

Critique of Cost-Benefit Analysis, and Alternative Approaches to Decision-Making

A report to Friends of the Earth England, Wales and Northern Ireland

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Introduction

Once upon a time, protection of human health and the natural environment did not seem to require economic analysis. Before the 1980s, public health and environmental policies were debated primarily on scientific, ethical, and legal grounds, with less emphasis on costs – let alone monetized benefits. More recently, it has become the norm to assume the need for cost-benefit analysis of new policies, comparing monetary costs and estimates of the monetary value of benefits. Just as a business should only make an investment if the expected revenues exceed the costs, the new approach suggests that government should only adopt a new initiative if its expected benefits exceed its costs.

Although the theory can be traced back to the nineteenth century, the first applications of formal cost-benefit analysis by government occurred in water projects in the US in 1936, and in evaluation of road and rail transport options in the UK around 1960.² By the 1980s, the academic development of environmental economics coincided with the heightened interest in eliminating waste and promoting “efficiency” in government under the Thatcher and Reagan administrations – leading to a much-expanded role for formal cost-benefit calculations both in the UK and the US.

Today it is often taken for granted that cost-benefit analysis is needed to ensure “better regulation” and avoid inefficiency in government. In an important recent example, climate change might seem like an issue where there is a clear need for science-based policy to avert global disaster. Yet the Government’s response to public consultation on the UK Climate Change Bill³ opens its argument with a short paragraph on the scientific case for action, followed by a much longer paragraph on the economic case for action; it then says, “The Climate Change Bill will provide a clear, credible framework to support emissions reductions in the UK, in a way which maximises the social and economic benefits and minimises costs.”⁴ The response repeatedly suggests that future changes in the carbon reduction goals should be based on the economic costs and benefits of any new targets.

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² David Pearce, “Cost-Benefit Analysis and Environmental Policy,” *Oxford Review of Economic Policy* 14 no. 4 (1998), 84-100.

³ “Taking Forward the UK Climate Change Bill: The Government Response to Pre-Legislative Scrutiny and Public Consultation,” October 2007, <http://www.official-documents.gov.uk/document/cm72/7225/7225.pdf>.

⁴ *Ibid.*, p.6.

While the discussion of the Climate Change Bill has accepted for now that the Stern Review makes a clear economic case for immediate action, the reliance on economic rather than scientific standards leaves the door open for later reconsideration. If Stern's conservative critics within the economics profession⁵ were to prevail in subsequent debates, the logic of maximizing monetary benefits and minimizing costs could lead to intentionally leaving ourselves unprotected against the worst impacts of climate change.

The argument of this report is that cost-benefit analysis is a flawed procedure, which should not be central to public policy decisions on climate change or other issues. In practice, cost-benefit analysis exhibits numerous problems, ranging from deep ethical and logical contradictions to a persistent tendency toward forecasting errors and partisan abuse. Some of these flaws could in theory be corrected; others are inherent in the methodology, and underscore the need for alternatives. Other, equally logical approaches to decision-making are available; these alternative approaches have the added advantage of acknowledging the multidimensional complexity of environmental issues and the inescapable role of uncertainty. Case studies of policies for airport expansion and for waste management, presented below, illustrate the weakness of cost-benefit analysis and the need for alternatives.

The report begins in Section 1 with a review of the flaws in cost benefit analysis. Section 2 sets out alternative approaches. Sections 3-5 present case studies of how decisions happen in practice and how alternatives could work. Section 6 offers some conclusions for policy makers.

I. Six flaws in cost-benefit analysis

It is surprising that cost-benefit analysis is such a failure; at first glance, it appears quite reasonable. Making decisions about public policy is a complicated process, facing the continual challenges of too many rival proposals and too little time and resources. If only one could assign monetary values to all the costs and all the benefits of a proposed policy, it would become a simple, transparent matter to add up the costs and benefits. Then there would be a strong argument for adopting a proposal if and only if the value of its benefits exceeded its costs. Everyone, on some level, weighs the costs and benefits of possible actions when deliberating what to do next; cost-benefit analysis looks like a natural extension of this commonplace activity to public life.

But consider a different picture of cost-benefit analysis in practice. When important benefits are not defined in monetary terms, economists often resort to implausible, circuitous methods of inferring and inventing the missing prices. When future outcomes are uncertain, analysts use "best guess" values, ignoring the concerns about worst case hazards that motivate many policy debates. When the measurement of costs and benefits becomes a complex, detailed process, the calculation loses transparency and often

⁵ See Frank Ackerman, "Debating Climate Economics: The Stern Review vs. Its Critics," report to Friends of the Earth, July 2007, <http://www.ase.tufts.edu/gdae/Pubs/rp/SternDebateReport.pdf> .

objectivity as well, as partisan interests learn to cloak their agendas in the opaque technicalities of the evaluation.

This is not just a hypothetical scenario. It is what has actually happened in the United States, above all in the approach to environmental regulation under President George W. Bush. This section argues that many of the absurdities and biases seen in recent American applications of cost-benefit analysis flow directly from the methodology. Alternative methods for rational deliberation on public policy are presented in the next section.

I.A. Pricing the priceless

The costs and benefits of health and environmental policies are not normally expressed in comparable units. The costs are frequently well-defined in economic terms: it is a straightforward process to calculate the price of end-of-pipe filters that reduce industrial emissions, or highways that go around instead of through nature preserves, or new energy-efficient equipment that reduces fossil fuel use and greenhouse gas emissions. The benefits, on the other hand, frequently involve human lives saved, ecosystems and endangered species protected, or other fundamentally nonmonetary values.⁶ What is the value of avoiding the deaths that will result from more frequent heat waves, more intense storms, and other consequences of climate change? What is the value of protecting coral reefs, polar bears, and other species whose habitats and existence are at risk from global warming? Cost-benefit analysis absolutely requires monetary values for these benefits. If the preservation of human life and natural systems are unpriced, they will remain mere footnotes or warning labels attached to an incomplete numerical calculation - and it is usually the numerical bottom line, complete or not, that will be remembered and acted upon.

For example, the Impact Assessment Guidance⁷ from the Better Regulation Executive (part of BERR, the Department for Business Enterprise and Regulatory Reform) describes the analysis that is required for virtually all regulatory initiatives:

The summary must take account of the full range of costs and benefits: economic, social and environmental; these should be monetised as far as possible. (*point 27, emphasis in original*)

Although the language here – “as far as possible” – contains the suggestion that some costs or benefits might not be possible to monetize, the subsequent text ignores such possibilities, acting as if only the monetized impacts are worth discussing:

⁶ Frank Ackerman and Lisa Heinzerling, *Priceless: On Knowing the Price of Everything and the Value of Nothing*, New York: The New Press (2004).

⁷ <http://bre.berr.gov.uk/regulation/documents/ia/iag.pdf>

Description and scale of key monetised costs and benefits accrued by the main groups affected by the proposal or other impacts (such as particular environmental impacts) should be clearly stated...

Annual cost and benefit figures should be presented in constant prices ...so that comparisons can be easily made. (*points 29, 30, emphasis in original*)

But is it the case that “comparisons can easily be made,” for instance, between money spent and lives saved? This is not just a rhetorical question; numerous regulations call for protective expenditures aimed at saving lives. Cost-benefit analysis, or impact assessment, of such regulations requires a numerical price to be placed on the lives saved. The impossibility of a meaningful monetary answer is no deterrent; some number, sensible or otherwise, is needed in cost-benefit analysis. And multiple, inconsistent answers have been offered.

In the United States, where cost-benefit analysis has been most extensively used, there is a burgeoning literature on the value of a life. One approach, popular under the Clinton administration, has frequently valued a life at about \$6 million, based on studies of the wage differentials paid for more or less risky jobs. Another approach, brought in by the Bush administration, relies on surveys, asking long series of questions about how much people would pay to avoid small risks of death under carefully contrived, hypothetical scenarios. The resulting value of a life is \$3.7 million (public outrage defeated a suggestion that the same style of survey research “proved” that the lives of older people were worth only \$2.6 million; critics labeled this lower value the “senior death discount”). None of these numbers are acceptable measures of the ethical significance of a human life, or the collective obligation to prevent any preventable deaths.

When it comes to valuing nature, there is no way to persuade fish or forests to answer questions; economists have instead asked people how much nature is worth to them. (In addition to its other flaws, this method necessarily omits any value of nature beyond its value to humans.) What, for example, is it worth to protect whales from extinction? An American survey, some years ago, estimated that the US population would pay \$18 billion to protect the existence of humpback whales. The corresponding global willingness to pay would of course be a larger number, several times this amount. But a moment's thought shows that any such number contains no real information. Imagine a multibillionaire who offers to pay twice the stated value -- \$36 billion for the US alone, proportionally more for the world as a whole -- for the right to hunt and kill all the humpback whales in the ocean. It is immediately clear that the offer is unacceptable, and the price doesn't matter. This is quite unlike an offer to buy your car for twice its value: whether or not you accept such an offer, you are unlikely to be offended by it; and the price does matter. Rather, the offer to “buy” a species for exclusive private use is ethically unacceptable in the same way that an offer to buy your spouse or children would be. Your car is a commodity with a meaningful monetary price. Your family, your life (or anyone else's), and the existence of whales and other species, are not commodities; it is offensive and misleading to treat them as if they were for sale at any price.

