., Chichilnisky, 1994).

Uncertainties about prices are not flagged in the article by Arrow *et al.* A warning sign with flashing red lights should be placed on all cost–benefit analyses of projects involving some of the most important environmental resources known to humankind: we do not know how to price them. Above I mentioned water; biodiversity is another important case in point, as is the atmosphere of the planet.

Similar problems emerge in doing cost–benefit analysis of projects spanning a long period of time. Here the discount factor is the issue. Anything discounted at a rate of 3–6 per cent becomes meaningless after 50–100 years. The economic income of the entire planet shrinks down to the value of a car when so discounted. Yet some of the most important environmental problems—risks from nuclear power plants, global warming and biodiversity destruction—are only meaningful over such a timescale. The article by Arrows *et al.* says: 'Both economic efficiency and intergenerational equity require that benefits and costs experienced in future years be given less weight in decision-making than those experienced today' (p. 200). This sentence could be dangerous if taken literally; indeed it can be said to be plain wrong. An economist would wish to qualify what is said here, and correct for the wrong inferences that can be drawn from this sentence by thinking of cases where it holds true. I am tempted to do the same. One can think of what the authors meant to say, and when it would hold true. But the sentence is not correct. Discounting the future is neither necessary nor sufficient for efficiency and intergenerational equity. Not at all. Indeed, the opposite can be said to be true. A famous sentence coined in the 1920s by Frank Ramsey, the father of modern intertemporal economic analysis, states: 'Discounting is ethically indefensible and arises from a failure of the imagination.'

All this could be taken into account when doing cost–benefit analysis. Indeed the article by Arrow *et al.* urges policy-makers to take into account uncertainties. However, there is a point that must be emphasized. Economists should be honest with themselves and with their customers, the policy-makers and the physical scientists of the world. There are cases when cost–benefit analysis does not pass muster. It may not pass its own test: the costs induced by uncertainties about prices and discount factors may overwhelm the benefits of using cost–benefit analysis as done today.

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What causes such uncertainties? Perhaps it is the novelty and depth of today's environmental transformation. Change, when it occurs, can be so swift that it stretches the boundaries of any discipline. Environmental changes on the global scale experienced today are new to humankind. For the first time in history, economic activity can change the atmosphere of the planet and transform the complex web of species that constitutes life on earth. Biologists admit today that they do not know the extent of biodiversity on the planet. Physical scientists are unable to predict the impact of forcing gases into the atmosphere. Economists have similar difficulties: they are no exception to the rule.

What to do? Scientific uncertainty need not be a deterrent for action. We know a considerable amount about making policy under conditions of uncertainty, even under conditions of scientific uncertainty. Indeed most human decisions are taken under uncertain conditions. We take precautionary actions, and use financial instruments to hedge and even to induce more conservative behaviour on the part of individuals or countries. Global environmental risks are 'endogenous uncertainty', because they are partly induced by human choices. This is a new type of uncertainty as far as economic analysis is concerned.[2] We can obtain more realistic prices under conditions of uncertainty, such as the value of options for dealing with irreversible losses.[3] Some of these techniques could be applied to standard cost–benefit analysis and make it more realistic. But first we must recognize the extent of the problem, the weakness of cost–benefit analysis as performed today. Then we can develop new, more powerful and realistic tools. These new tools may be interdisciplinary in nature because the environmental problems we face today do not fall within disciplinary boundaries.

An interim solution when prices are suspect is to forget them altogether. It may be better to state that a project is likely to lead to a 50 per cent decline in the quantity of water within an area than to give a dollar value that is meaningless. I took this approach when I introduced the concept of satisfaction of 'basic needs' as a foundation of economic development (see Chichilnisky, 1977a, b). We measured food consumption, education, health and housing of the population in five continents in real terms, without putting an aggregate dollar value to the whole bundle. The reason is simple. Any time one deals with costs and benefits related to the poor, market prices are suspect, precisely because they represent the interests of those who participate in the market and who have money. By definition, therefore, the very poor are not well represented. Avoiding prices in the definition of basic needs has been useful: in 1992 the notion of development addressed to the satisfaction of basic needs was endorsed explicitly by 150 nations in Agenda 21 at the UN Earth Summit of Rio de Janeiro as a foundation for sustainable development.

[2] See, e.g., Chichilnisky (1996c) which studies classic markets facing uncertainty about the probabilities of different events because these probabilities are influenced by human actions.

[3] Arrow and Fischer have written classical articles on this subject. Recent work includes uncertainty about own future preferences (see Beltratti *et al*., 1997).

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With respect to discount factors, we are developing rigorous economic tools that update cost–benefit analysis so it reflects a fair treatment for the present and the future (see Chichilnisky, 1996a; Heal, 1996). This is called 'sustainable' cost–benefit analysis and need not involve the type of discount factors that render long-run problems such as global warming meaningless. The mathematics used in this work is new and challenging. We are advancing with difficulty but we are advancing.

The example of global warming illustrates well the weaknesses of cost–benefit analysis for dealing with global and long-run problems. The Intergovernmental Panel on Climate Change (IPCC) has been concerned for many years with the economic costs of climate change. The cost–benefit analysis for restricting greenhouse gas emissions has been notoriously difficult. Figures derived from the US and projected worldwide underestimate the impacts in regions such as India and China. Furthermore the timescale has led to difficulties; it turns out that two very different emission scenarios have almost the same outcomes for the first fifty years, but differ radically thereafter. In traditional cost–benefit terms, because the differences occur fifty years ahead, the two are indistinguishable. This means that if we used traditional cost–benefit analysis we would only act when it is too late.[4]

Using discounted approaches could be misleading for phenomena which have rapid non-linear responses occurring fifty years into the future, as we showed in the example of global warming. Global systems have built-in inertia, so cost–benefit analysis may only warn us when it is too late. The consequences could be momentous: significant increases in sea level and drastically reduced food production, to name just two.

