VALUING NATURE PROGRAMME

VNP18

Demystifying Cost Benefit Analysis

Valuing Nature Paper | October 2019

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Introduction: **Why cost benefit analysis?**

Nearly all decisions involve trade-offs: investment now to produce future benefits; spending a limited sum of money on one project rather than another. Or even where to go on holiday!

Put simply, proper analysis of the costs and benefits of such trade-offs makes for better decisions. And in many cases decisions – particularly in government and large companies – will simply not be ratified without such analysis. However, such analysis – while an important input – should not be used to hide fundamental political or business decisions. Analysis supports decisions but the decisions are made by people, who will ultimately answer for them: to the public or to company boards and shareholders.

Of course, analysis needs to be proportionate: the business case for HS2 needs more analysis than a small pilot project. But we should be clear: a short cut to decision making which leaves some costs and benefits out is not without risk: if we do not include or value a benefit or cost, then implicitly we are placing a zero weight/value on it. Historically this has been a particular issue for some environmental benefits. This is seldom right.

[1] With editorial help from Ece Ozdemiroglu, Economics lead, Valuing Nature Programme Coordination Team.

[2] The views in this document should be taken as those of the author and not of any specific organisation. He retains all responsibility for any errors and omissions.

What this means in practice:

- Major policies for issues such as energy or transport will involve choices between solutions — for example, between energy efficiency and new supply, or between road and rail solutions (where, centrally, biodiversity and carbon implications are radically different). Such choices need to be properly analysed with regard to the costs and benefits of each solution.[3]

- Once solutions have been identified, major projects need a detailed analysis of costs and benefits. This should look at all relevant factors (including habitats/biodiversity), test analysis against alternative scenarios (e.g. for the size of the economy and the population, the impacts of climate change etc.), and make an allowance for 'optimism bias'/allow a 'contingency reserve'. This is even more true for a highly contentious project such as HS2 or Hinkley Point, where arguably the analysis needs to incorporate many more factors — e.g. stakeholder engagement, legal requirements, a wide analysis of alternatives including demand management. The analysis may form part of the evidence at public enquiry or investment committee/main board assurance and part of the audit trail for later evaluation (e.g. by the National Audit Office or Public Accounts Committee).

- For projects such as road or flood schemes, where the Treasury (or a company HQ) have allocated a fixed overall budget, proper analysis of costs and benefits will help ensure that the most valuable projects get financed. Usually in these cases there are agreed templates for identifying, recording and comparing these costs and benefits — and importantly there will be agreed approaches to including impacts on nature.

- Even for a small project[4] or a minor policy change, for which a very detailed analysis would be disproportionate, identifying the costs and benefits and the winners and losers is simply good practice.

[3] It has been suggested that left to themselves governments will tend to: a) delay difficult decisions for too long (e.g. how to expand London's airport capacity); b) avoid solutions which reduce demand (e.g. road pricing, increases in water bills); c) underinvest in maintaining existing assets (e.g. water before privatisation) and in 'resilience' (including adaptation to climate change); d) accelerate on occasion some projects for short term political reasons (e.g. the Humber Bridge announcement which was made allegedly to coincide with a key local byelection); and e) tend to relegate some environmental aspects to the land use planning system. While proper analysis cannot and should not necessarily change this, it will at least ensure that such decisions are made in knowledge of the consequences.

[4] A small project cannot of course be defined solely by cost – a project with an important environmental or social outcome, even at low financial cost, is too important not to merit proper analysis.

There are a range of tools to analyse trade offs:

- Formal cost benefit analysis (CBA), which seeks a monetary value for all costs and benefits, discounted over time, and derives a Net Present Value (NPV) and/or a Benefit Cost Ratio (BCR).
- Wider analysis of costs and benefits. This uses monetary values where possible, but also identifies harder to value aspects such as the impact on poorer parts of society and those environmental impacts where monetary values are not available. This is sometimes referred to as 'social cost benefit analysis'.
- Other tools such as multi criteria analysis, which place 'scores' on all aspects of a project and apply weights to these scores. This is less precise than more monetised analysis as scoring/ weighting is inevitably in part subjective.

This paper covers the first two approaches. That is not to say they are intrinsically superior to other approaches – and indeed in many cases using more than one approach is best. But for better or worse they are the approaches mainly used and indeed universally required in the UK – and similar countries – by government.