The discussion of values without prices has a long history. As the 18th century philosopher Immanuel Kant put it, some things have a price, or relative worth, while other things have a dignity, or inner worth. More than 200 years later, the categorical incompatibility remains as powerful as ever: The failure of cost-benefit analysis, in Kantian terms, stems from the attempt to weigh costs, which usually have a price, on the same scale as benefits, which often have a dignity. All too often, in a framework in which money is all that matters, priceless benefits are valued at zero by default.

I.B. Troubling trade-offs

Closely related to the problem of priceless values is the hidden assumption that everything can be traded for everything else. This assumption is appropriate for things that can be measured in money: your car, my computer, and someone else's art collection all have meaningful prices, making it clear whether or not it would be fair to trade one for the other.

But the assumption that anything can be exchanged for anything else becomes misleading and disturbing when artificial prices are applied to the fundamentally nonmonetary values of life, health, and nature, as is necessary in cost-benefit analysis. If you invest £100 in a company that pays you £300 a decade later, everyone will consider you a successful investor; your later income pays back the earlier investment plus 11.6% annual interest. But if a policy kills 100 people now in order to save 300 people a decade later, there is no way to pay back the original 100. It is ethically problematical to view the lives saved later as interest earned on earlier deaths; would the people who died earlier have given their consent to this "investment"?

This quandary is obscured, and the trade-off appears benign, when lives saved or lost are converted to monetary equivalents at any price. The problem is not that the price is too high or low, but simply that it is a price. Suppose that human life is worth £X per person, and convert the 100 deaths and 300 lives saved into their monetary "values." Giving up £100X now in order to gain £300X ten years later looks like a brilliant investment, not an ethical dilemma involving different people's lives and deaths.

The cost-benefit framework also implies that a cost, or a benefit, has the same impact on society regardless of who pays or receives. The net benefit of a policy, i.e. the total benefits minus total costs, is the same whether janitors pay the costs and business executives enjoy the benefits, or vice versa. In real life, of course, few people are indifferent about who pays and who benefits; many ethical, political, and religious beliefs imply that it matters a great deal whether the poor subsidize the rich, or the rich subsidize the poor. Economic theory tries to excuse this ethical lapse by observing that if net benefits from a policy are positive, the winners could choose to compensate the losers. All too often, however, the winners choose to keep the winnings for themselves – and thus the ethical problem persists. Assuming that additional carbon emissions from cheap air travel produce great benefits for rich countries, but lead to sea level rise that inundates large parts of Bangladesh, it would be theoretically possible for the benefits to air travelers to exceed the cost to Bangladeshis. But in this hypothetical scenario, the mere

fact of net global benefits would be of no help to anyone in Bangladesh – unless the air travelers actually paid compensation to the victims of flooding. The ethical implications of this scenario depend entirely on whether or not the winners compensate the losers.

I.C. Uncertainty and precaution

Cost-benefit analysis requires definite numbers on each side of the balance sheet, to allow the comparison of costs and benefits. Many important questions of environmental policy, however, involve inescapably uncertain outcomes. How toxic will a new, potentially hazardous chemical turn out to be? How much global warming will it take to trigger the irreversible collapse and melting of the Greenland ice sheet? In a nuclear reactor, with its numerous potential pathways to a serious accident, what is the probability of continued safe operation?

Faced with such uncertainties, it is effectively impossible to provide a precise quantification of the benefits of environmental protection. If the probabilities of different outcomes were known, as in casino games or classroom exercises in statistics, then a weighted average or expected value could be calculated, offering a meaningful best guess. But reality is more complex and more fundamentally uncertain than a night at a casino. There are very few real-world examples where useful information is available about the probabilities of alternative environmental outcomes.

In some cases, such as new, potentially toxic chemicals, uncertainty results from what we don't yet know about the problem. In other cases, uncertainty results from what we do know about systems so complex that they are essentially unpredictable in detail -- whether the natural complexity of the climate or the created complexity of a reactor. There is at best a range of possible outcomes, sometimes a disturbingly broad range, which must be considered. Estimates of the social cost of carbon, in particular, rest on expected values for the numerous uncertainties about precisely how much and how rapidly the climate will change. While a precise number emerges from the discussion, such as the recent value of £70 per ton, that estimate is only one way of summarizing the uncertainties surrounding future climate risks.

The precautionary principle (which will be discussed further in the next section) provides an alternative approach to decision-making under uncertainty. It calls for taking action based on credible warnings of harm, without waiting for complete certainty or scientific consensus. Interpreted, in the simplest terms, as an admonition to take worst-case possibilities seriously, precaution echoes any number of proverbial bits of folk wisdom along the lines of better safe than sorry, look before you leap, measure twice and cut once, and so on. It also corresponds to ordinary decision-making: insurance purchases, airport security procedures, and countless other protective measures are based on worst case, rather than average, possibilities. A precautionary approach to health and environmental policy extends the same mode of thinking to public protection of our common future; it does not require, and is not improved by, guesses about the monetary value or precise probability of uncertain benefits.

I.D. Distorting the future

Costs and benefits of public policies do not always occur simultaneously. While both can occur over a period of years, the benefits of health and environmental protection often extend much farther into the future than the costs. In addition to reducing all costs and benefits to monetary terms, cost-benefit analysis follows standard economic practice in discounting future amounts, converting them to their equivalent value today, or “present value.” The UK Treasury’s Green Book offers guidance on appropriate discount rates to use in evaluating future effects of policies.

Discounting is a perfectly sensible practice when evaluating financial transactions that occur within a single lifetime. You can make an investment today, giving up the use of your money for some time, in exchange for the promise of greater payment in the future. Or conversely, you can borrow today, gaining the use of someone else's money, in exchange for a commitment to repay the loan with interest in the future. Discounting at the prevailing interest rate makes sense of these transactions, showing that the present and future amounts are equal to each other when measured in present value terms.

This sensible bit of financial analysis becomes problematical and controversial when extended beyond its domain of validity. When the time span is so great that different generations are involved in costs today and benefits tomorrow, the analogy to an individual investment decision breaks down. Instead, questions of intergenerational responsibility are involved, ultimately reflecting our commitments to and desires for our descendents. To reflect any serious responsibility to future generations, the discount rate must be quite low - considerably closer to zero than the Treasury’s Green Book value, for instance. This is a much debated problem in the economics of climate change, as seen in the Stern Review and related discussion⁸; it also affects other very long-term environmental issues, such as the handling of radioactive waste.

A low discount rate does not simply highlight environmental impacts; rather, it increases the relative importance of the future, compared to the present. For long-lasting facilities with expected economic lifetimes spanning many decades, such as airports or nuclear power plants, a low discount rate makes projected future revenues loom larger, relative to the immediate costs of construction. Thus on narrow economic grounds, a business or government agency will usually find that a lower discount rate makes it “optimal” to build larger, longer-lived facilities. But climate damages, radioactive waste problems, and other environmental impacts will outlast the largest, sturdiest facilities; the projected centuries of future environmental impacts are invisible at high discount rates, but all-important at low rates. If the future matters, the discount rate must be very low.

⁸ See Chapter 2 of the Stern Review, and Frank Ackerman and Ian Finlayson, “The Economics of Inaction on Climate Change: A Sensitivity Analysis,” *Climate Policy* 6 no. 5 (2006), 509-526.

I.E. Exaggerated costs

The cost side of the cost-benefit comparison poses fewer problems than the benefit side, because many of the costs of health and environmental protection are naturally expressed in monetary terms. Yet even here there are pitfalls in the standard methods.

The costs of regulation are routinely overestimated in advance; several studies have found that advance predictions of costs are much more likely to be too high than too low.⁹ Once a regulation is adopted, it often spurs innovation in environmental technology, making earlier cost predictions obsolete. This is a longstanding pattern: the 1974 US proposal for strict regulation of workplace exposure to vinyl chloride, a known carcinogen, was greeted with industry predictions of financial ruin and shutdowns. But after industry lost the debate and the regulation took effect, new control technologies were quickly developed, allowing the continued profitable production of PVC.¹⁰ The same story has been repeated over and over again; while it may be hard to predict the exact extent of future decline in costs, it is clear that costs are more likely to go down than up. Advance predictions by the regulated industry itself, frequently the only available estimates, are particularly suspect: they may be developed and presented as part of an argument against regulation, where overestimates of costs would be strategically useful.¹¹

In addition, the costs of health and environmental protection are often remarkably small. Even a regulation as ambitious as REACH, changing business practices throughout the European chemical industry, will impose an estimated cost of only a few billion euros spread over 11 years. Over that time period, several trillion euros' worth of chemicals will be sold in Europe, so the result will be an increase in chemical industry costs on the order of 0.1% -- a trivial amount, lost in the noise of ongoing marketplace fluctuations.¹² In general, economists have found that there is no trade-off between jobs and environmental protection, both in the US and in the UK.¹³ Detailed studies in the US have found virtually no evidence of job loss associated with environmental regulation, except in resource-based, extractive industries such as logging and fishing. Compliance with environmental regulation is too small a fraction of most industries' costs -- under 1%, in the great majority of cases in the US -- to be decisive in decisions about production and employment.

⁹ Literature on this topic is cited in Frank Ackerman, "The Unbearable Lightness of Regulatory Costs," *Fordham Urban Law Journal* **33** no. 4 (2006), 1071-1096.

¹⁰ Frank Ackerman, Lisa Heinzerling, and Rachel Massey, "Applying Cost-Benefit to Past Decisions: Was Environmental Protection Ever a Good Idea?," *Administrative Law Review* **57** no. 1 (2005), 155-192.