In a time of environmental change it may be better to accept scientific change, as disruptive as this may appear to be to old-established disciplines. As already mentioned, there are now solid alternatives to discounted cost–benefit analysis, involving 'sustainable' cost–benefit analysis and the insertion of cross-disciplinary or 'real' measures that exceed the standard dollar values of costs and benefits. It is worth the effort. The earth will clearly survive no matter what humans do in the short run. But the survival of many species, including the human species, could be at stake. Better safe than sorry?

References

Beltratti, A., G. Chichilnisky and G. Heal (1997), 'Option values and irreversibilities with uncertainty about future preferences', *in* G. Chichilnisky, G. Heal and S. Vercelli, eds., *Sustainability: Dynamics and Uncertainty*, Dordrecht: Kluwer Academic Publishers.

Chichilnisky, G. (1977a), 'Development patterns and the international order', *Journal of International Affairs* **31**: 275–304.

[4] Cost–benefit analysis based on extrapolating US figures and discounting and averaging the impact, led to a widely discussed figure of 2 per cent loss of GDP from a doubling of carbon dioxide in the atmosphere. In the US the impact of doubling CO_2 emissions is very small; by contrast, in China and India it can lead to a 40 per cent decrease in agricultural production. See Chichilnisky *et al.* (1996).

https://doi.org/10.1017/S1355770X97210168 Published online by Cambridge University Press

Chichilnisky, G. (1977b), 'Economic development and efficiency criteria in the satisfaction of basic needs', *Applied Mathematical Modelling* **1**(6): 290–297.
Chichilnisky, G. (1994), 'North–South trade and the global environment', *American Economic Review* **84**: 851–874.
Chichilnisky, G. (1996a), 'An axiomatic approach to sustainable development', *Social Choice and Welfare* **13**: 231–257.
Chichilnisky, G. (1996b), 'The economic value of the earth's resources', *Trends in Ecology and Evolution*, **11**: 135–139.
Chichilnisky, G. (1996c), 'Markets with endogenous uncertainty: theory and policy', *Theory and Decision* **41**: 99–131.
Chichilnisky, G., V. Gornitz, G. Heal, D. Rind and C. Rosenzweig (1996), 'Building linkages between climate, economic and impact models: a new approach to integrated assessment', NASA–Goddard Institute for Space Studies, Columbia University.
Heal, G. (1996), 'Valuing the future', book ms., Columbia University.

Environmental regulation, benefit–cost analysis and the policy environment in less developed countries*

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The general argument presented by Arrow *et al.* runs as follows: government regulation might improve on free market outcomes, since markets sometimes misallocate resources. However, the costs of regulations need to be assessed against their presumed benefits. Benefit–cost analysis is a valuable technique for making such an assessment, even though it was developed for the appraisal of physical investment projects. However, since the technique is not perfect, it should not provide the only input into the process, but rather be part of an array of evidence.

Few economists or policy-makers concerned with the effective use of scarce resources would take exception to such a balanced view, or to the eight principles Arrow *et al.* offer on the appropriate use of benefit–cost analysis (BCA). In practice, however, we might apply their advice to the

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question whether BCA of the regulations is itself worthwhile. It is not always worth carrying out the investigation needed for fully informed decision-making. Given that such an exercise is not costless, it is only worth undertaking if the benefit from doing so outweighs the costs. Forgetting for the moment the size of the costs, the benefit must be that the decision we make about the regulations is better than the one we would have made in the absence of the BCA. It should lead to us either not regulating when we might but should not (avoiding a type II error), or regulating when we otherwise would not but should (avoiding a type I error). In those cases where the assessment does not change the decision that would have been made in its absence, the resources used are in a sense wasted. *We* might feel happier that we have done the right thing, but decision-makers' happiness probably has a low weight in most social welfare functions. If the assessment increased the number of errors made it would clearly be harmful.

Quantitatively, the net benefit from the changed decision should exceed the cost of the assessment exercise. *A priori* we might expect assessment costs to be of several orders of magnitude less than the impact of regulation/non-regulation. However, since the assessment is likely to matter only in marginal cases, the net benefit of the improved decision may well be small. Furthermore, the assessment costs are incurred up front, while the benefits of the improved decision might be spread many years into the future.

Arrow *et al.*'s argument is made in an American context. Can we transfer them *mutatis mutandis* to developing countries? The foregoing observations raise some speculative possibilities, particularly with regard to environmental regulation, which would lead us to be cautious in doing so.

First, regulation is likely to be a minor ingredient of an overall package to prevent environmental degradation. For many of the poorest countries, the immediate environmental problems—land degradation, siltation, deforestation—arise from population pressure and poverty. It is not clear that regulation should be a major component of policies aimed at such problems. The dispersed nature of the problem makes regulations inherently difficult and costly to enforce. More importantly, these problems will ultimately only be tackled by growth-promoting policies. For example, in Zimbabwe there is legislation, dating from colonial times, controlling stream-bank cultivation, aimed at preventing erosion and siltation. In colonial times, when the majority of the population had a low weight in the government's welfare function, these laws were strictly enforced. With independence they have become less so. In part this is simply because it is politically difficult for a populist government to enforce laws which discriminate against small-scale, undercapitalized agriculturalists, even when the longer-term consequences in terms of land degradation are well known and observable. But it is also because the appropriate solution is investment in irrigation, rural industrialization and other rural growth-promoting projects. The scope for regulation, and therefore for the application of Arrow *et al.*'s advice, is thus likely to be limited.

