Dealing with changing preferences over time

Key Messages

- The most significant uncertainty often not considered in the economic assessment of climate change damages is the change in the preferences of future generations. Generally, analysts assume that future generations will have the same utility functions as the present ones. But this is unlikely to be true as values, beliefs and priorities change over time.
- Despite the growing discussion about uncertainty inherent in climate change impact assessment, most of the economic estimations of climate-related damages and adaptation benefits are salient towards the changing preferences over time. The bulk of the discussion focuses on how much we should discount but there is not an adequate account until now of what to discount!
- Evolving preferences with respect to environmental goods and services could be captured by assuming that the marginal willingness to pay of our generation would change at some pre-determined rate.
- The rate of change can be assumed to be influenced by the growth of income, the depletion of environmental assets, the elasticity of substitution between man-made and environmental goods and services and the change in preferences of future generations.
- Factors influencing the rate of change are not-deterministic; therefore, simulation functions are constructed using flexible random walk-based stochastic models with and without drift (i.e. with and without change of preferences) to deal with the uncertainties involved. To this end, the model allows the analyst to visualize future paths of preference and value evolution and by doing so to bring future values of damaged assets realistically to the fore.

Context

Climate change policies are profoundly about the future; their impacts are going to be felt by future generations. In that sense, present policies subtly impinge on the welfare of future generations above and beyond that of present constituencies. Nevertheless, the timing, spatial scale and degree of impacted assets and social groups are beset with uncertainties. The economic dimension of climate change uncertainties is better encapsulated in efforts to quantitatively estimate the social cost of carbon (SCC), usually by means of Integrated Assessment Models (IAMs). The latter couple a baseline socio-economic scenario, a climate carbon cycle model and a function for transforming temperature change into economic damages. It is acknowledged, however, that IAMs are currently faced with a number of challenges regarding the estimation of climate change-related damages to environmental goods and services:

- A perfect substitutability between man-made and ecosystem goods and services is commonly assumed.
- Climate change environmental damages are based on market prices (i.e. they are estimated on a GDP basis through consumption reduction).
- Future changes in relative prices/values of man-made goods and ecosystem services are ignored.

There are a number of limitations with the above assumptions: Where is the uncertainty surrounding the evolution of markets and societies; the future growth of wealth and its distribution; changes in consumption modes and habits? To put it in a nutshell: where are future generations and their own preferences? The question then rises: who are future generations and how could their welfare be taken into consideration by present policies?

This Insight presents a robust methodology constructed for investigating future paths of preferences and values related to economic adaptation assessment.

Policy and methodological developments

The attitudes of future generations towards environmental goods and services may be different from those of present generations. This evolution/diversification of attitudes/preferences between generations can be considered both conspicuous and unpredictable simultaneously. Generally, preferences can be considered stable in the short-term future, but significant changes are expected in the long-term future. To this direction, strong indications have been identified that future generations will tend to be more sensitive about the environment (greening of preferences) leading to higher Willingness-To-Pay (WTP) values. Indisputably, the deterioration of the quality of environmental assets in combination with the upcoming depletion of natural resources constitutes the main reason for this tendency. The evolution of WTP values will be influenced mainly by the growth of income, depletion of environmental assets, elasticity of substitution between man-made and environmental goods and services and, change in the preferences of future generations. Nevertheless, the elasticity of substitution is omitted in the model to avoid double-counting issues since:

- In case of perfect substitution between man-made and environmental assets the effect of scarcity on WTP values is negligible and the nonmarket damages are estimated as consumption losses;
- In case of weak substitution between man-made and environmental assets the effect on WTP values is captured via the depletion factor, as discussed hereinafter.

Given that each and every of the above-mentioned factors has an independent and additive effect on the evolution of future WTP values, the total growth rate, α_{tot}, of WTP is given by:

$$\frac{W\dot{T}P}{WTP} = \omega \frac{I\dot{n}c}{Inc} + \lambda \frac{\dot{Q}}{Q} + \alpha_{pr}$$

When the right-hand expression of this equation is constant, the solution is $WTP_t = WTP_{0e\alpha t}$ with α given by the right-hand side of equation below:

$$\alpha_{tot} = \alpha_{inc} + \alpha_{sc} + \alpha_{pr}$$

where α_{tot} is the total growth rate of WTP; αinc the income growth factor; α_{sc} the environmental depletion (or scarcity) factor; α_{pr} the changing preferences factor.

Since future preferences are unknown, the α_{pr} works in the model as a ‘drift’ (upwards or downwards) and is defined ad hoc in a range of possible numerical values between pure ‘green’ and ‘materialistic’ preferences.