¹¹ Thomas C. McGarity and Ruth Ruttenberg, "Counting the Cost of Health, Safety, and Environmental Regulation," *Texas Law Review* **80** (2002).

¹² Frank Ackerman and Rachel Massey, *The True Cost of REACH*, Copenhagen: Nordic Council of Ministers, 2004.

¹³ Eban Goodstein, *The Trade-off Myth: Fact and Fiction about Jobs and the Environment*, Washington DC: Island Press, 1999; Matthew A. Cole and Rob J. Elliott, "Do Environmental Regulations Cost Jobs? An Industry-Level Analysis of the UK," *The B.E. Journal of Economic Analysis & Policy*, **7** no.1 (2007), Article 28, available at: <http://www.bepress.com/bejeap/vol7/iss1/art28>.

Of course, there is no promise that all environmental issues will be resolvable at trivial cost. Climate change is likely to be a major exception, requiring significant expenditures and changes in economic direction. But in numerous other cases, the costs of regulation are small enough, on a per capita basis or as a percentage of the relevant industry's costs, that they need not be decisive. Cost-benefit analysis, applied indiscriminately, can lead to fetishizing small cost differences – that is, claiming that we are compelled to change policies even for the smallest estimated savings – as if there were no goals in public life other than short-term cost minimization. (An egregious example appears in the case study of solid waste policy, below.)

Since, in reality, there are many other, unmonetized public objectives, an increased cost can often be “justified” by its other benefits, outside the scope of cost-benefit analysis. The smaller the cost differential between two policy alternatives, the more likely it is to be outweighed by unmonetized benefits. It is impossible to imagine monetizing all public goals; thus cost-benefit calculations alone can never be sufficient for decision-making. The existence of schools, parks, and libraries, to name just three examples, demonstrates that public funds are frequently spent on purposes other than cost reduction. One could, after the fact, make up prices for the apparent “willingness to pay” for public facilities, or for the long-term, tangible and intangible benefits provided by the facilities. But it would be more straightforward and comprehensible to acknowledge that there are multiple purposes in public life, including health and environmental protection along with other public goods.

I.F. Partisans and technicalities

Cost-benefit analysis is often proposed with the best of intentions. In the imagination of its advocates, it provides an objective, transparent calculation of the pros and cons of a policy proposal. Ideally, it seems as if this could reduce the partisan squabbling involved in policy debates, by providing a shared, empirically based understanding of exactly how good or bad a proposal would be.

This noble ambition can fail in at least two respects: biases may enter in the choice of alternatives for analysis, and in the interpretation of complex, technical data.

Cost-benefit analysis is often constrained by the range of alternatives it considers. When a highway is congested, building a bigger highway often seems like an appealing alternative. The losses caused by congestion could well be great enough that the construction of the new, wider highway would win in cost-benefit terms. But such an analysis only answers the question, “If there were no choices except the status quo or the new road, which would be better?” Other options such as improved railroad and bus service, or urban planning measures to reduce transportation demand, might be even more attractive – if they were included. By limiting the analysis to the status quo vs. one preferred alternative, the framing of the question can often determine the answer. Reframing the question – for example, asking “What is the least-cost strategy for reducing congestion on a highway by a given amount?” – may yield a different solution.

A second, subtler problem with cost-benefit methods is the assumption that the necessary data are above the partisan fray and independent of the analyst's point of view. US experience suggests the opposite: opposing camps with differing perspectives will find their own experts, whose interpretations of the data support their own beliefs. As a result, a political debate that might have been understandable in its original form is translated into a cryptic argument about technicalities, comprehensible only to other experts.

In one of the first major applications of cost-benefit analysis to US policy, the Environmental Protection Agency (EPA) analyzed the costs and benefits of a lower limit on arsenic in drinking water.¹⁴ In 2000, when the analysis was performed, the US still allowed 50 parts per billion (ppb) of arsenic in drinking water, while the World Health Organization recommended, and many other countries had adopted, a standard of 10 ppb. The attempt to quantify and monetize the benefits of reduced exposure to arsenic required repeated leaps of faith: for instance, the monetary value of a nonfatal case of bladder cancer was declared equal to the value of a case of chronic bronchitis, since a team of economists had studied the latter disease but none had studied the former.

Most empirical evidence about the harm caused by arsenic comes from studies of communities that were inadvertently exposed to much higher concentrations. The cost-benefit study therefore involved extrapolation to lower concentrations, requiring an assumption about low-dose exposures. Is the harm caused by arsenic strictly proportional to exposure, or is there a threshold below which there is no harm? Is the dose-response relationship a straight line, or curved? The estimated benefits of reducing arsenic exposure depend on the answers to these questions. So US policymakers were treated to the spectacle of lawyers and policy analysts, who lacked any training in toxicology, passionately debating the slope and shape of the arsenic dose-response curve.

Late in the Clinton administration, EPA recommended a standard of 10 ppb, even though the cost-benefit analysis did not literally support that value; EPA reasonably observed that there were important unquantified effects that justified doing more. The incoming Bush administration quickly suspended the regulation in order to do its own studies. Nine months later, after additional studies had confirmed that arsenic in drinking water is indeed harmful, the Bush administration quietly reinstated the 10 ppb standard.

Cost-benefit analysis contributed precisely nothing to the US decision about arsenic standards. Millions of dollars and many person-years of research, analysis, and debate could have been saved by simply observing that the World Health Organization and numerous countries around the world all advocated a particular standard, doing a little background reading to confirm the wisdom of that standard, and then adopting it. The result would have been exactly the same, although we would have missed the chance to debate whether chronic bronchitis is better or worse than nonfatal bladder cancer, or whether lawyers would make good toxicologists.

¹⁴ Among many accounts of this dispute, see Ackerman and Heinzerling, *Priceless*.

Of the six flaws in cost-benefit analysis discussed here, the first three – the central role of priceless values, the troubling implicit assumptions about trade-offs, and the significance of uncertainty – are inescapable features of the methodology, requiring a different approach to decision-making under the best of circumstances. The other three – trivialization of the future, recurrent exaggeration of costs, and partisan conflict over the technical details – could in theory be avoided if cost-benefit analysis were implemented by perfectly informed, unbiased individuals with no stake in the outcome of the policy decisions. Yet in the real world, such idealized, all-knowing, apolitical analysts are few and far between. The pressures that have distorted American cost-benefit analysis, including abstract economic theories about discounting the future, and the ever-increasing politicization of regulatory decisions, will be felt in the UK and elsewhere. And even if cost-benefit analysis was applied by philosopher-kings who could somehow avoid the numerous pitfalls of practical politics, they would still have to invent prices for priceless values, avoid the ethically unacceptable trade-offs that follow from those prices, and escape the inherent problems of uncertainty and precaution.

II. Better ways of making decisions

Most of the information collected for a cost-benefit analysis is useful under any approach to deliberation. The problems arise only in the final steps of crunching everything into a single bottom-line number: monetizing nonmonetary benefits, discounting future outcomes, and guesstimating the values of important uncertainties all have the effect of distorting and concealing the underlying data. An environmental policy proposal often has monetary costs, in the present and perhaps the near future, and a mix of monetary and nonmonetary benefits extending somewhat farther into the future. Knowing as much as possible about the costs and -- separately -- about the benefits, with each expressed in its natural units, is sure to lead to better decisions.

There are at least four other (somewhat overlapping) methodologies for making decisions, appropriate to different circumstances and levels of knowledge: multi-criteria analysis; holistic comparison of costs and benefits; precautionary approaches to decision-making under uncertainty; and cost-effectiveness analysis. The last two can often be combined, for a comprehensive response to a broad class of environmental problems.

II.A. Multi-criteria analysis

Money measures things in a single dimension. All the things that have meaningful prices can be unambiguously compared to each other; the market leaves no doubt about which are worth the most, and which the least. In contrast, human health and the natural environment involve many dimensions of incompatible measurements. The price of the human life, measured in hectares of wetlands, is no more meaningful than the price in pounds or dollars. How many toxic chemical exposures should be traded for a loss of an endangered species? Is it more important to reduce water pollution, air pollution, or solid waste?

Cost-benefit analysis fails, in part, because it depends on an impossible reduction of these multiple dimensions of value to the single metric of money. But the occasional attempts at other single metrics have also proved problematical. The currently popular calculation of "environmental footprints," or hectares of land required to absorb environmental impacts, is unable to include some important categories such as toxic chemical hazards, and in practice depends heavily on particular hypotheses about forest sequestration of carbon dioxide. In the wake of the 1970s energy crises, it was for a time fashionable to reduce a wide range of impacts to their equivalents in embedded energy; this, too, turned out to be simplistic if applied too widely. The health and environmental benefits that matter are intrinsically multidimensional; any attempt to reduce them to a single dimension of measurement does violence to our understanding of the issues.

Multi-criteria analysis accepts and builds upon this multidimensional set of objectives. Rather than a single score, or market value, multi-criteria analysis evaluates projects and proposals by multiple standards -- often six to eight criteria, although the number can vary. If a proposal looks good on some but not all criteria, multi-criteria analysis can report this finding in easily understood terms, whereas cost-benefit analysis or other unidimensional approaches would tend to hide the contrasting patterns of results from view.

The strength of multi-criteria analysis is its transparency in reporting such complex evaluations, where the result is not entirely black or white. It may be particularly well-suited to situations where different stakeholders emphasize different objectives, offering a formula for calculating and presenting everyone's favorite issues.