In principle, of course, regulation and growth promotion are complementary rather than mutually exclusive. But in the context of a tightly

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resource- and personnel-constrained government, they are often in practice substitutes. A non-myopic government will put its resources into growth promotion rather than regulation.

Apart from this essentially practical consideration, it is possible that theoretical problems with BCA and the institutional setting in which it is used in less developed countries could make its use lead us into making more, rather than fewer, errors of the type referred to above. In other words, there may be biases in its application which lead us not to regulate when we should, or to regulate when we should not.

Many regulatory problems entail an asymmetry,with the impact on a large and diffuse group being evaluated against that on a small, more cohesive one. Often this partition coincides with one based on income distribution. The existence of income inequalities poses a well-recognized problem for the use of BCA. Although it is possible to devise weighting systems which incorporate distributional issues into the analysis explicitly, most current practice seems to assess efficiency by treating a dollar cost or benefit as a dollar, regardless of who receives or pays it, and then providing an addendum discussing equity issues. This seems even-handed, but in practice there is often a bias in favour of the 'scientific' quantitative evidence on efficiency and against the qualitative equity assessment. (Indeed, the fact that practitioners make the equity, rather than the efficiency assessment, the addendum suggests this bias is there *ab initio*). Economic measures of the value of time, of health and of life itself are likely to be low for the poor, and efficiency assessments are therefore likely to place a low value on regulations designed to save their time or lives or improve their health. They would be similarly biased in favour of regulations whose costs are borne mostly by the poor. The apparent bias in this approach towards undervaluing impacts on the poor might not matter in relatively egalitarian economies, but is likely to be significant where high income inequalities exist.

This is essentially a problem about whose values are to inform our analysis. Arrow *et al.* argue that BCA 'is premised on the notion that the values to be assigned to program effects—favorable or unfavorable—should be those of the affected individuals, not the values held by economists, moral philosophers, environmentalists, or others' (p. 200). Most would empathize with this implied criticism of those who know what 'the' people want better than those for whom they claim to speak. But a major reason for BCA is precisely that the market fails to reveal appropriate values. The greater the extent of market failure, the more difficult it is to determine the values of those affected. This suggests that the problem will be greater in underdeveloped than in developed economies.

But even when we are able to determine these values, they will reflect the preferences and constraints of the present. Although economists tend to assume that individual preferences are stable over time, they are unlikely to be so in economies undergoing massive structural transformation and growth. Apart from any other changes in tastes and values that might accompany development, we should expect the social discount rate to fall when economies are growing. Whose preferences should we use to evaluate a regulation which prevents me from doing something now which I

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may regret later? Those of my current self? Or those of myself in twenty years when I am richer and (possibly) wiser?

Is there any reason for taking this into account? I am poor today and therefore have a short time horizon. In twenty years I will be better off; and my time horizon will have lengthened. At that time, I may well look back and regret decisions I made now, particularly with regard to non-reversible environmental impacts. Does this matter for our evaluation now? It seems implausible that it should. We do not, by analogy, argue that although a poor family today demands only one loaf of bread, in twenty years time they will demand two, and so we should provide them with two today. But is the analogy correct? Environmental problems are more like wealth. Just as we might have compulsory pension or health insurance schemes to protect individuals from their own myopia, is there not a case for bias in favour of environmental regulation?

We have become sceptical of arguments for government intervention based on the presumed myopia of private agents; but this scepticism appears to arise from our disillusionment with governments, rather than from proof that individuals are not often myopic. An evaluation of regulations which ignores such myopia is likely to be biased against them.

These problems, if they exist, apply equally to developed and underdeveloped economies. However, given the greater extent of distortions and failures, one might speculate that they compromise Arrow *et al.*'s advice more in the latter than the former.

Finally, in transferring Arrow *et al.*'s argument to developing countries, it might be argued that, even if the technique can be accurately applied, the institutional policy-making setting within which it is used makes its use undesirable. Is there a policy analogy with the theory of the second best: given that some flaws in decision-making are irremovable, worse techniques are better than good ones?

Where technical expertise within the policy process is weak, BCA might play an obfuscating role: a qualitative argument, based on political motivations might provide a better outcome than an economic one in which the decision-makers are blinded by science. Lending a pseudo-scientific authority to an argument might tip the scales against the sensible balance that Arrow *et al.* argue for. Further, we should remember that the interested parties in Third World regulations are not simply the citizens of the country; much BCA is used in conjunction with aid-financed projects which involve suppliers from donor countries. In these circumstances a voluminous appraisal, carried out by international experts, using computers, may appear to speak with more authority than badly marshalled protests by the poor and their subversive allies. The balanced approach of Arrow *et al.* might work in a country in which the political process constrains government to pay some attention to what people want, so that there may be political pressures to evaluate what people cannot express through the market. Where this is not the case it is unlikely that the evaluation process will correctly assess the values of the poor. BCA might provide the authoritative voice with which government seeks to rationalize its own agenda in a way which absolves it from moral responsibility: 'we did not want to do this, but it is what the experts advised'.

