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.

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.

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).

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?

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[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).

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