The weakness of multi-criteria analysis is its reliance on arbitrary judgments about the criteria. Both the choice of criteria to be included and the relative weight given to each criterion can bias the final result. There are too many possible criteria to include them all; choices about inclusion and exclusion must inevitably be made. In the evaluation of polyvinyl chloride (PVC) versus other common plastics, some studies find PVC to be at least as good for the environment as other plastics, while other studies find PVC to be far worse. Studies that endorse PVC generally do not include toxic chemical impacts as a criterion, sometimes on the grounds that it is hard to find systematic data on toxic exposures. Studies that criticize PVC generally emphasize its lifecycle toxicity as its principal drawback. In this case the choice of criteria appears to determine the result.

The problems do not end when the criteria for evaluation are chosen. How important are the criteria in relation to each other? Given the desire for a single, "bottom line" score, it is tempting to create a formula weighting the different impacts -- but once again, this may conceal the decisive judgment from view. Even a bar graph comparing disparate impacts embodies an implicit set of weights: how many hectares of wetlands would it take for one bar to reach the top of the page, and how many deaths for another bar to reach the same height?

Despite these limitations, multi-criteria analysis is still the right choice for some situations, where clear, conflicting objectives must be discussed and reconciled, and

where stakeholders are pressing rival claims. It is important to be aware of the limitations of the method when using it, and to recognize the influence of the arbitrary decisions that may be hidden in the framing of the question.

At times, the formal structure of multi-criteria analysis is helpful in organizing the discussion. In other cases, when the formal structure is problematical – for instance, because important effects cannot be measured – the next option may offer similar advantages, without the necessity to agree on criteria and quantitative scales for the multiple attributes that are relevant to the decision.

II.B. Holistic evaluation of costs and benefits¹⁵

Analysis of costs, and of benefits, is an essential part of any systematic thinking about public policy. The criticism of cost-benefit analysis, presented above, addresses just one specific, controversial way of expressing and weighing costs and benefits – based on monetization of individual benefits. A major problem with the dominant style of analysis is the atomistic and reductionist approach to the evaluation of health and environmental benefits: in effect, economists offer to break down the benefits into their component particles – so many avoided deaths, so many cases of bronchitis or bladder cancer prevented, so many hectares of wilderness saved –and provide an objective analysis of the monetary worth of each "particle" of benefits. It then appears possible to recombine the particles and determine precisely how much the public is willing to pay for environmental protection.

Too much information is lost, however, in the atomistic approach; the prices assigned to the “particles” of value are so artificial that the results do not necessarily agree with the public's actual desires, or indeed with common sense. Comparison of costs and benefits requires a different framework that uses the available information more appropriately.

Much of the information used in an atomistic analysis would also be relevant in a more holistic approach, where costs as a whole (usually expressed in monetary terms) and benefits as a whole (often largely nonmonetary) are considered together, but are not necessarily expressed in the same units. The evaluation of benefits and costs often means weighing pounds against people, ecosystems against economics. As a result, a deliberative process is called for. In addition to costs and benefits, there may be questions of rights and principles involved; the context may influence the decision in ways that economics cannot formalize; there are, in other words, ample reasons why rational deliberation about costs and benefits might differ from standard cost-benefit analysis.

It might appear that prices are implicitly lurking in the process of deliberation. A decision to spend a certain amount of money per life saved might be interpreted as a statement that lives are worth at least that amount. But there is no need to act as if saving every human life has an identical value. In the US, the death rate is coincidentally almost the same in downhill skiing and in working in the construction industry: both activities cause about one death per two million person-days. It would be unreasonable, however,

¹⁵ Much of this discussion relies on Ackerman and Heinzerling, *Priceless*.

to spend the same amount per avoidable death in both activities. Society has a much greater responsibility to provide protection in the construction industry than on ski slopes: construction work is done out of economic necessity, and involves risky activities undertaken at the direction of a supervisor or foreman; skiing involves risks resulting from a completely voluntary, self-directed, recreational pursuit.

Which is easier: to determine the appropriate monetary value of a life saved in the construction industry – or to vote on a proposal for safety regulations in construction? Rather than seeking to put prices on avoided deaths, it makes more sense to step back and evaluate proposals for life-saving expenditures as a whole. Assessment of overall impacts, not warring over minutiae, is what is needed to make a decision on a proposed regulation. If analysts can describe the costs, and separately the benefits, of a proposal -- here is what it costs, and here is the quantity of deaths and environmental damages that it avoids -- society can decide whether or not to "buy" the package as a whole. This is a far more transparent, understandable process than the attempt to put price tags on each individual component of the benefits.

Holistic evaluation is not the answer for every decision; there are cases that do not fit this paradigm. The problem of uncertainty, discussed below, calls for different approaches. However, when costs and benefits are known with reasonable certainty, but expressed in incompatible units, the holistic approach to evaluating costs and benefits is a valuable replacement for traditional methods.

II.C. The logic of precaution

What happens when the benefits of a policy change – or equivalently, the risks of continuing the status quo – are uncertain? Neither conventional cost-benefit analysis, nor the more flexible, holistic approach to evaluation described above, is well-suited to the problems of policymaking under uncertainty (aside from the rare circumstances when the probabilities of different outcomes are known). The natural inclination of risk-averse people, i.e. almost everyone, is to respond to uncertainty in a cautious manner, heavily influenced by the worst case possibilities. Although recognized by environmental advocates as the "precautionary principle," the focus on worst case outcomes often appears to be at odds with conventional economic logic.

There are, however, at least two rigorous economic theories of decision-making under uncertainty, which support the precautionary principle. One analysis, applicable in cases where nothing is known about the probabilities of different outcomes, is based on a little-known work co-authored by Nobel laureates Kenneth Arrow and Leonard Hurwicz.¹⁶ A more recent restatement of the Arrow-Hurwicz theory by other economists¹⁷ presents the

¹⁶ Kenneth Arrow, and Leonid Hurwicz, "An Optimality Criterion for Decision-making under Ignorance," in *Uncertainty and Expectations in Economics: Essays in Honour of G. L. S. Shackle*, C.F. Carter and J. L. Ford, editors, (Oxford: Basil Blackwell, 1972).

¹⁷ Richard T. Woodward and Richard C. Bishop., "How to Decide When Experts Disagree: Uncertainty-Based Choice Rules in Environmental Policy," *Land Economics* **73** (1997), pp. 492-507.

problem of uncertainty in terms of the “expert panel problem.” A panel of experts, all of whom have in-depth knowledge of an issue, disagree about the expected outcome of a policy proposal. All of the expert forecasts are known to be plausible, but nothing is known about their probabilities. In the absence of *any* information about probabilities, the standard models of economics and risk assessment cannot be used to make a decision. In particular, averaging the opinions of the experts is not a valid solution under these rules: using the average implicitly assumes that are all equally likely to be correct, which is not the same as knowing nothing about probabilities. If one side of the debate were much better financed than the other – as in a dispute between industry and citizens' groups – then the wealthier side could hire multiple experts to offer repetitive forecasts. This would inappropriately tilt the scales if all the experts' forecasts were averaged; it demonstrates one shortcoming of the assumption that all expert forecasts are equally likely.

Under the assumptions of the expert panel problem, it can be proved that all the information needed to make the optimal decision is contained in the extremes of the range of forecasts. That is, ignore the middle, don't look for averages or compromises, but just consider the best and the worst of the credible forecasts. In one broad category of policy decisions, involving regulation of potentially toxic chemical exposures, one extreme typically predicts that regulation will avoid substantial harm from continued exposure, while the other extreme asserts that the health and environmental harm is unproven, and predicts economic losses from needless use of more expensive alternatives. Evaluation of these two extremes resembles the holistic analysis described above: the rival forecasts involve harms measured in incompatible units, such as health impacts versus monetary expenditures. There is, again, no need to assign artificial monetary prices to health impacts, nor to value deaths consistently from one context to the next. People might, for instance, be more alarmed at deaths resulting from unknown (in advance), involuntary exposure to pollutants in the air or water, as opposed to deaths from voluntary risks that individuals knowingly undertake for themselves. Calculating an entire menu of values per death under different circumstances does not seem like a promising direction for policy analysis. The conclusion must be that the decision-making process, although informed by quantitative research, is irreducibly deliberative and cannot be reduced to a formula.

The focus on the extremes of the range of credible forecasts eliminates the impossible problem of choosing a single best, average, or consensus forecast in a situation of uncertainty and debate. In exchange, it creates a merely very difficult problem, of deciding who is qualified to be on the expert panel. The advance of scientific knowledge can often be seen as narrowing the range of credible expert positions, long before it arrives at a single consensus estimate. After some amount of research and debate, those who claim that tobacco does not cause lung cancer, or that fossil fuel use has nothing to do with global warming, lose their seats on the expert panel. The rules for deciding who has a seat, however, are themselves potentially subject to debate.

A second analysis, reaching similar conclusions, applies when we know only a little about the probabilities of different outcomes. In an important recent contribution to the

economic theory of climate change, Martin Weitzman has demonstrated that uncertainty is inescapable, and has a profound effect that is obscured by any simple average for the cost of carbon.¹⁸ Because the world is constantly changing, our latest estimates of crucial, uncertain effects – such as how hot the planet will eventually get if we continue “business as usual” carbon emissions – are inevitably based on a small number of observations. But this makes it impossible to evaluate the worst case possibilities: for example, if we have less than 100 observations of an uncertain effect, we have virtually no information about the 99th percentile of risks.