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This scepticism applies to any policy advice, not simply that given on environmental regulations, and it would be unduly pessimistic (and wrong) to reject all technically based advice. It is at best an argument for caution. Even where advice may be misunderstood or deliberately abused, it may be right to give it. The evolution of a better policy-making environment is a process, and perhaps learning-by-doing is the most important component in this process.

To conclude, the weak link in Arrow *et al.*'s argument is captured in the qualifying phrase they use at the start of the final sentence: 'If properly done, benefit–cost analysis can be of great help to agencies . . .' In the face of some of the structural and institutional constraints alluded to above, can we be sanguine that it *will* be properly done in Third World countries?

Benefit–cost analysis, environment, and health in the developed and developing world

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Arrow *et al.* revisit the case for using benefit–cost analysis in a developed country, the USA, where markets work reasonably efficiently and where the capacity to implement such studies is undoubted. Their recommendations deserve wholehearted support in that context, particularly their recommendation 1 calling for a comparison of gains and losses from regulatory actions. Those who have not worked in government will find that recommendation simplistic. Those who have worked in government will recognise that most decisions are not in fact made with any form of calculus that we might describe as 'cost benefit thinking'. Indeed, the whole process of policy priority setting is all too often *ad hoc*, reactive, crisis-based and over-responsive to often ill-informed pressure groups (of all kinds).

Arrow *et al.* do not ask if benefit–cost is generalizable to the rest of the world, nor do they ask why, if it is such a valuable approach to decision-making, we are still arguing about it nearly thirty years after the early textbooks and manuals on it were produced (e.g. Little and Mirrlees, 1969, 1974; Mishan, 1971; Dasgupta *et al.*, 1972; Pearce, 1972). Until recently, the USA was probably the only country where some form of benefit–cost was mandated for some regulations. It is also probably the only country where

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benefit and damage assessment, i.e. the monetary valuation of benefits or damages, has entered the courts (Kopp and Smith, 1986). Europe has at best had limited skirmishes with the idea of putting damage assessments into quasi-judicial contexts such as public inquiries, whilst Australia's experiment with a Resources Assessment Commission quickly petered out. Nonetheless, benefit–cost has returned to Europe in a major way. Article 130r of the revised Treaty of European Union actually requires the European Commission to carry out some (admittedly unspecified) form of benefit–cost appraisal of its Directives (regulations binding on all member states). Within the United Kingdom, the process of deregulation has been accompanied by the introduction of Regulatory Appraisal (reminiscent of the US Regulatory Impact Assessments) (UK Government, 1996), and the Environment Act 1995 requires the new Environment Agency to have regard for the likely costs and benefits of any regulatory and protective actions. The prospects are therefore for more systematic and better-integrated benefit–cost assessments in Europe, and that is long overdue.

Why, then, has it taken so long for the principles of benefit–cost to be put into practice outside of the USA? Several reasons can be advanced. First, the USA has a longer tradition of applied welfare economics, even though the prime movers in developing what came to be the basic theory of benefit–cost were European (and, more specifically, British: we think of Kaldor and Hicks). The US had already embraced the basic principle of benefit–cost in the Flood Control Act of 1936. Little by way of practice appears in Europe until the early road investment appraisals in the UK in the early 1960s. Second, the USA embraced the whole idea of efficiency in government far earlier than Europe. Europe emerged battered and bruised from the Second World War, and the emphasis thereafter was very much on the public sector as the agent of reconstruction and the agent of welfare protection. The whole free market ethic was some way down the road, and with free enterprise came the emphasis on deregulation. Only now, with a new focus on the unsustainability of the size of public expenditure, has efficiency become a keyword, and 'value for money' become synonymous with benefit–cost appraisal. Third, the US had a long tradition of close links between academic economists and government. In Europe those links tended to be confined to macroeconomic concerns. Consequently, government personnel were not always apprised of the latest thinking in benefit–cost, an essentially applied microeconomics discipline. Fourth, the US quickly developed environmental liability regulations, something that is absent from much of Europe, though threatened now via European Commission Directives. Liability entails an approach to monetary damage estimation. Fifth, there have been setbacks to benefit–cost in Europe and elsewhere. Within the UK the most notable was the Roskill Commission's embrace of benefit–cost in recommending a site for London's third airport in 1969–71. That benefit–cost appeared to dictate an inland site with maximum nuisance to residents struck most (quite rightly) as illogical. Hence benefit–cost was damned. Revisiting that exercise today with the benefit of developments in valuation techniques in the last two decades shows that it was a more than limited exercise: while noise nuisance was valued (through what was effectively a hedonic property price model), air pol-

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lution from aircraft and vehicles was not; nor was loss of amenity—despite mischievous publicity for a suggestion, never adopted, of using fire insurance values to value a Norman church.