Given that the focus is in the very long term, simulation functions were constructed using flexible random walk-based stochastic models. The random walk-based stochastic process is equivalent to a Brownian motion. Based on the general model, the aggregate growth rate α of WTP in period (t) is estimated as follows:

$$\alpha_{tot}(t) = \theta(0) + k_t + \varepsilon_t$$

where $\alpha_{tot(t)}$ is the total growth rate of WTP at time t; θ(0) the sum of $\alpha_{inc} + \alpha_{sc}$ at time 0; k the drift that reflects changes in future preferences; ε_t a random component estimated by σW(t).

In order to implement the model the following parameters should be quantified:

- The income elasticity of WTP (ω)
- The income or growth rate (g) on an annual basis
- The WTP elasticity of demand (λ)
- The environmental depletion rate (q) on an annual basis
- The preferences factor (α_{pr}), which is expressed by k
- The volatility (σ) for the stochastic term

Illustration: future Willingness-To-Pay for recreational services by temperate and boreal forests

The model was applied to estimate the effect of growth rate α_{tot} on the WTP values of temperate and boreal forests that constitute a significant part of the total forest area in Europe. The analysis focuses on recreational opportunities. Present WTP is estimated on the basis of the Ecosystem Service Value Database used in TEEB and presented by de Groot et al. (2012). In order to offset influences concerning differences of income, price level and time, the original values are expressed to Euros in 2015 prices using the methodology for benefit transfer proposed by Pattanayak et al. (2002). The preferences factor α_{pr} is defined ad hoc under three different behavioural scenarios: Scenario A: Stable preferences; Scenario B: Green preferences; Scenario C: Materialistic preferences. In order to represent the wider range of uncertainty that affects future growth rate α_{tot}, the Maximum Entropy approach was chosen. The idea behind maximum entropy is to formulate a distribution for the data such that the distribution maximizes the uncertainty in the data, subject to known constraints.

The following observations on the results can be made:

- In all scenarios studied the probabilistic assessment results in higher estimates than the deterministic analysis. The disparities between the deterministic estimates and the probabilistic simulations are attributed primarily to the wide range of present WTP values.
- The effect of total growth rate α_{tot} on the estimated PV of WTP is significant, even when preferences are assumed to remain constant. The effect of total growth rate α_{tot} is even more apparent when changes in the preferences of individuals are involved in the stochastic model.
- The comparison of the estimates for the three Scenarios A, B and C reveals the importance of considering the effect of evolving preferences, especially in long-term analyses. In fact, the Present Value of WTP for constant preferences is about 35% higher than the estimated Present Value for the case of materialistic preferences and about 30% lower than the Present Value estimated for the case of green preferences. The comparison between the estimates of Scenarios B and C highlights the significance of the assumptions adopted regarding the evolution of preferences in the next decades: the Present Value of forests corresponding to greening of preferences is around 88.5% higher than the corresponding value of Scenario C. This finding is worrisome, considering that future preferences are unknown since complex and interlinked socioeconomic and behavioural factors are involved, which are also changeable. Therefore, potential behavioural patterns should be considered in the analyses, at least for sensitivity purposes.

Main implications and recommendations

The model developed for estimating the evolving preferences with respect to the values of environmental goods and services, via WTP growth rate α, should be implemented in evaluation processes of climate change policies and measures to address the problems stemming from the uncertain and long-term nature of the problem. It is flexible, transparent and easy-to-use, allowing the examination of various scenarios related to changing preferences, environmental scarcity, etc., in order to ‘get the prices right’.

Ignoring the growth rate of the WTP could:

- Result in inconsistencies between the assumptions about the evolution of the future emissions and climate conditions and the inputs of policy evaluation and optimization models (i.e. IAMs and others);
- Hinder the implementation of effective adaptation policies by distorting the damage assessment results; and
- Lead to failure to recognize the influence of socioeconomic parameters.

Thus, it is important to create linkages between climate scenarios and the parameters of growth rate of the WTP for the socioeconomic and environmental drivers of climate change. In addition, separate modules for use in existing IAMs and other models should be developed. As a first step, the social discount rate, *s*, considered in the models should be replaced by the ‘net’ social discount rate (i.e. s-α) so as changes in non-market values to be captured. To the same direction, the random-walk model of the WTP growth rate should be associated with flexibility analysis models, e.g. Real Options, Monte Carlo simulations, etc.

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Further Information
Future values for adaptation assessment: Developing methods to model changing preferences over future time periods
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