People routinely buy insurance against events with annual probabilities far below 1%, such as residential fires, or the deaths of healthy young adults. The 99th percentile (i.e., nearly the worst possible) outcome of climate change would represent a true global catastrophe. So rather than arguing about the 50th percentile, or the most likely outcome, perhaps we should “buy” life insurance for the planet against the 99th percentile of risk. If both extremes implied enormous risk – if, for example, one extreme implied enormous environmental risk while the other implied enormous economic costs – this analysis would suggest a focus on the two extremes, rather than the middle.

The methodology of comparing the extremes addresses a common criticism of the precautionary principle: the suggestion that it requires an expensive response to every fear, however small, and would lead to paralysis in practice. It is certainly possible to imagine a proposed protective regulation which would at best prevent only very small environmental harm, while at worst causing an enormous unneeded expenditure; there is no need to adopt such a proposal. Even in the “pre-economic” era of policy analysis, before the widespread adoption of cost-benefit methods, regulatory agencies have always rejected some proposals on the grounds that they would be too expensive.

Conversely, there are important cases where the comparison of extremes is equally lopsided in the opposite direction. In the case of climate change, one extreme of the credible forecasts suggest that a vigorous mitigation program, along the lines proposed by the Stern Review or even somewhat more, could avoid catastrophic changes in the earth's climate. The other extreme, if it is still credible, suggests that climate damages might, with luck, turn out to be minimal, so that by following Stern's advice, the world might end up overinvesting in energy efficiency, emission reduction, and other new technologies, spending perhaps 1% of GDP more than is strictly necessary on innovations in energy supply and demand. The risk of overinvestment in a suite of clever new technologies seems trivial compared to the risk of irreversible changes for the worse in the physical conditions of life on the planet.

II.D. Fixed targets and cost-effectiveness analysis

In the case of climate change, there have been a number of economic analyses that attempt to determine the optimal degree of mitigation, or the optimal upper limit on the concentration of CO₂ in the atmosphere. But cost-benefit analysis of this multi-century

¹⁸ Martin Weitzman, “On Modeling and Interpreting the Economics of Catastrophic Climate Change,” December 2007, <http://www.economics.harvard.edu/faculty/weitzman/files/modeling.pdf>.

problem, which inescapably involves uncertainty about priceless benefits and irreversible losses, leads to unimpressive, incomplete results. It is much simpler to approach the problem in a precautionary manner, focusing on the maximum atmospheric concentration of CO₂ at which unacceptable climate outcomes can be ruled out with a high degree of confidence. This has led to widespread supports for numerical goals such as staying under 450, or with somewhat greater risk 550, parts per million of CO₂ in the atmosphere.

Once goals have been set, then there is an important role for economic analysis in determining the least-cost strategy for reaching the goals – and for adjusting the strategy as conditions, and perhaps even the goals, change in the future. For a complex global problem such as climate change, the answers are far from obvious. This use of economics, known as cost-effectiveness analysis, avoids most of the pitfalls of cost-benefit analysis. It deals exclusively with cost minimization, largely avoiding the problems of priceless values; costs are much more likely than benefits to have meaningful monetary prices. Costs of environmental protection tend to occur sooner than benefits, so the problems of discounting across generations are reduced or eliminated. Uncertainty is directly addressed in the choice of a precautionary target. Economics remains central to policy decisions, but its role has changed: rather than drawing up the goal for policy, cost-effectiveness analysis is an essential tool for implementing a blueprint which has already been adopted by political deliberation.

For proponents of cost-benefit analysis, it is common to express climate damages in terms of the “social cost of carbon” (SCC), defined as the increase in damages caused by an additional ton of carbon emissions. In the cost-benefit framework, the benefits calculation, with all its flaws, seems to allow a precise estimate of the SCC. (That estimate is indeed precise, but also flawed: all the critiques of cost-benefit analysis and monetization of benefits, discussed above, still apply to calculations based on the SCC.) If one accepts the SCC estimate, it can be used for project evaluation, to determine the cost of a particular strategy for carbon reduction. Any project that reduces emissions at a cost lower than the SCC would pass the test, having benefits that exceed its costs. On the other hand, if a project would reduce carbon emissions at a cost greater than the SCC, it can be rejected and the taxpayers can be protected from spending “too much” on preventing climate catastrophe.

A partially analogous measure, the marginal cost of carbon reduction, can be calculated from a cost-effectiveness analysis. In principle, the least-cost strategy for reducing carbon emissions should involve listing all possible carbon-reducing measures, in order of increasing cost per ton of carbon reduction, and then going as far up the list as necessary to reach the target. The cost of the most expensive measure needed to reach the target determines the marginal cost of abatement; any project that reduces emissions at a lower cost per ton of carbon should be implemented, since it should be already included in the least-cost strategy. Thus cost-effectiveness analysis generates a different version of the cost of carbon emissions, based on emission reduction costs rather than damage estimates.

The use of the cost estimates, however, is quite different in the two approaches: in cost-benefit analysis, the social cost of carbon determines the plan, whereas in cost-effectiveness analysis, the plan determines the marginal cost of carbon reduction. The focus on the plan for carbon reduction, rather than the SCC, is appropriate because price incentives alone will never be sufficient to solve the problem. Many carbon reduction measures would be cost effective even at a carbon cost of zero – they are immediately profitable – but have not yet been fully implemented. Many more would be profitable at a cost of carbon below the current estimates of the SCC; these, too, are not automatically adopted once the SCC is announced. Other initiatives, in some cases as simple as providing broader access to information, technology, and financing, will be needed to carry out the full menu of “cost-effective” options.

Emission targets, lending themselves to cost-effectiveness analysis, can be set on a precautionary basis, as in the case of climate change. But this is not the only reason to set numerical policy targets prior to economic calculation. The transparency of simple targets may lead to greater public support; it is much easier to explain and adopt a 50%, or 70%, recycling goal, rather than engaging in complex calculations that claim to estimate the optimal quantity of recycling. In this case it is not the uncertainty and risk of catastrophe that motivates a numerical standard, but rather the importance of promoting public support and participation.

III. Better regulation: is less always more?

For the past 10 years, the mantra of UK government reform has been "better regulation." Like cost-benefit analysis, it has a sunny sound to it: who could be against regulations being better, or costs and benefits being analyzed? And like cost-benefit analysis, "better regulation" has come to have a more specific, less obviously attractive meaning in practice.

To some observers, less is more, and better regulation simply means deregulation. The not so hidden premise of this argument is that all pre-existing regulation is worse regulation, which we would be better off without. But surely this doesn't include the prohibition on child labor, or the ban on leaded paint and lead in petrol, or laws against race and gender discrimination... It is all too easy to think of cases where more is better. The category of regulations which we are better off without is ill-defined, shaped by anecdotes about occasional, ludicrously bureaucratic errors and needless burdens on business.

Equally important, there are cases where we would be much worse off without regulation. In the 1990s, as private enterprise rushed into Russia, some of the newly wealthy bankers began hiring gangsters to kill their business rivals. This is a perfectly logical way to increase market share, unless of course it has been prohibited by burdensome government regulations. In short, there is a need for thoughtful discussion of the appropriate size and scope of government activity, and the kinds of market

competition that should be allowed. Cutting back on every function of government is not in anyone's interest.

More serious proposals for better regulation call for regulatory impact analyses, consisting of cost-benefit analysis plus tabulation of several categories of unmonetized impacts. While the inclusion of multiple impact categories is admirable, it is unlikely to have much effect in practice. The definiteness of the cost-benefit "bottom-line" figure satisfies the desire for a single, simple evaluation; the accompanying text describing other effects will tend to be lost in the media, and in the final process of decision making. Since cost-benefit calculations are necessarily incomplete, it is misleading to report their conclusion; there is no way of knowing how incomplete the data are, or whether the cost and benefit sides are equally incomplete. Notice, also, that it is not necessarily an improvement to incorporate a few more impact categories into the cost-benefit analysis, if it remains fundamentally incomplete (as it must). If the additional information reinforces the existing slant of the analysis, for instance providing even more data on the cost side in a case where the calculation of benefits is more deeply incomplete, it could make a misleading situation worse.

The next two sections look at two important examples of recent UK policy proposals where cost-benefit analysis played a part, demonstrating in practice why alternatives are needed.

IV. Case study: aviation policy

In 2003 the Department for Transport (DfT) released its White Paper, "The Future of Air Transport," projecting a huge increase in air travel, arguing that cost-benefit analysis supported a third runway and sixth terminal at Heathrow, along with additional runways and expansion at a number of other airports, and suggesting that the alternative was unacceptable economic losses for the UK as a whole. In 2006, the Progress Report updated the White Paper's data and calculations, making only slight changes in the projections of future air travel, and reaching the same general conclusions. An accompanying technical report in late 2007 provided more detail and additional updates. Despite vigorous opposition from communities affected by airport expansion and from environmental advocates, the White Paper and Progress Report remain the basis for government policy, and the first steps toward airport expansion have begun, notably proposals for expansion at Stansted and Heathrow.

The DfT analysis can be faulted on several grounds. Its economic calculations are suspect even on their own terms; as with some of the American examples discussed above, it appears to mobilize data selectively to prove a predetermined conclusion. It fails to consider a viable next-best alternative, comparing airport expansion only to congestion and economic losses. And it does not recognize its likely incompatibility with other policies, above all the commitment to reduction in greenhouse gas emissions.