Within this, for larger or more complex projects good practice is very much to adopt the second approach (often augmented by multi criteria approaches) and it is this which is described in the paper. But the first approach can have utility in comparing similar projects: e.g. it is used to compare some flood defence schemes to choose the scheme with the higher BCR.

The context for Cost Benefit Analysis in the UK: the Treasury Green Book, project Gateways and the 5-case model

The HM Treasury Green Book, updated last year for the first time in over a decade, describes itself as the 'definitive analytical guidance for government'. The revision reflects long term and positive collaboration between HM Treasury and the Natural Capital Committee through which the natural capital approach has been brought into government appraisal of spending options.

The Green Book defines its scope as covering:

- Policy and programme development
- All proposals concerning public spending
- Legislative or regulatory proposals
- Sale or use of existing government assets
- Appraisal of a portfolio of programmes and projects
- Structural changes in government organisations
- Taxation and benefit proposals
- Significant public procurement proposals
- Major projects
- Changes to the use of existing public assets and resources

It sets out an overall approach to these issues:

- Justify the rationale for intervention
- Generate options and undertake 'long list appraisal'
- Narrow options down to a short list and then decide on a proposed solution
- Monitor progress and evaluate success against the initial success factors as the project is completed.

These are reflected in the 'policy cycle' presented in the Green Book.

Policy Cycle Source: HM Treasury (2018).

The Business Case

Rationale

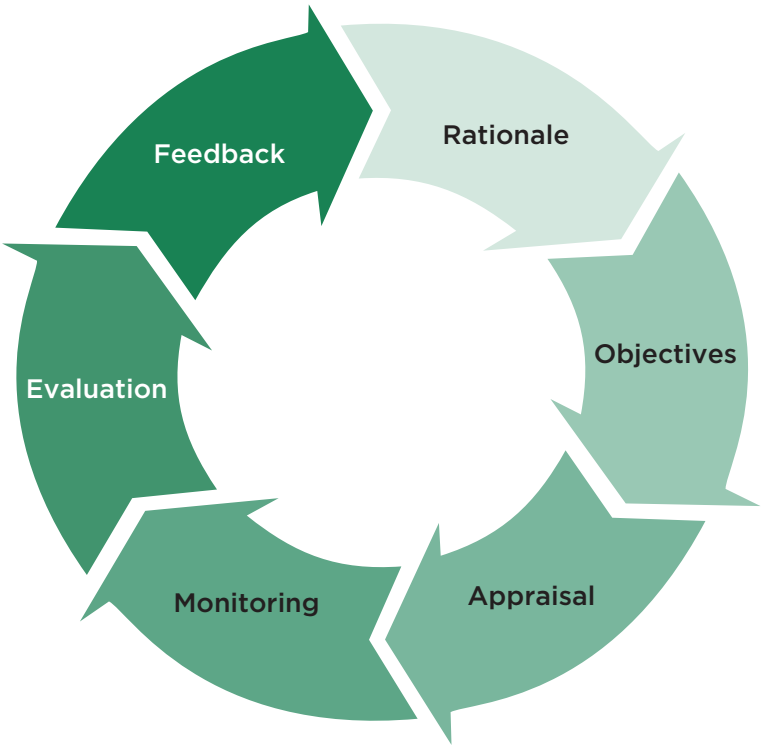
Objectives

Appraisal

Monitoring

Evaluation

Feedback



Social Cost Benefit Analysis[5] is perhaps the major tool used in the generation of options and in particularly the narrowing down of options and deciding on the proposed solution.

The Green Book also advises on the construction of scenarios and sensitivity analysis, the treatment of risk/uncertainty and discounting: topics which we cover in later sections of this paper.

Perhaps the main critique of this approach, which in general is well judged, is that governments can move too rapidly towards a specific project, without fully assessing the high-level strategy and non-project options such as demand management. Another critique which has been levelled is that there can be insufficient differentiation between the particular issues surrounding 'mega projects' and more normal projects. There is perhaps too much of a tendency to adopt a one size fits all approach (Hurst, 2019).

[5] A reasonable definition of this is 'analysis of all possible costs and benefits of the options of achieving an objective'.