As far as Europe is concerned, then, benefit–cost appears finally to have arrived. What of the developing world? The early manuals (Dasgupta *et al.*, 1972; Little and Mirrlees, 1974; Squire and Van der Tak, 1974) were elegant treatises on how to calculate all kinds of shadow prices for everything except environmental assets and services. Indeed, the word environment does not appear in these texts. The emerging modern appreciation that environmental assets and quality are not luxury goods, something that is purchased only when the 'struggle for development' is won, and that they are in fact essential forms of capital for the development process is likely to enhance the role that benefit–cost plays in the developing world. It is very arguable that some nations have pursued and are pursuing unsustainable development paths precisely because they have 'mined' their natural assets without reinvestment in other forms of capital and technology (Pearce *et al.*, 1996). It is only through monetary valuation techniques that a full appreciation of this hypothesis can be secured. But there is still something to be explained. We know that benefit–cost principles were thoroughly worked out in the early manuals, and that project appraisal was (and is) routinely applied by agencies such as the World Bank. Why then has environmental valuation, an essential component of a full benefit–cost appraisal, apparently been slow to be implemented? Several observations are in order. First, valuation techniques have been widely applied in the developing world, far more so than might be thought. All the relevant techniques—travel cost, random utility models, production functions, opportunity cost, hedonic property prices, and contingent valuation—have been applied in developing countries (Pearce *et al.*, 1997). The limited application is more apparent than real. Second, there are limitations to monetary valuation. Not only do some markets not function well enough to show response to environmental and risk variables (especially labour markets and property markets), but the equity issues tend to be more to the fore. The shadow pricing manuals devoted considerable attention to the incorporation of 'distributional weights' into benefit–cost for precisely this reason. This procedure for integrating efficiency and equity into project appraisal fell largely into disuse, partly because it was not always easy to see the scientific basis for the equity weights, but partly because using projects to correct for fundamental inequities in income distribution is the wrong way to deal with inequality. The fact remains that equity is important, and because benefit–cost has perhaps not demonstrated its ability to handle that issue (as Arrow *et al.* imply) the technique is less widely used than it might be. Thirdly, until recently, developing countries lacked the capacity to engage in sophisticated project appraisals, especially those involving environmental factors. That situation is changing rapidly.

A final remark concerns the importance of benefit–cost in the developing world. There are surprisingly few instances of rigorous policy priority assessment in the developed world. Perhaps being rich means that one can afford the highly probable inefficiency in the use of resources by not pursuing

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priority assessment exercises. That is categorically not a luxury that the developing world can afford, least of all in an age where aid flows are falling, not rising. Efficiency is critical for the developing countries. Benefit–cost offers, as they say, 'the best game in town' yet devised for assessing those priorities, for all its faults. And if we are right about the fundamental role of en-

Table 1. *The total economic costs of air pollution damage to human health in developing-country urban areas*

Coverage	*Mortality cost ($m)*	*Morbidity cost ($m)*	*Total health cost ($m)*	*Cost as % of GNP*	*Cost per capita ($)*
Cairo[1] (All exposure, PM only)	186–992	157–472	343–1464	n.a.	38–161
Jakarta[2] (All exposure, PM, lead, NOx)	138	82	220	n.a.	27
Mexico[3] (All exposure, lead, PM, ozone)	480	590	1070	n.a.	63
Bangkok[4] (Benefits of 20% reduction in lead, PM, SOx and ozone)	429–2785	317–353	746–3138	n.a.	97–402
Santiago[5] (Benefits of package of measures)	8	96 or 112	104 or 120	n.a.	22–25

Notes: PM = particulate matter. SOx = sulphur oxides. NOx = nitrogen oxides.

[1] Estimates of mortality and restricted activity days (RADs) taken from Chemonics International and Associates (1994). Value of statistical life taken to be $2.25m × GNP per capita Egypt/GNP per capita USA = $62,021. RADs valued at daily GNP per capita of $1.75 per day. Population taken to be 9.08 million. Estimates of hospital admissions valued at $260; minor RADs and days or respiratory symptoms valued at $0.4; asthma attacks valued at $2.5.

[2] World Bank (1994a). Value of statistical life of $75,000 and population at risk of 8.2 million. Morbidity effects include RADs, out-patient visits, hospital admissions, respiratory illness among children, asthma attacks, and respiratory symptoms. See also Ostro (1994).

[3] Margulis (1992). Value of statistical life of $75,000 assumed based on human capital approach. Population of 17 million assumed.

[4] World Bank (1994b). Bangkok population of 7.67 million assumed. Value of statistical life of $336,000 based on compensating wage differentials in Bangkok for risky occupations.

[5] World Bank (1994c). Estimates are based on dose response functions for mortality and morbidity converted to workdays lost, each workday being valued at US$9.55. Population of Santiago taken to be 4.8 million. Control costs for this package of measures were estimated at $60m, so that, even without considering other pollutants, the benefits of reduced PM_{10} exceed the costs of control. Other benefits arise from the associated control of ozone, NOx and SOx. Alternative estimate for NOx assumes NOx is credited with half the benefits of avoided ozone pollution damage.

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vironmental capital in sustainable development, it is even more important that priority assessment should look carefully at the costs of environmental neglect. By all accounts, they are very large, even for one medium, air pollution, and one receptor, human health (see Table 1, taken from Pearce, 1996).

References

Chemonics International and Associates (1994), 'Comparing environmental health risks in Cairo, Egypt', vols. 1 and 2, report to US AID, Egypt, September.

Dasgupta, P., S. Marglin and A.K. Sen (1972), *Guidelines for Project Evaluation*, Vienna: United Nations Industrial Development Organisation (UNIDO).

Kopp, R. and V.K. Smith (1986), 'Benefit estimation goes to court: the case of natural resource damage assessments', *Journal of Policy Analysis and Management* **8**(4): 593–612.

Little, I. and J. Mirrlees (1969), *Manual of Project Analysis in Developing Countries*, vol. 1, Paris: Organization for Economic Cooperation and Development.

