Chapter 1

Summary and recommendations

This chapter summarises the three key aspects of the assessment of climate change effects in transport appraisal considered in this report: the valuation of carbon; the treatment of risk and uncertainty; and methods for discounting long-term effects.

Valuation of carbon

This report examines four types of estimates for the cost of carbon commonly used to inform policy and investment appraisals. They are damage costs, two variants of abatement costs and the carbon market price. These estimates are established for different purposes. Only the damage cost estimate attempts to measure the marginal cost of carbon emissions.

The price of carbon on current emissions trading markets is strongly influenced by decisions on the total number of emission allowances to be issued and by the exemptions accorded to specific sectors of the economy. As limits on emissions allowances have tended to be relaxed over time and large parts of the economy are not included in the trading systems in operation so far, current prices are unlikely to reflect efficient abatement cost levels and are extremely unlikely to give a useful indication of the social cost of CO_2 emissions. Therefore, current market prices are not suitable for use as a direct indicator of the cost of carbon in transport CBA.

The value of carbon derived from the abatement cost approach varies with the policy options selected in the emissions mitigation strategy and with the CO_2 emissions target chosen. It will reflect the true cost of CO_2 emissions only if the emission target is set at the economically optimal level. If countries believe their emission target is set at the right level, then cost of abatement can be used in CBA without creating internal inconsistencies, especially if CBA is performed from a national and not a global perspective.

Theoretically, the damage cost approach is the most appropriate approach for assessing the climate effects of CO_2 emissions. The approach reflects mitigation options and adaptation potential in calculating costs. A range of Integrated Impact Assessment Models (IAMs) have been developed by scientists and modellers to calculate damage costs. The resulting estimate is usually referred as the social cost of carbon (SCC). The SCC intends to be a comprehensive measure of a wide range of climate effects covering environmental, social, economic, health and ecosystem effects. In practice, estimating the SCC is very difficult and modelling work is still subject to a number of limitations including inconsistent assumptions between models, potentially inappropriate assumptions and omitted effects.

At this stage, there is no consensus as to which carbon value estimates should be adopted globally. Different jurisdictions adopt different values and different approaches to estimating the cost of carbon. In some jurisdictions different values for carbon are used in appraisal from sector to sector.

There is, however, consensus that carbon values are not constant over time as the impact of the emission of an extra tonne of CO_2 will vary depending on the current concentration of CO_2 in the atmosphere. As the concentration of CO_2 in the atmosphere is expected to rise with emission level, a number of jurisdictions apply different carbon values to different time periods in appraisal. This report shows that the choice of discount rate schedule can have significant impact on the discounted carbon value used in a CBA. Even with a moderate discount rate (e.g. 3-5% per year), the discounted carbon value will be much lower than the undiscounted value.

Since future carbon values are likely to be subject to high uncertainty and change over time, it is perhaps more important to ensure CBA consider these uncertainties than to determine a point estimate for the value of carbon.

Recommendations on the valuation of carbon

- A common carbon value should be assigned for national investment and mitigation policy appraisal in all sectors within the same jurisdiction.
- There is merit in countries working together to develop a set of principles on how carbon values used in assessment should vary over time in real terms.

Risk and uncertainty

Treatment of climate change risk

As distinguished by Knight (1921), measurable uncertainty refers to risk that can be approximated by a statistical distribution of possible outcomes whereas uncertainty refers to circumstances where statistical quantification is not possible. This distinction has important implications because it means that methodologies designed to reflect risk in CBA do not address the issues associated with uncertainty.

This report looked at possible tools to supplement CBA in face of climate change risk. These include adoption of risk-adjusted discount rates and conduct of separate impact assessments, cost-effectiveness analysis, sensitivity testing or scenario testing; and the use of real-option approaches to improve the development and selection of projects. While CBA continues to play a key role to inform the value for money of policy or investment decisions, these supplementary analyses can improve the richness and robustness of the results of a conventional CBA.

Treatment of climate change related uncertainty

Climate change effects are subject to two types of uncertainty – scientific uncertainty resulting from incomplete knowledge about the climate system and socio-economic uncertainty due to unknowns about how societies and economies will function in the future and how they will respond to climate effects.