IV.A. Bringing airport economics down to earth

There are multiple flaws in the DfT analysis of the economics of airport expansion. Most obviously, it assumes long-term prices for oil which no longer seem realistic: the White Paper assumed \$25 per barrel in 2000 dollars, equivalent to about \$30 today; in November 2007 new DfT forecasts assume oil prices falling “from \$65 per barrel in 2006 to \$53 per barrel in 2030, with most of the decline occurring by 2012”.¹⁹ In late 2007, however, the price passed \$100. Even the Report’s high oil price scenario, \$82 per barrel in 2030, would represent a reduction from the price of oil as of this writing, while that report’s low oil price scenario of \$25 per barrel seems irrelevant to a discussion of future fuel costs.

A high oil price scenario today, reflecting risks in energy markets, would go well above \$80 – with a consequent increase in fares and reduction in the demand for air travel. The 2003 White Paper assumes that fuel costs represent (as of 2003) 10% of the cost of airfares, and that a 1% increase in fares leads to a 1% decrease in demand – in technical language, a price elasticity of 1 – implying that higher fuel costs should have a significant effect on demand. Assumed elasticities have been reduced in the latest documents, but still the inescapable uncertainties of long-term economic forecasting are particularly severe in the area of fuel prices; with a worst-case outcome in oil markets (i.e., long-lasting high prices), DfT’s expansion plans could end up creating expensive, unneeded capacity.

Other flaws in the analysis include the following, some of them documented in the detailed critique of the White Paper forecasts from the Greater London Authority (GLA)²⁰:

- DfT projects that the real price of air travel will decline by 1% per year over the long run, even with a constant fuel price; if instead fares remains constant, there will be much less growth in demand.
- Aviation has historically been exempt from fuel taxation. A gradual elimination of this loophole, bringing the duty on aviation fuel up to the level of the duty on petrol for cars by 2025, would eliminate the projected decline in the price of air travel. This would slow the projected demand increases. These demand increases supply a large proportion of the net economic benefits, classed as “generated user benefits”. With these demand changes, there is instead a net cost to Stansted expansion – in contrast to the White Paper’s projection of large net benefits.²¹
- Climate change costs of air travel are discussed, but not included in the White Paper calculations. The White Paper speculated that including the cost of

¹⁹ DfT, “UK Air Passenger Demand and CO₂ Forecasts,” p.18; <http://www.dft.gov.uk/pgr/aviation/environmentalissues/ukairdemandandco2forecasts/airpassdemandfullreport.pdf>

²⁰ Greater London Authority, “Heathrow Economics Study: Expansion of Heathrow Airport,” 2006, http://www.london.gov.uk/mayor/economic_unit/docs/heathrow-economics-study-nov06.rtf; see also Friends of the Earth (FOE), “Pie in the Sky: Why the Costs of Airport Expansion Outweigh the Benefits,” 2006, http://www.foe.co.uk/resource/briefings/econ_aviation.pdf.

²¹ See FOE critique (previous note), pp.7-8, and sources cited there.

emission permits might reduce demand for air travel by 10%.²² The Progress Report states that it includes the costs of emission permits beginning in 2010, but surprisingly shows demand to be almost unchanged from the White Paper. Climate change has been factored into the latest Heathrow Consultation, but (see later section) an unrealistically low price has been used.

- The value of time saved by travelers is a large component of the projected benefits of airport expansion. Although DfT does not state the value of time used in its analysis, a 1999 DfT technical paper assumes the value of time for business travelers is £62 per hour during working hours and £31 at other times. This is, on average, above accepted European standards for the valuation of time in air travel – and would tend to inflate the projected benefits of airport expansion²³.
- Claims that airport expansion will increase UK tourism revenues ignore the fact that outbound tourism is considerably larger than inbound; if both experience the same rate of growth, the result will be a net loss to the national economy as British citizens increasingly vacation abroad instead of at home.

As with some of the American examples of cost-benefit analysis discussed above, the "errors" in the economic analysis do not seem randomly distributed; rather, all tilt in the same direction, toward increasing the perceived net benefits of airport expansion. This tends to undermine any confidence that cost-benefit analysis provides a neutral, objective method of analysis.

IV.B. What is the alternative?

The White Paper projects enormous demand for air travel, and for air freight, but never seriously examines an alternative (aside from incremental changes in the degree of airport expansion). The alternative, it suggests, is a loss of competitive advantage, decreasing attractiveness of the UK as a place to do business or to visit, and reduction in the projected future growth rates of GDP and employment. The latter point has been exaggerated by the aviation industry into the threat of "massive job losses," although it is actually a projection of job *growth* at a slower rate than a rapidly expanding aviation sector would allow. Yet the option of limiting aviation merits more detailed examination. It seems unlikely that, if airport expansion were rejected, the alternative would be to passively watch the lights being turned out as the economy ground to a halt. A reasonable analysis requires comparison to the next best alternative.

With higher ticket prices and lower demand, it is possible that the status quo provides a viable alternative. If additional capacity for international air travel is not available, so that congestion at Heathrow becomes even worse than at present, the likely result would be even greater use of the Eurostar high-speed trains to Paris and Brussels, along with teleconferencing to reduce the need for business travel, and increased use of alternative hubs for international transit passengers who would otherwise change planes in London. None of these changes would represent a disaster for the British economy. If the

²² White Paper Appendix A, p. 150, paragraph 11.

²³ GLA critique, pp.5-6.

alternatives make expensive major airport investments unnecessary, freeing up funds for other uses, it is not clear that they would represent economic losses at all.

If alternative investments in transport infrastructure are needed, for instance for travel within the UK, what are the alternatives to airport investment? The White Paper suggests that two to three hours of travel by rail, for example from London to the Midlands but not further north, is the limit before air travel becomes more attractive. On the one hand, rising fares for air travel might extend this perimeter, perhaps making four or five hours on the train look reasonable; on the other hand, investment in upgrading railroads might extend the distance that can be traveled in any given number of hours.

A comprehensive evaluation of airport expansion requires a contrast to a fully fleshed out alternative scenario, perhaps centered on investment in rail or other transport modes. Choosing only between more and less airport congestion, as the White Paper and Progress Report suggest, is no choice at all.

IV.C. The shadow price of carbon: what does it buy?

In December 2007 the UK government published its new guidance on the “shadow price of carbon” (SPC), to be used to incorporate climate change into decision making. The guidance includes a thoughtful review of many aspects of the problem of pricing carbon emissions, and relies on the Stern Review, the best of the available cost-benefit studies of climate change. Yet despite these strengths, the new guidance produces an estimate - £26 per ton of CO₂ in 2008 (at 2007 prices), rising by 2 percent per year – that does not approach being a complete measure of the climate damages caused by carbon emissions. The SPC is misleading in its apparent precision, and far too low to reflect what we know about the threat of climate change. In the context of airport expansion, rigid application of the SPC could endorse far too great an increase in emissions.

The immense uncertainties surrounding the process of climate change have led to a correspondingly wide range of uncertainties in forecasts of future climate damages. The Stern Review incorporated more of these uncertainties than most economic models – and as a consequence, Stern recommended taking more vigorous and immediate action than a number of other economic analysts. However, even Stern fails to reflect the full range of climate risks; in particular, he uses dated, and implausibly low, estimates for the risks of an abrupt, irreversible catastrophe such as the loss of the Greenland ice sheet.²⁴ Moreover, Stern does not escape the problem of priceless, unmonetized impacts, as discussed above; he includes an arbitrary, modest estimate for the monetary value of all unpriced damages. Thus the real value of climate damages is uncertain, partially unmonetizable, and potentially much larger than the Stern estimates and the government’s current SPC. The cost of abatement needed to achieve a targeted level of reduction is subject to a much smaller range of uncertainty, and provides a more reliable basis for calculation of carbon costs.

²⁴ See Frank Ackerman, “Debating Climate Economics: The Stern Review vs. Its Critics”, <http://www.ase.tufts.edu/gdae/Pubs/rp/SternDebateReport.pdf> .

As noted in the discussion of the SPC, and the closely related concept of the social cost of carbon (SCC), the value of climate damages depends on the climate trajectory and the level of greenhouse gases in the atmosphere. The higher the concentration of greenhouse gases, the greater the damages will be from an additional ton of CO₂. Paradoxically, this means that if we do better in reducing emissions, the SPC should be lower; if we do worse, it should be higher. The current SPC is based on the assumption that the world will stabilize at 550 parts per million (ppm) of CO₂-equivalent in the atmosphere, the upper end of the arguably safe range according to Stern. By this logic, if we are not on track to the 550 ppm target, the SPC should be higher, encouraging greater reductions.

SPC and SCC calculations assume that the cost-effective, logical first steps toward carbon reduction will all be taken. Yet studies repeatedly find that many cost-effective energy conservation measures have not been taken; price incentives alone do not appear sufficient to achieve the large technical potential for reduction. Setting the SPC at £26 per ton creates the impression that if, say, an airport expansion program produces £27 of benefits per additional ton of CO₂ emissions, it passes the test and should be built. This conclusion rests, however, on the assumption that we have already eliminated all activities that generate £25 or less per additional ton of emissions. If that is not the case – if potentially cost-effective reductions are not yet happening – then the SPC may “endorse” a dangerous increase in total emissions. The prudent course would be to go slow on any major project that causes a big increase in carbon emissions, until we are sure that we are able to achieve the bulk of the available reductions.