Little, I. and J. Mirrlees (1974), *Project Appraisal and Planning for Developing Countries*, London: Heinemann.

Margulis, S. (1992), 'Back of the Envelope Estimates of Environmental Damage Costs in Mexico', Working Paper WPS 824, Country Department II, Latin America and the Caribbean Regional Office, World Bank, Washington, DC, January.

Mishan, E. (1971), *Cost–Benefit Analysis*, London: Allen and Unwin.

Ostro, B. (1994), *Estimating Health Effects of Air Pollution: A Methodology with an Application to Jakarta*, World Bank, Washington, DC, March.

Pearce, D.W. (1972), *Cost Benefit Analysis*, Basingstoke: Macmillan.

Pearce, D.W. (1996), 'Economic valuation and health damage from air pollution in the developing world', *Energy Policy* **24**(7): 627–630.

Pearce, D.W., K. Hamilton and G. Atkinson (1996), 'Measuring sustainable development: progress on indicators', *Environment and Development Economics* **1**(1): 85–102.

Pearce, D.W., D. Whittington., S. Georgiou and D.Moran (1997), *The Economic Value of Environmental Benefits in Developing Countries*, London: Edward Elgar.

Squire, L. and H. van der Tak (1974), *Economic Analysis of Projects*, Baltimore, MD: Johns Hopkins University Press.

UK Government (1996), *Regulation in the Balance: A Guide to Regulatory Appraisal Incorporating Risk Assessment*, London: HMSO.

World Bank (1994a), *Indonesia Environment and Development: Challenges for the Future*, Environment Unit, Country Department III, East Asia and Pacific Region, World Bank, Washington, DC, March

World Bank (1994b), *Thailand: Mitigating Pollution and Congestion Impacts in a High Growth Economy*', Country Operations Division, Country Department I, East Asia and Pacific Region, World Bank, Washington, DC, February 1994.

World Bank (1994c), *Chile: Managing Environmental Problems—Economic Analysis of Selected Issues*, Environment and Urban Development Division, Country Department I, Latin America and the Caribbean Region, World Bank, Washington, DC, 1994.

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Cost–benefit analysis and the environment

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The thrust of the principles enunciated by Arrow *et al.* is that economic benefits and costs can be a great help in organizing disparate concerns, in identifying issues, and in designing regulatory policies and individual projects with environmental impact. While this is true, I must disagree with the authors that 'formal benefit–cost analysis should not be viewed as either necessary or sufficient for designing sensible public policy' (p. 201). At least there can be little doubt that cost–benefit analysis is *necessary* for sensible policy. I comment below from the perspective of developing countries.

The developing-country context

Careful balancing of costs and benefits is especially important for developing countries, where resources are more scarce and basic needs still unmet. The extent of deprivation is vast: billions of people are without adequate sanitation or safe drinking water, billions are exposed to unsafe conditions caused by soot and smoke, nearly a billion women and children suffer from indoor air pollution from cooking fires, and hundreds of millions of people rely on land and forests which are vulnerable to rapid degradation or depletion.

Absolute standards thus make little sense. For example, universal access to safe water is a goal that all must accept, but the distance to this goal varies enormously in developing countries. The question is not whether such a goal is desirable, but how fast a country should try to attain it. The setting of practical standards is itself an important cost–benefit question.

Complementarities and trade-offs

There are many complementarities. Policies that are bad for economic efficiency are also often bad for the environment, so that policy reforms will benefit both objectives. For example, many developing countries sought to promote industrialization behind high tariff walls during the 1970s and 1980s. This so-called import-substitution strategy was bad for economic growth, and it also created a bias against agriculture which accelerated migration to urban areas and contributed to the neglect of rural capital and land. The problems of soil erosion in sub-Saharan Africa, for example, were exacerbated by such inappropriate economic strategies.

Another example is the nexus between poverty, population growth, and the environment. There are large masses of desperate poverty in developing countries, and the poor can ill afford to take a long view of the natural resources to which they gain access. Their poverty, heightened by the still fast growth of populations, puts enormous pressure on the environment. High

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economic rates of return, as well as environmental improvements, can be realized in such situations by investing in primary education, especially of girls, and in family planning. Improvements in incomes will mean that the immediate problems of day-to-day survival will be alleviated, and therefore the demand for amenities like cleaner air and water will grow.

Such complementarities do not mean that policy-makers in developing countries can relax about environmental matters as long as they think policies are moving in the direction of higher economic efficiency. Situations in which income growth entails poorer environment are, alas, all too common. For example, when fertilizers and pesticides adversely affect the environment, they should be taxed if the resultant losses of income are offset by environmental gains. Similarly, instead of coffee being taxed in a place like Haiti, thus contributing to the tragic erosion of the hills, a coffee subsidy might be the right policy. A coffee subsidy in such situations may be bad for the national income but good for the environment. As these examples suggest, environmental concerns should be an integral part of economic policy discussions because of such trade-offs.

The trade-offs can be quite dramatic in practice. In China, for example, phenomenal income growth has increased the demand for energy manifold. The vast increases in energy demand will in future be met partly from nuclear sources, partly from hydroelectric dams, but mainly from coal, with attendant increases in air pollution. Paradoxically, many environmentalists have focused their scrutiny on hydro projects, in particular on the proposed Three Gorges dam, and not on the serious environmental costs of alternative coal-based energy. Whether in China, India, Nepal, or other countries, the opponents of large dams have often emphasized the costs and neglected the potential environmental benefits.

