Methods for expressing risk and ambiguity in economic analysis

Key Messages

- Social preferences regarding risks relating to climate change, for example one's attitudes to the certainty of achieving benefits in adaptation projects is an important factor to take into account in decision-making.
- A variety of methods based on risk coefficients have been developed which aim to account for risk in social discounting, such as accounting for intertemporal risk or uncertainty over time.
- Wealth premia are another option which account for inequality aversion in a particular context.
- Transferring calculated values of costs and benefits from one studied site to another is accomplished either through unit transfer or through value function transfer. It is important to fully understand the assumptions and biases that can be involved in this process, including how attitudes to risks are accounted for.
- There are a number of best practices involved in such benefits transfers. The intertemporal risk aversion coefficient is highlighted for its stronger methodology over long project lifetimes and its ability to differentiate risk preferences between countries.

Context

Advanced economic appraisal attempts to provide a robust picture of costs and benefits for the life of a project or programme. Climate adaptation projects are likely to have prolonged lifetimes for benefits from avoided damages from climate change, potentially spanning multiple generations. Information on social preferences around time and risk help illustrate trade-offs between present consumption and investment in future welfare changes.

This Insight presents the latest developments in considering risk preferences when conducting economic appraisals, reviews best practices for incorporating these preferences into cost-benefit analyses and suggests which of the alternatives discussed may prove useful to analysts and decision makers.

Policy and methodological developments

Methods for considering risk preferences

Attitudes to risk may vary from risk-averse behaviours (avoiding risks) to risk-lover and risk neutral behaviours. These different preferences are usually represented in economic terms through different risk coefficients which are incorporated into the social discount rate (through what is called the Ramsay formula). Risk preferences have typically only a small impact on the discount rate, and often associated with assumptions about consumption smoothing over time and population.

More direct methods of accounting for risk in social discounting have been developed, including:

a. Aversion for intertemporal risks can be accounted for through the "RIRA" (Relative Intertemporal Risk Aversion) coefficient (Traeger, 2009). This allows disentangling risk aversion preferences between time periods from consumption smoothing preferences in the present. It is expressed as a function of intertemporal elasticity of substitution (the strength of preference for welfare in the present over welfare in the future) and risk aversion in terms of volatility of outcomes. A strong RIRA coefficient will favour distant outcomes with stronger certainty over better outcomes that are less certain.
b. Uncertainty over time can be account for through the Relative Ambiguity Aversion coefficient (Traeger, 2009). It captures the empirical findings that shows a dislike amongst decision-makers of ambiguous outcomes and unknown probabilities, and has the benefit of accounting for

changes in risk as time frames expand. Gierlinger and Gollier (2009) show that an ambiguity prudence effect reduces the discount rate with increased uncertainty. The authors find, though, that ambiguity-neutral discount rates are often higher than socially-efficient rates that do not account for ambiguity aversion.

c. The Relative Risk Aversion (RRA) is a more general measure of risk aversion. It reduces preferences for a particular option as uncertainty around that option grows. Applied to climate change, RRA appears to be directly correlated to emissions taxes, showing that uncertainty reduces discounting (Ha-Duong & Treich, 2004). The use of RRA requires some knowledge of probability around possible outcomes.

Discount rates and risk coefficients

A 2012 study commissioned by the U.S. Environmental Protection Agency identifies two main branches of discounting over long time horizons: declining discount rates (DDR) and expected net present value calculations (EPNV). The former calls for a stepwise decrease in discount rates applied to projects as time horizons for realised benefits grow (similar to the approach the United Kingdom's government has taken). The latter averages different growth scenarios to yield a mid-range discount rate. The study argues that an EPNV approach can be used when disagreement among experts on Ramsey parameters exists. A DDR approach may be used when uncertainty exists over the state of the future economy. Both have implications for valuing projects with uncertainty and long-term impacts, which climate adaptation projects often include. The source of the uncertainty can help inform which approach is more appropriate for each situation.

A debate has emerged between Weitzman and Gollier on how to account for uncertainty over distant time horizons has been followed closely in environmental economics. Weitzman's argument (1998) that ENPV should be employed to represent a probability-based level of discounting yields a diminishing discount rate, bolstering the welfare of future generations when compared to other approaches. He presents the ENPV approach as an insurance policy against catastrophic risks. Gollier (2009) shows that Net Future Value over distant horizons increases rather than decreases and resources would create more welfare if they were saved in the present for future use (2002). Freeman (2010) argues for Weitzman's approach, citing a general preference for smoothing consumption over time. A bias towards caution (lower discount rates for long horizons) may be prudent given the exclusion of deep uncertainty events such as climate feedbacks that could yield higher damages than expected by existing models.