Once short listing is done, progress on projects in Government is, in general, assessed at three key 'Gateways':

- Initial approval to proceed — assessed through the 'strategic outline case' (SOC)
- Approval to proceed to procurement — the 'outline business case' (OBC)
- Approval to commence work/sign contracts: the 'final business case' (FBC)

The three 'cases' should each be constructed in five parts:

- The strategic case: why is the project being proposed, what is it seeking to achieve
- The financial case (constructed in cash terms): how much does it cost and what, if any, are the financial pay backs. This is often conflated with 'value for money'. In fact, value for money is a more subtle concept than this, and should take into account wider costs and benefits than simply financial ones
- The economic case (in inflation adjusted 'real' terms): what are the monetised and non-monetised benefits, what is the net present value etc. In essence, this is the social cost benefit analysis and where much of the environmental assessment will be included
- The management case: how will the project be run. What are the key milestones and dependences, how are risks managed etc.
- The commercial case: what are the options for procurement — either of the whole project or of key inputs, how will this be run, and how will best value be secured and how will any contracts be managed.

(Social) Cost Benefit Analysis

Given this context, how does one construct a cost benefit analysis?

In what follows we assume that the overarching objective of the project is clear and well defined. This is not however a given. While it is beyond the remit of the practitioner to decide what outcomes are desired, we strongly recommend before starting on a CBA the practitioner satisfies themselves that the objective is suitably defined and that there are no more 'grey areas' than are strictly necessary.

Defining options[6]

As the above section says, as one proceeds through a project the range of options are narrowed down. So, at strategic outline case – i.e. when one is deciding whether to announce/create a formal project – there should be quite a full assessment of alternative ways of delivering the objective. But by the time one reaches final business case – signing a contract – there may be no more than an assessment of proceeding against doing nothing. Equally, the amount of effort that is put to detailed analysis will be greater by FBC stage. At SOC analysis of impacts may be more impressionistic.

In what follows we mainly look at the assessment of a particular proposal against not proceeding. But the principles are equally valid for a wider range of options.

Setting the baseline

Going further, it is necessary to think very carefully about what one is comparing the project with: in other words **what might happen if the project did not go ahead**. A bit of lateral thinking helps.

Comparing with and without' states of the world is not the same as comparing the states before and after a project. There could be many factors that lead to changes after a project, while CBA tries to identify what changes are solely due to the project.

Baseline is sometimes referred to as the 'do nothing' option. It is not the same as looking for the 'opportunity cost' of a project – how at the margin one might spend the money if the project does not go ahead: that is tackled below.

[6] There is no unique definition of an 'option' but something like 'an action/ set of actions that are feasible ways of achieving the given objective' would fit the bill most of the time.

Setting the baseline: an example

Suppose one is considering increasing airport capacity in the South East of England. A simple analysis might be to simply work out the direct costs and benefits against a scenario where everything else stays the same. But how far is this realistic? If capacity is not created will the lack of extra flights mean people simply don't travel or will some of them travel through other means. In the absence of extra capacity in the South East of England, might other airports (for example Schiphol or Charles de Gaulle), expand to take some of the transit flights. If either of these are the case, it is probably wrong simply to add up the carbon from the new flights from the South East of England, or to attribute the full benefit to passengers to the extra South East airport capacity. It may even be too simplistic to look at the local biodiversity/habitat implications: expansion elsewhere may well have its own implications.

Finally, of course there is a credible argument for ensuring that air travel faces the full costs it imposes — e.g. in terms of carbon emissions. This might require increased costs of flying and therefore lower demand.

We take it as read that before one gets to do a CBA, one has a very good idea why the project is needed and what success looks like – see the strategic case and the 'justify the rationale' parts of the Treasury Green Book.

A digression: projects, programmes and portfolios

It is important here to understand that while the Green Book analysis is mainly concerned with individual projects, there are also issues about how projects interact with other related projects in programmes, and how, at a wider level, even seemingly unconnected areas have important 'dependencies' between them. The wider one casts the net the less cost benefit analysis can tell us.

For example, supposing there is a problem with sewage treatment capacity in a town. The water company may create a programme of works to address this, including: a) expanding the existing sewage treatment works (one project) b) paying developers to create 'grey water reuse projects, such as diverting water in new housing from showers to flush toilets, thus reducing the amount of water needing treatment, and also saving water (a second project), and c) creating new 'sustainable drainage' to ensure that rain water does not run into the sewers placing extra burden on the network (a third project). CBA can both be used to justify each project but also to help decide on the optimal mix of projects in the 'sewage management programme'.

But the specification of the sewage treatment works expansion will be designed in part to reduce water pollution in the river into which treated sewage is discharged. The desired specification may depend on how much pollution is already entering the river upstream from farms (e.g. through use of fertilizers or from cattle manure running off into the river when it rains). This may be uncertain and very hard to judge[7]. Some of these things may not be determined until well after the project has been completed.