While policy-makers in developing countries often justifiably protest the unrealistic standards that many environmentalists preach, they also often err by overestimating the costs of adopting environment-friendly policies. The really serious cases of industrial and municipal pollution can often be mitigated, or even avoided, at relatively low costs. For example, controlling urban traffic congestion, or introducing unleaded gasolene, would certainly go a long way toward alleviating urban air pollution.

Environment and the rate of return

Contrasting income growth with environmental effects might suggest that better environment is a 'non-economic' objective. But for the most part it is not, and Arrow *et al.* fail to emphasize this. Economic costs and benefits are market-based measures which reflect the willingness of individuals to pay for the goods and services used or produced by projects (or induced by policy actions). The valuation of most types of environment effects can in principle be based on the same concepts. Thus the provision of cleaner air can be valued by the amounts the beneficiaries could pay to have it and still be at least as well off as before. The valuation of statistical lives saved can similarly be based on measures revealed by the beneficiaries through the choices they make in labour and other markets (Cropper and Oates (1992) provide an exhaustive account of valuation along these lines; see also Dixon *et al.*, 1994).

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Cost–benefit calculus should include environmental effects in the above manner. The 'shadow' price of a commodity, which is intended to remove distortions in the market price due to incorrect taxes and subsidies, should reflect significant environmental effects (as for fertilizers or pesticides). Similarly, the shadow cost of using labour in particular occupations will be greater if there are attendant environmental damages. Some authors have suggested making the discount rates commonly used in cost–benefit analysis lower in order to give greater weight to activities which mature over long periods (such as teak forests), but the theoretical basis for doing so has not, however, been established. If a small developing country borrows abroad at a constant real interest rate, the appropriate discount rate cannot be below that rate (which has rarely been below 3 or 4 per cent).

The valuation of life and limb is of course controversial, and in any case the statistical problems of estimating environmental effects can be formidable. It is standard practice to use sensitivity tests, which help identify the variables of most importance and throw light on how the merits or demerits of proposed actions turn on assumptions regarding uncertain data or controversial judgments. Sensitivity tests can convey some idea of the risks involved. When there are many variables involved, none being individually important, formal risk analysis becomes necessary to inform the decision-makers what are the odds of success and how the risks change with different designs.

Social valuation

Environmental concerns are likely to involve an element of social valuation, arbitrarily given from outside the standard efficiency calculus. This may not be a problem in practice if such valuation issues arise very infrequently. But suppose they arise frequently, then what? It would be futile to go to great lengths to calculate economic costs and benefits, only for this work to be nullified by some arbitrary, if not capricious, amendments of the final results. Arrow *et al.* provide no guidance for such situations, but appropriate methods can be developed. An analogy with income distribution may be helpful.

All texts on cost–benefit analysis refer to income distribution as a potentially relevant decision variable, but few show how one can take it into account in a disciplined way (for a survey, see Ray, 1984). If distributional issues arose only occasionally, that discipline would not be worth the trouble. However, distributional issues are pervasive in developing countries, and discussions of policies or projects quickly go beyond economic efficiency. This is unfortunate because it is seldom possible to pin down what is meant by income distribution. And even after a common definition has been agreed upon, there remains the difficult issue of what value to place on improvements in distribution.

To maintain discipline, one should try to integrate distributional concerns within the body of the analysis in a systematic way. One possibility is to postulate a simple relationship between income levels and social weights applicable to marginal changes in incomes, as in Ray (1984). The case in which the decision-makers are not interested in distribution *per se*, but in the alleviation of poverty (defined in terms of a minimum con-

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sumption standard) is a special variant of this approach. Similarly, the basic-needs approach, which assigns special weights to the consumption of particular commodities, can also be seen as a special variant.

No matter what particular specification is chosen, the standard analysis without distributional concerns must always be presented. Sensitivity tests can then indicate how the results change if distributional concerns are introduced. If this procedure is followed systematically, and if the decision-makers make consistent choices, then a social valuation function will emerge which incorporates distributional concerns. The non-quantifiable considerations in the case of environment can be treated in the same way, but much work remains to be done in this area.

Processes

I am all in favour of a single agency laying down the default values for such parameters as the discount rate and for such benefits as statistical lives saved, and developing a common format for presenting information to the decision-makers. But the greatest need is for transparency. Just as taxation without representation is unfair, expenditure of tax revenues without transparency is highly questionable. The ordinary taxpayer has no information on how effectively the government spends its revenues or on what; indeed few in government offices maintain such an overview. Ideally, governments should publish full statements on economic rates of return, and on environmental impacts, both before and after expenditures are made or regulations enacted.

References

Cropper, M. and W. Oates (1992), 'Environmental economics: a survey', *Journal of Economic Literature* **30**: 675–740.

Dixon, J., L. Scura, R. Carpenter and P. Sherman (1994), *Economic Analysis of Environmental Impacts*, London: Earthscan.

Ray, A. (1984), *Cost–Benefit Analysis*, Washington, DC: The World Bank.

Benefit–cost analysis as a mechanism for evaluating conservation policies in developing countries

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Can benefit–cost analysis (BCA) be used in the developing world in the same way in which it is used in developed market economies? The paper

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by Arrow *et al.* makes a good case for employing BCA to evaluate environmental, health, and safety regulations in the United States. It offers a number of principles to guide the use of benefit–cost analyses, some of which can be applied to developing countries. Conservation policies in the tropics can help illustrate the relevance of BCA for evaluating regulations in less industrialized countries. I use a set of studies on the Mantadia National Park to show in practical terms how and when BCA can serve as an effective evaluative tool.