IV.D. Busting the carbon budget

The White Paper on airport expansion is a long tale of alleged economic benefits and environmental costs. In one area after another, it is hard to deny that airport expansion has undesirable effects on surrounding communities and on the local and global environment. Issues of noise, land use, and local air pollution have motivated opposition to plans for bigger airports in many areas, including the London Council's opposition to Heathrow expansion. In this case, DfT's attempt at analysis and evaluation of individual externalities evidently fails to satisfy the people most directly affected; the atomistic approach to analysis, as discussed above, does not capture the values that are at stake. A holistic analysis -- based on an overview of what the package of airport expansion will do, including both its economic benefits and its undesirable environmental impacts -- might find many people rejecting it. For some of the impacts, it may be possible to compensate the affected communities; widespread opposition suggest that further negotiation with stakeholders is required, regardless of what cost-benefit analysis has found.

In two cases, the plans for airport expansion appeared to collide with absolute, already adopted environmental standards. The smaller problem is that Heathrow expansion will violate the EU standards for NO₂ air pollution that will take effect in a few years. It is possible that some local mitigation strategy could address this problem.

The much larger problem is that, as Tyndall Center research has shown, the current trend in carbon emissions from air transport is absolutely incompatible with the level of greenhouse gas reduction required to stay under 450 ppm; it is likely incompatible with even the looser goal of staying under 550 ppm – the figure which forms the basis for the government’s current SPC.²⁵ At present the emissions from international air travel are not counted as part of a country's domestic emissions, but there is a growing recognition that this leak in the system has to be plugged. If a flight's emissions are attributed to the country where it originates (or equivalently, half to the origin and half to the destination), the growth in international flights through Heathrow could consume an enormous fraction of the available emissions for the UK. If international flights are counted, then either the national carbon targets or the airport expansion strategy would have to change.

To address this problem, the cost-effectiveness analysis of meeting carbon reduction targets might usefully be contrasted to the analysis of the next best alternative, involving investment in rail transport or other options. In a carbon constrained world, such as the one we live in, it is not just the abstractly next best alternative, but the best alternative compatible with the applicable carbon limits, that should be considered. With a sufficiently high price and/or sufficiently low cap on available carbon emissions, the loss of international transit passengers passing through Heathrow en route to other countries might seem attractive: the meager economic gains from those who change planes at Heathrow could be outweighed by the cost of carbon for the UK's share of their flights' emissions.

V. Case study: waste strategy

In May 2007, DEFRA published its strategy for solid waste management in England. This massive document says many good things; it emphasizes waste reduction, proposes an increase in recycling targets, and reaffirms the goal of sustainable management of materials and waste. Look under the surface, however, and the details of DEFRA’s proposed waste strategy are based on a narrow version of cost-benefit analysis – in which the only environmental benefits that are monetized and counted against costs are reductions in greenhouse gas emissions. Even by its own standards, the DEFRA analysis rejects a higher recycling target by the narrowest of margins, ignoring the possibility that most people might be happy to pay a few pence per year for the numerous unpriced environmental benefits of recycling. Along with increased recycling, the new waste strategy calls for a rapid expansion of incineration, while slighting other, more ecologically benign technologies for energy recovery.

V.A. What are the goals of the waste strategy?

²⁵ Alice Bows, Kevin Anderson and Paul Upham, “Contraction & Convergence: UK carbon emissions and the implications for UK air traffic,” Tyndall Center for Climate Research, 2006, http://www.tyndall.ac.uk/research/theme2/final_reports/t3_23.pdf.

The waste strategy begins on a high note, emphasizing that its goal is to help to end the unsustainable consumption of natural resources, to break the link between economic growth and waste growth. The familiar “hierarchy” of waste management is prominently displayed, giving priority to waste prevention and reuse, followed by recycling and composting of “most” products, then energy recovery from other wastes “where possible,” and finally landfilling of a “small amount of residual material.”²⁶

These general statements of intent, however, are notoriously difficult to translate into action plans. Starting with the top of the hierarchy, there is no standard methodology for achieving a given level of waste prevention or reuse across the board. Initiatives in these areas must be tailored to individual products, and are often difficult to scale up. In practice, the biggest decisions, involving expenditures for new facilities and changes in collection practices, concern the balance between recycling and composting, energy recovery, and landfilling.

Recycling and composting are, for good reason, more popular than incineration and landfilling; they do more to promote sustainable material use, and cause less damage to human health and the natural environment. Thus one approach to waste management planning would be to determine how much recycling society can afford, and then do the best possible job for that amount.²⁷ For instance, one could calculate the least-cost method of waste disposal and ask how much people are willing to pay, above that amount, for recycling (see the discussion of “holistic cost-benefit analysis” above). Then it would be a matter of engineering and economics to develop plans for maximizing recycling within that budget constraint.

That is not, however, what DEFRA did in developing its waste strategy. Rather, it screened waste management options using a strangely limited version of a standard cost-benefit calculation. As usual, the costs are relatively easy to measure, consisting largely of well-defined monetary expenditures on facilities, collection vehicles, and labor. The environmental impacts of waste management, in contrast, do not have market prices (other than revenues from the sale of recovered materials or energy). DEFRA uses just one benefit to represent all environmental impacts – greenhouse gas emissions, valued at the social cost of carbon:

The monetised benefits are presented in terms of carbon savings. These are based on an assessment of climate change impacts as a proxy for total environmental impact.²⁸

With this definition of benefits, the cost-benefit test was evidently applied throughout:

Options are not taken forward in *WS2007* [Waste Strategy 2007] where the costs did not justify the benefits, where it was not yet possible to assess the costs and

²⁶ DEFRA, “Waste Strategy for England 2007,” p.9.

²⁷ The same considerations apply to recycling and composting throughout this discussion; for brevity, the text refers only to “recycling” in many cases, rather than repeating “recycling and composting” each time.

²⁸ Waste Strategy 2007, Annex A, p. 11, p.33.

benefits or where a new regulatory burden would be imposed without seeking a voluntary approach first.²⁹

That is, DEFRA's cost-benefit calculations identify the options that would minimize costs if greenhouse gases were priced at the current estimate of the social cost of carbon, while all other environmental impacts were ignored, or priced at zero.

It is hard to believe that greenhouse gas emissions, priced at the social cost of carbon, are an inclusive proxy for all environmental impacts of material use and disposal. The derivation of the social cost of carbon does not include any such proxy values; it is based strictly on estimates of climate damages. In the text of the Waste Strategy, as opposed to its cost-benefit calculations, many other environmental impacts are acknowledged: a sketch of the life cycle of a cell phone is not restricted to greenhouse gas emissions, but lists environmental effects including emissions to air, land, and water; impacts on biodiversity; raw material use; water use; ozone depletion; energy use; and transport impacts.³⁰ A complete list might emphasize the impacts of extraction and primary processing of raw materials as particularly damaging stages. The recent WRAP (Waste and Resources Action Programme) study reviews the state of knowledge on many dimensions of the environmental benefits of recycling, extending well beyond greenhouse gases.³¹ There is, of course, no obvious way to assign prices to all of these benefits – but that does not mean that people are wrong to care about them. If there are important benefits that are difficult to price, then it is perfectly sensible to advocate more recycling than a narrow cost-benefit analysis would support.³²

V.B. The costs of “too much” recycling

The waste strategy calls for recycling targets, currently 25% of municipal waste, to increase to 50% by 2020. On the one hand, this is a large increase; on the other hand, there is no suggestion that this is the maximum technically feasible level. How was it determined that 50% is the appropriate recycling target? The background documents to the waste strategy make it clear that DEFRA's version of cost-benefit analysis was decisive:

Many stakeholders are pressing for higher recycling and composting targets for household waste. ... Somewhat higher recycling levels [i.e., above 50%] in the later years (2015 and 2020) may be achievable but the results of our modelling (set out in the partial RIA) show this would incur significant cost which may not be justified by the additional benefits gained.³³

The RIA (Regulatory Impact Assessment), in turn, says

²⁹ Waste Strategy 2007, Annex K, p. 53, paragraph 181.

³⁰ Waste Strategy 2007, p.22.

³¹ WRAP, “The Environmental Benefits of Recycling,” 2006, http://www.wrap.org.uk/wrap_corporate/about_wrap/environmental.html

³² Frank Ackerman, *Why Do We Recycle? Markets, Values, and Public Policy* (Washington DC: Island Press, 1997).

³³ DEFRA, Consultation Document on the Review of England's Waste Strategy, 2006, p.23, paragraph 34.

Option E considers the impact of higher recycling levels. An option has been modelled that reaches 53% recycling by 2015 and 58% by 2020. (These are not the levels the Government is proposing in the consultation document and is not the Government's preferred option).

Option E incurs extra costs of over £770m (net present value). It shows additional environmental benefits valued at between £320m and £990m (net present value).³⁴

As shown in the detailed table later in the RIA, "Option E" has benefits of £320m at the low estimate for the cost of carbon, £540m at the medium estimate, and £990m at the high estimate.³⁵ The costs of £770m therefore lie almost exactly halfway between the medium and high estimates of the cost of carbon.

Even with DEFRA's exclusion of all environmental impacts other than carbon emissions, in other words, the costs of a higher recycling target fall well within the range of credible benefit estimates, given the current uncertainty in the social cost of carbon. To conclude that the higher recycling levels are not justified in cost-benefit terms, one has to believe that the medium estimate of the social cost of carbon is precisely correct – and that the implicit pricing of all other impacts at zero is correct as well. Even so, the net cost of the higher recycling target, at the medium cost of carbon, is a mere £230m for all of England over 16 years – less than 30 pence per person per year.

