

# Integrating distributional objectives in the cost:benefit analysis of adaptation options

## Key Messages

- Traditional [cost-benefit analysis](#) methods for the evaluation of adaptation options tend to ignore various issues regarding their distributional impacts.
- Adaptation investments may facilitate job creation or increase labour supply. This is usually not considered in cost-benefit analysis. One approach to integrate employment effect is to use a conversion factor to convert market wages into shadow wages.
- [Cost-benefit analysis](#) generally ignores which segments of a population may be on the receiving end of the costs and benefits, leading to an inequitable result. Using distributional weights can help avoid this problem, where weighting factors are applied to reflect the relative income levels of those affected by the costs or benefits of an investment.
- People are generally assumed to be risk averse, but this consideration has long been ignored in cost-benefit analyses. A case study of climate change-induced flooding in Bilbao demonstrates the critical role these factors can have on the evaluation of adaptation options.

## Context

In adopting measures to adapt to climate change, adaptation options need to be based on robust assessment approaches which allow for the allocation of scarce resources. An important part of this process involves determining the costs and benefits of adaptation options in order to reduce vulnerability, enhance adaptive capacity and build resilience.

Frequently, [cost-benefit analysis \(CBA\)](#) is used to carry out this assessment. CBA is commonly used when decision makers are chiefly concerned with the economic efficiency of the options; the method calculates and compares the discounted costs and benefits of the adaptation options, giving insight into the benefit-cost ratio or the rate of return of given projects. The strength of CBA is that it compares costs and benefits using a single metric, provided that we are able to measure all benefits in monetary terms. However, CBA also has some limitations, in particular regarding the consideration of the distributional impacts of adaptation options. This includes employment effects, equity considerations related to the distribution of benefits and cost across affected stakeholders, and risk aversion.

Policy and methodological developments

### ***Taking into account effects on employment***

Adaptation investments may affect employment by directly creating jobs, facilitating job creation, or augmenting labour supply. Ignoring this correction may lead to an underestimation of the social benefits of public investment, especially in labour markets with high unemployment where employment changes may have significant net efficiency benefits which should be included in CBA (Bartik, 2012). Nonetheless, traditional CBA has usually ignored effects of public investment on employment.

The social profitability of an investment project is greater when labour is correctly evaluated and incorporated into the analysis. This can be done translating observed market wages into shadow wages by conversion factors (i.e. coefficients computed as the ratio between the shadow and market wage).

There is a significant range of conversion factors observed in the literature. Bo et al. (2009) found a value of 0.38 for many regions in Spain, Portugal, France, central Italy, UK and Ireland, northern Germany, Baltic and Scandinavian countries- and 0.46- for regions of southern Spain, southern Italy, northern France, northern Greece, east Germany, Hungary and Poland. A conversion factor of

around 0.10 is found in capital cities like Paris, London, Vienna, Amsterdam and Stockholm.

In spite of the vast theoretical and empirical contributions and the requirements of project evaluation by international organisations (e.g. European Commission, Asian Development Bank, World Bank) and national governments (e.g. Australia, Belgium, Canada or Ireland), actual estimation and practical applications of shadow wage rates have been limited.

### ***Considering the distribution of benefits***

Standard or traditional CBA emphasises the growth or efficiency objective, often to the detriment of the equity objective. It is thus notoriously insensitive to distributional concerns across the population. For example, if a policy produces net benefits for higher income individuals and net costs for lower-income individuals, CBA will choose the policy as long as the (positive) sum of monetary equivalents of the higher-income group is larger in magnitude than the (negative) sum of monetary equivalents of the lower-income individuals.

This bias towards the growth objective has been usually justified on the grounds that this would ensure that the available resources yielded the maximum increment in total national income, and that governments can use fiscal devices to redistribute project-generated income in any desired direction (Squire et al., 1975). But the capacity of governments to redistribute income is sometimes limited, especially in developing countries which sometimes lack the necessary administrative and organisational structures.

Arguably, distributional considerations should be incorporated into CBA (Adler, 2013). This can be done via so-called “distributional weights”, where monetary equivalents (e.g. benefits) are adjusted by weighting factors reflecting incomes of people receiving benefits or bearing the costs of a project (with lower-income individuals tending to get larger weights). Therefore, it is possible to account for the benefits to different groups by applying a distributional weight according to their relative income level. Let us assume the following social welfare function (Atkinson, 1970) for estimating the income distributional weights attributable to incomes of individuals belonging to different income groups in a region or country:

$$W = \sum_{i=1}^N \frac{AY_i^{1-\varepsilon}}{1-\varepsilon}$$

where  $W$  is social welfare function,  $Y_i$  is the income of individual  $i$ ,  $\varepsilon$  is the elasticity of social marginal utility of income or inequality aversion parameter and  $A$  is a constant.