In order to curb loss of biological diversity, several governments worldwide have established parks and protected areas. Such conservation policies, most of which regulate resource use, have considerable costs and benefits associated with them. They impact on the welfare of people living near natural areas and they have national and international implications because of the nature of the demand for biodiversity (Van Schaik *et al.*, 1993). From an efficiency perspective, as argued by Arrow *et al.*, it would be important to evaluate the costs and benefits of conservation policies before implementing them. What follows is an assessment of the usefulness of BCA to evaluate one type of regulatory mechanism, a protected area in eastern Madagascar.

The Mantadia National Park (MNP) is one of four national parks in Madagascar. It covers an area of 9,875 hectares and is next to an already existing protected reserve called the Special Reserve of Analamazaotra. Approximately 10,000 people live within the vicinity of the park (Shyamsundar and Kramer, 1996).

BCA is useful for understanding economic implications of conservation policies

In the Mantadia case several studies were undertaken to assess the economic implications of establishing a protected area. We used two methods to estimate the costs to households resulting from loss of access to lands within the park: contingent valuation and cash-flow analyses of production losses. In parallel studies potential benefits from the park were assessed by estimating the demand for eco-tourism at the Special Reserve and the benefits from reductions in flooding (Kramer *et al.*, 1995). The results from these studies were illuminating. For example, the contingent valuation study indicated an average annual cost to each household of $50 (Shyamsundar and Kramer, 1996). Estimates from the cash-flow analyses of production losses were comparable (Shyamsundar and Kramer, 1997). These numbers illustrate the substantial costs and benefits associated with many conservation policies. As in the United States, BCA can act as a useful filter for identifying efficient policies in developing countries.

BCA helps clarify the distributional effects of policies

The studies we undertook in the Mantadia region suggested that there were significant geographic differences in the costs borne by local households. The largest burden is borne by households in regions to the southwest of MNP relative to villages in the north and east. Furthermore, different groups of villagers bear different types of costs. Some households are burdened by the loss of agricultural lands, while others have lost ac-

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cess to forest products. BCA can be used to understand how different groups of people are affected by environmental policies. This information, referred to under principle 8 of Arrow *et al.*, is critical for developing countries where issues of equity are tremendously important.

BCA can be a practical management tool

The cost estimates obtained from the MNP studies represent the benefits required to make the park into a protected area that is accepted by local residents. Protected-area managers are currently striving to find a balance between conservation of ecosystems and satisfaction of local needs. BCA shows in very concrete terms why local residents often resist conservation efforts: the stakes are very high and they differ according to location. The magnitude of costs can inform managers about local people's attitude toward protected areas. Understanding the nature of the costs borne can also be of help in devising alternate livelihood mechanisms for forest-dependent households.

BCA can be expensive and requires sound data and analysis

Accurate BCA requires detailed ecological and economic data. Often, short cuts may be taken because of time, information, and monetary constraints, and the implications of these short cuts need to be well understood. Valuation of non-market resources will pose even greater challenges in developing countries than they do in the United States and Europe. Our study indicated that contingent valuation can be used in a rural non-market economy if a strong use value is associated with the good being valued; if surveys are carefully constructed and interviewers well trained; and if a subsistence good that is valued and exchanged is used as a numeraire instead of money (Shyamsundar and Kramer, 1996). Further evidence of the usefulness of non-market valuation techniques will need to be developed before they are commonly applied.

An overarching recommendation to use BCA on all environmental policies cannot be made. Environmental economics is a young science in developing countries. Further training and testing of research methods is required to enable developing-country scholars to use BCA. Scholars and policy-makers in developing countries also face non-trivial monetary constraints that frequently preclude them from undertaking BCA. Finally, BCA of policies that affect ecosystems would need to be cognizant of a number of complex variables including irreversibility of changes, scale of impacts, uncertainty of current and future effects, etc. (Bingham *et al.*, 1995). An undiscriminating recommendation of BCA could result in quick studies that produce precise numbers hiding seriously flawed assumptions. BCA should be one among several criteria used for making judgments about policies and management strategies. As suggested by Arrow *et al.*, BCA can serve as a powerful organizing framework for assessing regulatory policies, as long as it is not the only tool used in decision-making.

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References

Bingham, G. *et al.* (1995), 'Issues in ecosystem valuation: improving information for decision making', *Ecological Economics* **14**(2): 73–90.

Kramer, R.A., N. Sharma and M. Munasinghe (1995), 'Valuing tropical forests: methodology and case study of Madagascar', Environment Paper No. 13, World Bank, Washington, DC.

Shyamsundar, P. and R.A. Kramer (1996), 'Tropical forest protection: an empirical analysis of the costs borne by local people', *Journal of Environmental Economics and Management* **31**(2): 129–144.

Shyamsundar, P. and R.A. Kramer (1997), 'Biodiversity conservation—at what cost? A study of households in the vicinity of Madagascar's Mantadia National Park', *AMBIO* **26**(3): 180–184.

van Schaik, C., R.A. Kramer, P. Shyamsundar and N. Salafsky (1992), 'Biodiversity of tropical rainforests: ecology and economics of an elusive resource', Duke University Center for Tropical Conservation report, Duke University, Durham, NC.

https://doi.org/10.1017/S1355770X97210168 Published online by Cambridge University Press