Wealth inequality and risks: appropriate applications to the discount rate

It is important to note the use of weath premia in social discounting can affect the use of risk aversion coefficients, Gollier (2001) shows that wealth inequality can reduce the risk-free rate of return on investments in the same way as the intertemporal risk aversion rate introduced by Traeger do. While his analysis does not offer a direct method of applying an equity premium to the Ramsey formula, this bias should be considered when calculating discount rates for climate adaptation projects. In particular, because the impact of a wealth premium is conditioned on risk aversion, the two qualifiers should not be used in combination, but rather should be seen as two alternative methods of controlling for risk preferences in a discount rate. Results from a study carried out in Sweden (Carlsson et al., 2005) indicate that risk aversion may be a stronger preference than inequality aversion, and that the former can be inclusive of the latter in a discounting calculation.

Comparison between countries and contexts suggests that risk preferences can differ from country to country due to differing social norms and structures, or within a country. For example, Mazzocco & Saini (2007) show that the caste system in India creates a separate level of social decision making, where risk-sharing takes place at the caste level rather than the market or geographic level. Specific types of economic activity can experience different preferences related to risk based on the use and benefits stream they provide to a society. For example, Ananda and Herath (2005) find that old-growth forest conservation is treated with much higher risk aversion than native forest removal in Australia. Soane & Chmiel (2005) discuss the influence of domain and personality on

risk preference. By examining behaviour in work, personal health and personal finance, the authors show that costs and payoffs of a decision are relevant in personal, but not professional matters. Of note, perception of risk is found to have a significant role in promoting risk-averse behaviour.

Case Study: Brazil

Issler and Piqueira (2000) study the Brazilian economy to measure the impact of risk aversion and wealth premia on discount rates. While the relative risk aversion coefficient is high, the overall discount rate remains high due to strong growth projections. They find a risk aversion coefficient between 1.10 and 4.89, indicating the potential for relatively high risk aversion among Brazilians, though high variability in these findings make it difficult to compare to other economies. Across all measures though, Brazilians display two to three times the level of risk aversion when compared to U.S. consumers. The authors do not find strong evidence of an equity premium in Brazil, indicating little impact on discounting from wealth inequality. This is surprising as Brazil has a relatively high, but decreasing, Gini coefficient of inequality (The Economist Online, 2011). These findings lend support to the theory that risk aversion increases concavely with wealth, at least between countries, if not within.

Transferring value between locations

Because risk preferences may vary so widely, empirical data may be needed to determine the impact of risk preferences on discount rates. However, this can be time-consuming and expensive. Transferring values from previously-studied sites is an important policy tool given limited resources for direct research. Methods are similar to benefit transfer approaches, such as the unit value transfer (adjustment by income but considering no other factors) and through value function transfer (which converts a relationship for the same good in two different sites by transferring a value function responsive to specific characteristics at each site). Other best practices related to benefits transfer include the use of meta-analyses for data, consistency in method used to collect data on preferences and controlling for differences across a range of social, economic and natural science factors. An econometric test may be able to reveal whether values in one country will transfer to another.

Main implications and recommendations

Several options exist for incorporating risk preferences into cost benefit analysis with more accuracy than the general relative risk aversion term in the social discount function. The context of specific projects may favour one method of accounting for risk preferences over another.

1. Risk premia in discount rates
    a. For projects with an especially long lifetime, the relative intertemporal risk aversion (RIRA) coefficient in the Ramsey discounting equation, can model the impact on discount rates over time, given the specific characteristics of a country or population.
    b. As RIRA calculation requires some knowledge of local preferences over time that can be difficult to gather and interpret, the use of a declining discount rate over longer time horizons, or an expected net present value approach to account for increasing uncertainty provide lower-effort alternatives for policymaking in constrained environments.
2. Ambiguity aversion in discount rates
    a. For projects requiring the adoption of a new technology (i.e. agricultural adaptation), local preferences for ambiguity may provide a more accurate picture of societal discount rates. In cases requiring technology uptake, and without very long project lifetimes (10 years or less), the Relative Ambiguity Aversion term is well suited to model social preferences. Estimating the value for this term will similarly require data on local ambiguity preferences.

As the wealth premia has been shown empirically to be similar to risk aversion, RIRA appears to be the best method for capturing risk preferences from different populations over a lengthy timeframe. RIRA allows for differentiation between countries, which is important in value transfer and offers

more methodologically than the wealth premium alone.

Including a RIRA or RRA term in a country-specific discount rate can provide a fair estimate of the social preferences at a given location and thus inform a value function for cost benefit analysis. While other options improve upon a simple unit transfer approach or non-risk-weighted value function transfer, the RIRA-specific method may yield the most accurate benefits estimate.

These tools assume a perfect world of robust data sources, which is often far from reality. Application of risk premia parameters may be reliant on data collection across a country or region. Decisions on how to manage heterogeneity in risk preferences to yield a single value for the parameterisation discussed above should be considered and well-documented.

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Further Information
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