Finally, the water company may be judging between 20 or 30 of such projects and increases in customer bills (a portfolio). These may all have requirements on scarce resources (e.g. legal and procurement teams and/or on cash flow). It may therefore be deciding on sequencing between projects and on issues such as the extent to which key decisions can be delayed in time to better understand pressures from population and/or climate change.

Long List and narrowing down costs and benefits

A good first stage here is to write down or workshop **all the possible costs and benefits**, without attempting to put values on them. It is particularly important to think quite widely and out of the box at long list stage.
So, for example, think about issues like:

- How much energy might be used in constructing and then operating the project? How much carbon/greenhouse gases does this generate?
- Who benefits and faces costs? Are there groups in society who benefit more or less from the project? Is there a particular impact on disadvantaged groups?
- What are the impacts of building the project: is there disruption to traffic/local residents?
- How might we judge wider environmental impacts (for example on air pollution, or habitats)?
- Where might jobs be created, or lost? And do these jobs create lasting skills?

[7] This is one example of a much wider point: natural capital approaches suggest that many biodiversity impacts will depend intensely on what is happening elsewhere across a habitat, catchment or wildlife corridor.

- Are there groups of people (taxpayers, utility bill payers) who might legitimately have views and place costs on some of the options? Usually the first will be covered by the government, but utility bill payers may not have a similar voice. For example, the Thames Tideway super sewer requires an increase in Thames water bills to pay for the infrastructure. But many of those bill payers live nowhere near the parts of the river which will see reduced sewage discharge. They may place an existence value on the quality of such a unique river. Their individual benefit will likely be less than those who live near the river, but in totality of their benefit may be more than those who live near the river – depending on the relative size of those who live near and far from the river.

- Are there people who care about some of the benefits/costs who will not directly benefit? For example, many people will place an 'existence value' on totemic species or habitats, even if they may never see them. If we limit CBA to 'use values' only we will underplay environmental costs.

This may sound quite straightforward but seldom is. So, for example, a new road scheme may be designed to ease congestion – a big benefit in itself. But in as much as it makes travel easier, it will increase the number of journeys, and thereby in time the congestion benefit may be eroded. Construction will itself create short term congestion. There will be a cost of land take and nature destruction. And while local congestion may be reduced by the scheme it may also place greater burden on the roads at either end of the scheme.

The next step is to undertake/commission such modelling as is required to **estimate the extent of change in key variables** – so for example to estimate the amount of air pollution, the impact of local biodiversity against a background of other existing pressures, the extent to which it impacts on population centres or workers, and to estimate the number of journeys a transport project may facilitate/generate. This will also allow one to assess which, if any, of the costs and benefits you have identified are negligible and can be described only for completeness sake. However, it is important to be clear about what constitutes a proper assessment of 'negligible' – inability to value or quantify an impact is not a reason for ignoring it.

In some ways these last two stages (the do nothing and the narrowing down of costs and benefits) are both the most important and the most creative. There is no simple algorithm or set of instructions – you have to think: hard. Brainstorming sessions and stakeholder engagement may well help.

Valuing costs and benefits in monetary terms

After this, one needs to **assess which costs and benefits can be** put into monetary terms. In some cases, this is straight forward: a central estimate project cost can usually be estimated in cash terms (obviously this figure will have more solid basis once one has tested the market – i.e. at FBC stage). And there are also well-known values for things like journey time saved and the value of reduced deaths from lower air pollution. That is not to say these things are uncontroversial, indeed there is a huge debate about them. But it is simply not possible to try and get to the bottom of the debate for each cost benefit analysis.

Environmental costs and benefits that are covered in the Green Book and WebTag (the appraisal guidance used by the Department for Transport) include time savings, the 'value of statistical life', the value of quality adjusted life years, carbon and greenhouse gas effects, mortality and morbidity from air pollution, impact on land and landscape value, increase or reduction in noise, flood risk and coastal management impacts, changes to water, soil, habitat quality and amenity or welfare impacts of landscape, and recreational opportunities. Tricky issues include estimating the generated labour demand/skills enhancement, tax effects but these are outside the scope of this paper.

Economic valuation methods are covered in Demystifying Economic Valuation (Ozdemiroglu and Hails, 2016).