To ensure the quality of policy and investment decisions, decision-makers need to be informed about how uncertainties (e.g. around future demand, economic conditions and climate impacts) affect the estimated costs and benefits of an intervention or investment. This can be done by carrying out an uncertainty assessment, which will be similar to sensitivity testing or scenario analysis but rather than testing a distribution of statistically likely outcomes around a mean will assess project or investment outcomes under a number of different uncertain future states that cannot be assigned a statistical likelihood. The assessment will provide decision-makers with explicit information about the uncertainties involved and how they impact on the overall cost and benefit positions. In the absence of a statistical technique to account for uncertainty, a separate uncertainty assessment will be of value to decision-makers.

In practice, this would mean providing a likely range of results after considering risk and another wider range of results that consider the impacts of uncertainty. The latter will need to be supported by descriptions of the sources of uncertainty, its determinants and potential impacts.

Recommendations on the treatment of risk and uncertainty

- CBAs should be supplemented with information on long-term impacts that are subject to a high level of uncertainty.

- Risk should be factored into CBA by using appropriate tools such as adoption of risk-adjusted discount rate or use of sensitivity analysis or scenario testing.
- A separate uncertainty assessment should be carried out to better inform decision-makers on the potential impacts of uncertainty on the costs and benefits of an intervention or investment decision.

Discounting under risk and uncertainty

Discounting is an integral part of CBA for policy or project appraisals with costs and benefits that spread over a number of years. The choice of discount rate has a significant impact on assessment outcomes. There is no consensus on what discount rate to use. The uncertainty involved in estimating the climate effects, which affect generations further into the future most, complicates selection of an appropriate discount rate schedule to use in CBA.

The Ramsey formula is usually used as a basis for determining intergenerational discount rates. The Ramsey formula can be extended by subtracting a precautionary term to account for consumption growth risk (extended Ramsey formula). To account for systemic project risk, a risk premium term can then be added (systemic risk-adjusted Ramsey formula).

Uncertainty around interest rates and/or components of the social discount rate, such as consumption growth or expected project benefits, can both affect the choice of the discount rate used in CBA. In the absence of project risk, the discount rate would be close to the risk-free rate. In this situation, taking account of uncertainty (by introducing a precautionary factor in the extended Ramsey formula) reduces the discount rate. The adjustment is larger the greater the uncertainty and this can justify adoption of a declining risk-free discount rate.

If there are project risks, the risk premium component of the discount rate is likely to increase with uncertainty. The overall effect of uncertainty is thus ambiguous. If the effect of uncertainty on the risk-free rate is less than the effect on the systemic risk premium, the discount rate (in the systemic risk-adjusted Ramsey formula) may increase over time.

Thus far, common methodologies to consider uncertainty in the discount rate can only capture risk. More recent literature has developed models to capture part of the Knightian uncertainty in the discount rate by applying a subjective probability distribution over the objective probability distribution. As research matures, practical steps to establish a discount rate that can partly capture some aspects of uncertainty should become available.

Recommendations around discounting under risk and uncertainty

- As the debate around which discount rate method to use and what parameter values should be used within the chosen method is unlikely to be resolved in the near future, one way to reflect 'Knightian uncertainty' is to carry out a sensitivity analysis of CBA results using a high and a low (but constant) discount rate.
- On-going work on reflecting uncertainty in discounting through statistical techniques shows promise and its value in informing long-term policy and investment decisions should be kept under review.

Concluding remarks and next steps

Risk and uncertainty are key challenges for incorporating climate effects in transport appraisal. They affect the assessment of the value to place on carbon emissions and the quantification of climate impacts. Risk and uncertainty also affect the choice of discount rate, which in turn affects the valuation of carbon through the damage cost modelling process. This report presents techniques to deal with risk in transport appraisals, such as risk-adjusted discount rate. More research is still required to develop a robust framework for addressing uncertainty, e.g. in setting the discount rate schedule.

This report can be extended by carrying out the following additional analysis:

- Identify international best practices around life-cycle assessment in transport appraisal and understand the impact of such practices on the estimated costs and benefits of transport interventions.
- Identify other international CBA practices that affect the valuation of carbon and the estimated costs and benefits of proposals.
- Examine the desirability of harmonising key CBA practices (e.g. discount rate, carbon value, evaluation period and procedure for treating residual value) and identify the benefits from doing so.

References

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