This is a *very* small gap. To suggest that this amount is decisive in cost-benefit terms, despite the numerous excluded benefits and uncertainties, is to fetishize the smallest projected economic effects. DEFRA's own cost-benefit methodology would endorse the additional recycling effort if any one of the following assumptions is accepted:

- the annual non-climate environmental benefits of a higher recycling rate are worth at least 30 pence per person, *or*
- the social cost of carbon turns out to be halfway between the current medium and high estimates (or higher), *or*
- the net monetary costs of increased recycling fall by 30 pence per person (perhaps due to higher prices for recovered materials).

In short, DEFRA's analysis could reasonably be described as finding that the difference in net benefits between the two recycling scenarios lies within the margin of error of economic and environmental forecasting. And in that case, why not make the choice that favors greater environmental protection?

³⁴ DEFRA, Partial Regulatory Impact Assessment of the Review of England's Waste Strategy, 2006, p.11, paragraphs 69-70.

³⁵ Partial Regulatory Impact Assessment, Annex G, pp.48-49. Note that these tables appear to compare two scenarios that reach 57% versus 59% recycling by 2020, rather than the expected comparison of 50% versus 58% recycling; the presentation of data in the tables is at least in need of explanation, if not simply a typographical error.

V.C. What role for incineration?

The narrow focus on climate impacts distorts one of the most critical questions in waste policy, namely the role of incineration. The waste strategy projects not only an increase in recycling and composting to 50% of waste, but also an increase in “recovery”, a category which includes recycling, composting, and energy recovery, to 75%. Incineration, currently handling about 10% of municipal waste, could rise to 25% by 2020 as part of the growth of “recovery.” The justification for this rapid expansion of incineration can be faulted on at least two grounds: the case for burning waste, on climate grounds, is not as strong as DEFRA suggests; and the leading arguments against incineration involve non-climate environmental impacts, which have been intentionally omitted from the cost-benefit analyses.

The climate impacts of incineration are the subject of a study by Dominic Hogg.³⁶ A waste incinerator which only generates electricity is better than a coal-burning power plant (i.e. has lower carbon emissions per kWh of electricity), but marginally worse than a new gas-fired plant. Incinerators which produce combined heat and power (CHP) can outperform gas power plants in climate terms, but only if the heat can be used to reduce fossil fuel consumption throughout most of the year. While some Scandinavian CHP plants meet this standard, most British incinerators produce only electricity.

When comparing incinerators to waste management options such as landfills, Hogg argues that the climate benefits of burning waste depend on the so-called “biogenic assumption,” which leaves much of the carbon dioxide from incinerators out of the inventory of greenhouse gas emissions. When plants grow, they absorb carbon dioxide from the atmosphere; when organic matter is burned, the same amount of carbon dioxide is released to the atmosphere where it can be absorbed by next year’s plant growth. Thus it has become standard to omit carbon dioxide from combustion of organic matter from greenhouse gas inventories and calculations, on the assumption that it is part of a biological cycle which causes no net increase in atmospheric carbon.

The biogenic assumption does not apply to carbon emissions from burning plastic waste, which is projected to be the source of an increasing fraction of the energy and emissions from incinerators. Moreover, the biogenic assumption conceals the fact that carbon emissions from incineration happen at once, while the corresponding emissions from landfills stretch out over decades as organic waste gradually decomposes.³⁷ An additional problem with the biogenic assumption arises when paper and cardboard waste is the source of energy and emissions from incinerators. It has become increasingly common for countries to claim credit for sequestration of carbon in forests, as trees grow. But if the growth of trees has been counted as sequestration, reducing carbon emissions, then the combustion of wood and paper made from those trees must be counted as increasing

³⁶ Dominic Hogg, “A Changing Climate for Energy from Waste?” (Bristol: Eunomia Research and Consulting), 2006, http://www.foe.co.uk/resource/reports/changing_climate.pdf.

³⁷ When landfills release carbon to the atmosphere, roughly half emerges as carbon dioxide and half as methane, a much more potent greenhouse gas. The same biogenic assumption applies to the carbon dioxide from landfills; the methane is counted as a net contribution to global warming.

emissions. The biogenic assumption can only apply to the combustion (or landfilling) of organic material if no credit for sequestration was counted as the material grew.

A reader could be forgiven for thinking that this intricate dissection of climate impacts was missing the main story about incinerators. Depending on the composition of the waste stream and the design of the facility, an incinerator may emit particulates, nitrogen oxides, heavy metals, and other pollutants; it may create dioxins, which cause cancer and other diseases even at extraordinarily low doses; and it leaves a substantial quantity of ash which requires land disposal. These troubling impacts are all excluded under DEFRA's single-minded focus on carbon emissions.

A more comprehensive cost-benefit analysis of incineration vs. landfilling, examining numerous types of emissions, was performed by two Dutch economists, Elbert Dijkgraaf and Herman Vollebergh. They used waste management costs for the Netherlands, along with environmental shadow prices reflecting Dutch marginal abatement costs for emissions.³⁸ Even in the most densely populated country in Europe, where land for waste disposal is presumably scarce, Dijkgraaf and Vollebergh found that landfilling was strongly preferred on cost-benefit grounds. The conventional cost of building and operating the facility was much greater for incineration, as was the environmental cost of air emissions and "chemical waste" (such as fly ash from incineration). The environmental benefits of electricity production from incineration were not nearly large enough to offset the advantages of landfilling on both financial and environmental grounds. While this study will not be the last word on the debate, it is a thoughtful piece of research that should be closely examined.

If the goal is simply to recover energy from waste, there are attractive alternatives to incineration that deserve consideration. Anaerobic digestion, in essence an advanced form of composting, can convert organic matter, such as food and garden waste, and paper products that are unsuited for recycling, into biogas. Most of the drawbacks of incineration can be avoided if source-separated organic material is fed into a digester and converted to gas, while inorganic materials, along with paper products, are recycled whenever possible; a small residue might still have to go to landfills.

Is this technology ready to use on a large scale (and if not, what is needed for its further development)? Are its costs affordable? How much would it reduce the environmental impacts (including but not restricted to climate impacts) of waste management? These questions deserve a serious analysis, taking a harder and deeper look at the issues than DEFRA's waste strategy was able to manage.

VI. Conclusion: Why not cost-benefit analysis?

Cost-benefit analysis, widely favored today as a technique for making public policy decisions, is a failure both in theory and in practice. In theory, it cannot comprehend important but priceless values, cannot escape the assumption that everything is for sale

³⁸ Elbert Dijkgraaf, Herman R.J. Vollebergh, Burn or bury? A social cost comparison of final waste disposal methods, *Econological Economics* 50 (2004), pp.233-247.

and can be traded off against everything else, and cannot accurately reflect the central role of uncertainty and the need for precaution in practice. It persistently tilts toward overstating costs, toward trivializing the future, and toward replacing clear policy debates with obscure technical quarrels. The American experience with cost-benefit analysis, above all under the second President Bush, does not inspire confidence in the utility or fairness of the methodology.

The introduction or continued use of cost-benefit calculations does not provide “better regulation” for the UK, as the examples of aviation policy and waste strategy demonstrate. The case for airport expansion rests on uncertain forecasts and judgments about a host of parameters, from oil prices to the value of time spent in congested airports, and the continued downplaying of environmental impacts such as climate change. The case against a higher recycling target, and for a rapid expansion of incineration, rests on a strangely narrowed form of cost-benefit analysis, from which all environmental impacts save one have been banished. Even so, the more ambitious recycling targets favored by many citizens and stakeholders lose by only a whisker: they would, on DEFRA’s own reckoning, impose the ruinous additional costs of 30 pence per person per year.

This is not a sensible way to make decisions. It is not an almost-perfect methodology in need of a small adjustment. Rather, it is a profoundly mistaken representation of our collective choices, our understanding of economy, environment, and their complex interactions. Books have been written about the limitations of cost-benefit analysis.³⁹ It is past time to reject this mistaken path, and turn to something better. Alternatives are easy to find: multi-criteria analysis explicitly recognizes the plurality of objectives; a “holistic” evaluation of monetary costs and nonmonetary benefits acknowledges the irreducible complexity of many issues; a precautionary approach to uncertainty is recommended both by common sense and by advanced economic theory; cost-effectiveness analysis of the least-cost strategies for meeting society’s targets can make better use of the sophistication and power of modern economics, once it is freed of the theoretical confusions and mystique of cost-benefit analysis.

For the debate on the Climate Change Bill, and for climate policy in general, it might appear that the Stern Review has used traditional cost-benefit techniques to good effect. Yet this is not a reason to forget the many limitations of cost-benefit analysis. The case for action on climate change is based on the clear scientific consensus: our common future is at risk; without strong, immediate action, our children and grandchildren will inherit a degraded earth. Meanwhile, a technical dispute is raging among economists about whether Stern’s analysis of costs and benefits was accurate, or overstated the urgency of the problem. How many of us would be ready to reject the scientific consensus on climate change, and downgrade the problem to one requiring only slow, gradual responses, based on the outcome of a controversy among economists?

That question, repeated for other issues as well, goes to the heart of the problem. Far from being transparent and objective, cost-benefit analysis transforms public policy into a

³⁹ See Ackerman and Heinzerling, *Priceless*.

technical dispute accessible to only a few. If you are content to let a debate among economists tell you how important public health and nature really are, and what (if anything) to do about it, cost-benefit analysis might be the answer for you. If, on the other hand, you know that human health, the natural environment, and the hope of a sustainable future are at serious risk and in need of protection, you are already on the road to a better way to make decisions.