Optimism bias and contingency

Over the past 15 years there has been an increasing body of analytical literature about the tendency for public and private sector projects to come in late and over budget. In fact, the two phenomena are related: project delay is a major source of cost overrun. Early analysis was undertaken by a team led by Bent Flyvbjerg. This has been built on by Flyvbjerg himself and by the UCL Omega team [8].

[8] http://www.omegacentre.bartlett.ucl.ac.uk/

There are a number of conclusions of this work, including the need to understand the 'context' or 'operating environment' within which a project is being delivered and the fact that most infrastructure (and IT) projects are not only about the physical 'build' but also the change in behaviour/culture which these projects entail – and that these latter elements tend to be underplayed. But for our purpose, one key finding is that project teams will tend to create an unconscious bias about their costs and benefits, tending to overestimate direct benefit quantities and timings and underestimate project costs and timings.

To some extent this has always been accepted: so, construction projects will tend to have a 'contingency' built in. But in modern practice there is a clear requirement to build optimism bias into formal analysis of costs and benefits. Such a figure should be higher in early stages (e.g. at SOC) than later on, once the basic procurement costs are (in contractual terms at least) understood.

Non monetised effects, distributional analysis

Separate literature also suggests there is a systematic tendency to underestimate some non-market costs, such as environmental costs – particularly wider impacts such as on biodiversity corridors/interaction with other pressures on habitats. One of the findings of the UCL Omega work referenced above is that this is a systematic tendency particularly in Anglo-Saxon economies – with a traditional rather conservative approach to such valuation – and hence the UCL preference for the use of techniques based around multi criteria approaches. That said, the Green Book is itself clear that monetisation will not always be possible and that such impacts should not be ignored.

Examples of non-monetised effects (or effects where monetisation is so imprecise as to be dangerous [9]) might include:

- Some aspects of distributional analysis: e.g. impacts on inequality through changes to the 'Gini coefficient'; regional impacts; non-standard impacts on particular genders/races/ages; and
- Some environmental impacts: for example, the impact of microplastics on sea life and or impacts on the operation of biodiversity 'systems'.

Discounting, inflation and constructing the Net Present Value

Having assigned values to costs and benefits, it is possible to **estimate how monetised costs and benefits change over time**. It is important to do this in real terms – i.e. after adjusting for inflation – in particular the available project costs may well be in cash terms, but many of the benefits will be in real terms, so the former needs to be adjusted to ensure there is a genuine comparison of like with like.

Before moving to the next step, it is important to understand discounting. Once the appropriate discount rate has been chosen, and the optimism bias added in, we can now calculate a discounted net present value (NPV) of the monetised costs and benefits. This is simply the discount values of net benefits. A positive NPV means benefits exceed costs; and a negative one means costs exceed benefits.

It is also relevant to present/calculate the benefit cost ratio. This is simply the ratio of discounted benefits to discounted costs. A BCR above 1 means benefits per £1 invested are greater than £1 and this is equivalent to a positive NPV. A BCR of below 1 is equivalent to a negative NPV.

[9] For example, the habitat loss — service loss relationship is not a simple linear one. Say for an infrastructure project, if x% of a habitat is lost, services may be damaged by x% or all services may be lost, if x% changes the ability of the habitat to function. This is a scientific question rather than an economic one — but if there isn't sufficient consensus here a purely valuation approach is not justified. It also illustrates why the cost benefit analyst needs to be more than simply an economist.

For some projects within a fixed budget – e,g. flood defence and road schemes – the BCR offers a simple way of comparing projects – those with the highest BCR would be funded first. In government at least, different types of projects will require a different marginal BCR in order to receive funding. Rail schemes may require a BCR of 1.5, flood schemes as much as 8.

Discounting

Discounting accounts for the fact that people generally prefer to receive goods and services now rather than later ('time preference'). It should be applied to future costs and benefits, and it is important to note that this process is separate from adjusting for inflation. The discount rate is the rate at which the present is valued compared to the future, and for society as whole it is known as the 'social time preference rate' (STPR). The STPR has two components:

- **'time preference' – reflects the preference for value in the present rather than the future (ρ)**
- **'wealth effect' — since per capita consumption is expected to grow over time, additional consumption in the future is less valuable than consumption today. This reflects the diminishing marginal utility of consumption: as consumption increases the utility derived from each additional unit fall (μg)**

Hence it is represented mathematically as $r = \rho + \mu g$

Time preference ρ includes pure time preference δ (measure of impatience) and systemic risk L (the probability of a major disruption, which incentivises consumption in the present). The wealth effect equals the marginal utility of consumption μ multiplied by the expected growth rate of real per capita consumption g.