This method of dealing with distributional considerations goes back to the 1960s, but was criticised on the grounds that the value of  $\varepsilon$  is unknown. However, Stern (1977) argued that the value can be derived from government social policies and suggested a figure close to 1.0. Young found values of 1.63 and 1.40 for West Germany and Italy respectively. Gouveia and Strauss (1994) and Young (1990) found values between 1.52 and 1.94 for the US.

In very broad terms, evidence suggests that an extra Euro to someone earning 1000 Euro is worth twice as much as to someone receiving 2000 Euros a month (UK Treasury, 2003). Empirical evidence shows that there is increasing utility to benefits with decreasing income.

### ***Accounting for risk aversion***

It is generally assumed that individuals are risk averse and concerned about their expected utility. Individuals are willing to pay for insurance which limits their loss in case an unfavourable event takes place, e.g. their home is flooded. In other words, individuals usually do not only consider the expected return but also the distribution of the return.

Nevertheless, risk aversion is typically ignored in CBA. As Noah (2014) explains, there are two

potential explanations for this. First, there is an extensive public economics literature on conditions whereby governments should behave in accordance with risk neutrality (i.e. zero risk aversion) with respect to risky public investments with uncertain costs and benefits (e.g. adaptation projects). This reasoning goes back to the 1970s, and is based on the idea that in large populations the risk can be “spread out” among the population. However, this rationale for ignoring risk aversion when evaluating risky public investments does not provide any basis for ignoring risk aversion in the presence of pre-existing environmental uncertainty, when risk cannot be “spread out” across the population. Policies that reduce pre-existing environmental uncertainty will provide risk-reducing benefits to all affected risk-averse individuals, and in no sense is the risk “spread out” across affected stockholders. Policy evaluations should therefore account for risk aversion in situations when pre-existing uncertainty is significant.

Second, there are theoretical difficulties to attempt to quantify risk aversion and there is thus no well-accepted level of societal risk aversion. Computational and theoretical difficulties of estimating risk premiums exist, but are not a valid justification.

Assuming that individuals are risk averse, the expected losses avoided (i.e. benefits) estimated under the standard cost-benefit analysis underestimate the willingness of households to pay to avoid the costs because they do not include the WTP for the reduced risk. The latter can be valued by calculating the expected utility from a scenario in which the household maximises expected utility.

#### **Applying distributional objectives for flood protection in Bilbao**

The table below shows the cost-benefit analysis done for the Canal of Deusto considering different elements in the analysis: (i) standard CBA; (ii) accounting for benefits on employment creation; (iii) including distributional weights for benefits; and (iv) taking account of risk aversion.

**Table: Calculation of NPV and IRR considering different elements (in 2015 prices)**

	<b>Net Present Value</b>	<b>Internal Rate of Return</b>
<b>Standard CBA (simplest case)</b>	-1.98	4.2%
<b>Distributional Benefits from Employment</b>	0.33	5.2%
<b>Distributional Weights</b>	0.03	5.0%
<b>Risk Aversion</b>	0.88	5.4%

The standard CBA is the “simplest” case. It uses market data on costs. In the simplest case, estimated benefits do not include benefits on employment, weights for benefits or risk aversion. The benefits on employment case add effects on employment to the standard case. The weights for benefits case takes into account both benefits on employment and distributive concerns, but still considers risk neutrality when estimating the benefits of the adaptation measure. Risk aversion is taken into account in the last case, which adds this issue to previous calculations.

The NPV and the IRR vary over a range of values. All cases yield a positive NPV, except the simplest or traditional case, meaning that if the adaptation measure assessed would be put in place this year, the expected benefit over a period of 61 years would exceed its cost in all cases but the first one. This example illustrates the critical role that the elements considered plays in any adaptation measure cost-benefit analysis. The highest NPV is exhibited when we take risk aversion into account (NPV of 0.88).

#### **Main implications and recommendations**

CBA frequently does not account for the employment benefits of investment projects. Often it focuses only on efficiency, by comparing aggregate benefit figures with costs, and considers risk neutrality. Still, from the public policy discussions it is clear that distributional benefits from

employment creation, distributional weights and risk aversion are often very important.

The outcome of a CBA can be very different with and without weights for projects that particularly benefit either rich or poor people, with and without benefits from employment creation, and with and without considering risk aversion of individuals affected by projects.

In practice, simplicity of analysis is presumably one of the most important arguments in favour of the traditional cost-benefit analysis and against using weights or taking account of risk aversion. Providing guidance and values would help to policy evaluators to account for these elements in the estimates of the NPV of investment projects on how to include these elements in standard cost-benefit analysis would help evaluators to account.

## Bibliography

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## Further Information

[Distributional objectives and non-monetary metrics: Transfer of distributional weight parameters \[pdf\]](#)

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