This method is of course an inexact science, as ρ and μ vary by individual, we cannot know their precise values at a societal level. But there is a wide literature which suggests that the societal discount rate – as used in discounting future costs and benefits – is lower than the rate which individuals would choose.

CBA decision rules: Net Present Value and Benefit Cost Ratio

The Net Present Value of an action equals the total value of discounted benefits minus the costs of that action. When calculating NPV one must include all identifiable costs and benefits, the discount rate and, where relevant, the optimism bias. If all societal costs and benefits are included, the Net Present Social Value (NPSV) can be calculated. The NPSV summarises the overall impact of an action.

For example, a business is planning a project which requires an estimated initial investment of £10 million and provides estimated benefits of £4 million per year from year 1 due to improved efficiency. The discount rate is assumed to be 4% and the optimism bias 3%.

Costs and benefits (£m)	Year			
	0	**1**	**2**	**3**
Nominal cost	-10	0	0	0
Cost including optimism bias	-10 x 1.03 = -10.3	0	0	0
Nominal benefit	0	4	4	4
Benefit including optimism bias	0	4 x 0.97 = 3.88	4 x 0.97 = 3.88	4 x 0.97 = 3.88
Net benefit	-10.3	3.88	3.88	3.88
Discounted net benefit	-10.3	3.88 x 0.96 = 3.72	3.88 x 0.96^2 = 3.58	3.88 x 0.96^3 = 3.43

NPV = Discounted benefits – discounted costs: (3.72 + 3.58 + 3.43) – 10.3 = £0.43 million

BCR = Discounted benefits / discounted costs: (3.72+3.58+3.43)/10.3 = 1.04

Uncertainty/sensitivity

One thing is almost certain on projects. Whatever the precise central estimate for the costs and benefits in the business case, that will not be the figure which is actually the case once the project is considered after completion. It is therefore really important to avoid over dependence on a point estimate.

All practitioner guides therefore recommend undertaking some scenario work. Typically, this might look at:

- The effects of external parameters: economic growth, climate change.
- Internal factors: what if the project takes longer because of changes in the number of person days needed in construction; what happens if a rail tunnelling project has issues with communication between signalling (e.g. Jubilee line, Cross rail).

There is also a strong case for sensitivity analysis, looking at your key assumptions and investigating the effect of changing them. So, for example, what happens if construction price inflation is different, or if financing costs vary.

To be frank, although the literature attempts to create a clear distinction between scenarios work and sensitivity analysis in practice this needs a degree of pragmatism. For example: where might the increase in construction prices come from: the answer is – probably from a change in the economic scenario!

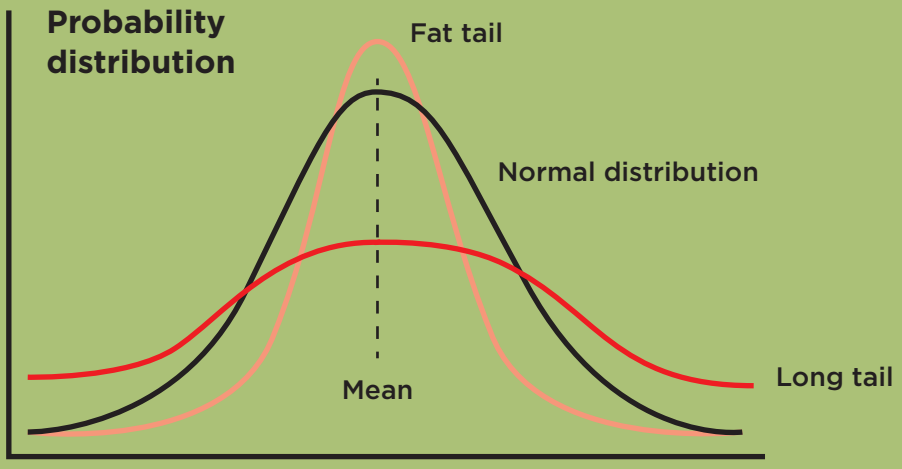
The UK government sometimes uses a P50 / P90 approach to present these (more often the second of these). P50 is the central case (probability 50%). P90 is close to 2 standard deviations.

Whatever tools you use, understanding the margins within which you are figuring for how much costs and benefits might vary is really important. A project with a relatively tight range of costs and benefits is much safer than one with very wide ranges.

These ranges can be examined using tools such as monte carlo analysis and switching techniques, which are beyond the scope of this paper. But care is needed, the point below about asymmetric distributions can render them inaccurate.

A note on expected value / fat tailed / long tail distributions

A number of approaches to uncertainty and to NPV – for example, P50 and P90 analysis that present a central figure with some sensitivity analysis assume that probabilities and impacts are symmetric around the central case. Increasingly we know this is not the case. A classic example is climate change. A central scenario of (say) a 2-degree temperature increase has an impact perhaps ⅓ of the impact of a 4-degree increase. This is what is referred to as a fat tailed and/or long tailed distribution.



It may well not be sufficient in these cases simply to present a 'central' NPV and present a few sensitivity analyses plus a P90.

Note that: E(NPV) = the sum of probability for each scenario times NPV for different scenarios. For a fat tailed distribution E(NPV) will be markedly different from and may even have a different sign to the central case NPV - the NPV of E(outcome).

Opportunity cost

Few projects will have a decision rule for progressing simply that the NPV, plus any allowance for non-monetised benefits, is positive. In other words, it is generally not enough simply for the benefits to outweigh the costs. This is for two main reasons:

- In government there are controls on total public spending. So, for floods or road schemes for example there will be a fixed total budget. Typically, there will be many more positive NPV projects than there is money to fund them.
- In the private sector, often there will be a required rate of return for projects which includes not only the organisation's cost of borrowing but also a required margin above that. It is not untypical for projects to require a rate of return in excess of 15% (so for example the project would only be funded if it has a positive NPV using a discount rate of 15%).

So, for any project it is important for decision makers to understand what the money which a project costs could alternatively be used for: the opportunity cost. For anyone undertaking an analysis of costs and benefits it is important to conduct analysis and present results in a way which enable these trade-offs to be undertaken.

Opportunity costs: an example

An example which brings together the concept of opportunity cost and the value of being able to monetise ecosystem services is the flood defences for the Yorkshire town of Pickering. In the UK money for flood defence is 'rationed' by the Treasury's spending settlement. So typically a flood defence may only be funded if, among other things, it has a benefit cost ratio of up to 8.

The town of Pickering had suffered a number of floods, but the benefit cost ratio of conventional defences was well below that required for funding to be granted. Instead of this, a series of ecosystem based defences were instigated increasing the absorption and slowing the run off from the surrounding moor land and woodland. Including the ecosystem benefits in the CBA meant the benefit cost ratio rose to close to 5.

Benefit–cost ratios based on central estimates for all assessed ecosystem services (habitat creation, flood regulation, climate regulation, erosion regulation, education and knowledge, and agricultural production) over a 100-year time horizon, for the Pickering Beck catchment, ranged from 5.6 for the woodland measures, 3.8 for the combined set of woodland, moorland and farm measures.

Recognising the need for defence and the case for piloting this form of defence the ecosystem based defences were approved, and have subsequently been found to reduce the peak flow of water through Pickering and thereby avoid flooding.

See for example Defra FCERM multi objective flood management demonstration project, PROJECT RMP5455: Slowing the Flow at Pickering, Final Report, May 2015.

Presentation of results

With any analytical tool, the presentation of the results is as important as the calculations. It is critically important to take the audience through the key stages and assumptions. It is best to avoid excessive reliance on single figures, which can give a spurious impression of precision.

If a social cost benefit analysis is to avoid issues caused by non-monetised benefits, for example, it is important to ensure that there is a summary presentation which sets out what is and is not included in the monetised NPV.

Additionally, make sure you don't fall into the trap of presenting a single scenario. Demonstrating sensitivity of your analysis to different assumptions, and to different real-world development is very important.

Dos and Don'ts!

I hope that the above material has given you quite a few hints here. In short:

DO:	DON'T:
Start by thinking about the problem, not the solution	Forget about non monetised impacts
Think outside the box about options	Fall into the trap of putting too much emphasis on a point estimate
Identify the full range of costs and benefits	Forget about the opportunity cost
Only then start to move to a short list of options for fuller analysis	Uncritically assume 'normal' distributions
Tailor your approach to whereabouts in the project you are (see SOC, OBC and FBC)	
Think about uncertainty and recognise the need for some contingency	
Think about presentation	

Notes

Notes

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