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Environmental Costs: Balancing the Present and the Future

Introduction

Many present day decisions will impact the environment far into the future. A good example is the climate development. Most scientists agree that with current and in particular increasing emissions of so-called greenhouse gases (of which carbon dioxide is by far the most important), we will experience significant climate changes in the coming decades and centuries. Moreover, there is not much we can do or not do to influence the climatic development over the next 30–50 years. However, present decisions regarding emissions in coming decades will strongly influence the climate during the latter half of this century. If little or nothing is done to limit climate change, it will most likely have very severe adverse effects in the future. Many scientists argue that there is a significant probability of catastrophic climate change during the next one to two hundred years unless greenhouse gas emissions are reduced considerably.

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Decisions that limit or prevent deterioration in the quality of the environment in the future are usually costly in the sense that such decisions reduce current levels of material consumption. To reach good decisions, one must therefore balance such current costs against the future benefits of avoiding environmental degradation. This requires two types of measurement. First, we must in some way be able to measure environmental quality in the same units as we measure costs (often expressed in terms of 'money'). Second, we must be able to compare costs and benefits (measured in the same units) at different points in time.

Measuring environmental quality

Can environmental quality be measured in 'money'? Standard economics responds 'yes' to this question. More precisely, it is usually assumed that a decision maker (politician, household, voter) can give an answer to the following type of question: "What do you prefer, 'low' material consumption and a 'good' environment or a 'high' material consumption and a 'bad' environment?" If such questions (with good/bad and low/high defined precisely) can be answered, one can in principle draw indifference curves in a diagram of the type illustrated in Figure 1, with some measure of environmental quality E on the horizontal axis and an aggregate measure of material consumption C on the vertical axis. All points along an indifference curve are valued as equally good by the decision maker, and indifference curves further out in the diagram represent better combinations of environmental quality and consumption than combinations further in.

Consider in particular point I in Figure 1 (forget about the red curve for now). The slope of the indifference curve going through this point tells us something about the marginal valuation of environmental quality. More precisely: The slope tells us how much 'compensation' is needed in terms of consumption to just offset a deterioration of one unit in the environmental quality measure. In a sense, the slope of an indifference curve thus measures the price of the environment. Notice that this slope depends on the initial conditions, an important feature I will return to subsequently.

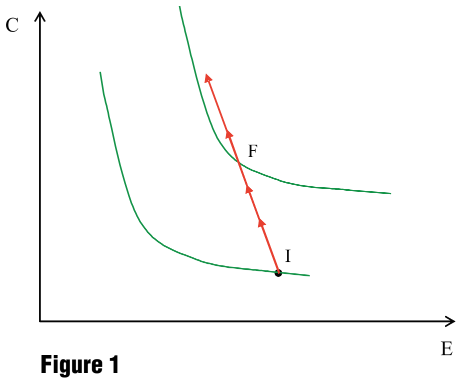

Figure 1

In practice there are obviously several important issues regarding whose preferences we are measuring, how to aggregate preference across different persons, and how to actually measure preferences. I ignore all these issues in the current presentation.

Comparing costs and benefits at different time points

When economists add together costs and benefits that occur at different points in time, all items are typically calculated first in present value. This means that a cost/benefit item 10 years from now is discounted at some discount rate before being added to a cost/benefit item today. For example, at a discount rate of 5 per cent per year, an item valued at NOK 1 million 10 years from now is equivalent to just NOK 614 000 today. For cost and benefit items in the distant future, the effects are much more dramatic: NOK 1 million in 100 years is equivalent to only NOK 7 604 today. Even at the much lower discount rate of 2 per cent, NOK 1 million 100 years in the future is worth only NOK 138 032 today.

Why should the discount rate be positive? The answer involves a combination of technology and preferences. Figure 2 gives a very simple picture of a world consisting of two periods: present and future. The present is on the horizontal axis. The more we invest for the future, the less we consume at present (the lower C_1), the higher the consumption in the future (C_2). Moreover, in a productive economy, an investment will pay back more than the invested amount, at least if we start in a situation where consumption is equalized across periods as it is where the 45-degree line cuts the consumption possibility curve (the blue curve in Figure 2). Preferences regarding present versus future consumption are illustrated by the green lines in Figure 2. It is often assumed that these preferences have the following property: Starting in a situation where consumption is equalized across periods, we would prefer 1 unit more consumption now rather that in the future. This element of 'impatience', or discrimination against future generations, is captured by the slope of the indifference curve being steeper than the one on the 45-degree line.

Given the assumptions about technology and the preferences described above, the tangent of the optimal point P in Figure 2 must be steeper than one. Denoting this steepness $1+R$, R is the positive discount rate between the two periods: if we give up one unit of consumption today, we must have $1+R$ additional units of consumption in the future to be as well as off as before the change. This discount rate R is a compound rate, and is linked to the yearly discount rate r by the formula $1+R = (1+r)^N$, where N is the number of years between the present and the future.

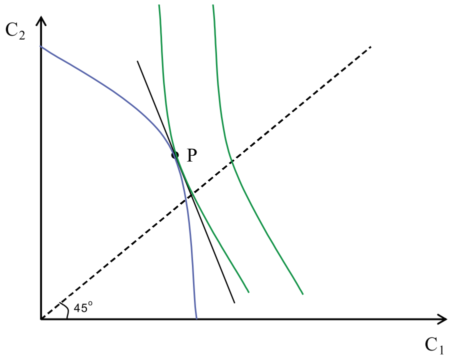

Figure 2

Given that the discount rate is positive, its size is obviously of great importance for all decisions that are based on calculating the present value of all benefits and costs. As demonstrated above, a discount rate of e.g. 5 per cent per year implies that the present value of a cost item 100 years in the future will have a present value that is much lower than its future value. Estimates of discount rates are typically in the range of 3 to 8 per cent.

Given the reasoning above, the discount rate follows directly from the curves representing preferences (green lines) and technology (blue curve) in Figure 2. However, the locations of these curves are not in reality without problems. Regarding preferences, it is one thing to know the preferences of a single decision maker, but it is far more difficult to define preferences across different generations. Without consensus on such intergenerational preferences, the positions of the green curves in Figure 2 are not well defined. Moreover, for a given level of present consumption, future productivity growth and thus future consumption are uncertain. The position of the blue curve in Figure 2 is thus uncertain. Partly for these reasons, Martin Weitzman has argued that "While there is uncertainty about almost everything in the distant future, perhaps the most fundamental uncertainty of all concerns the discount rate itself"[1] and "The most critical single problem with discounting future benefits and costs is that no consensus now exits, or for that matter has ever existed, about what actual rate of interest to use".[2]

The future price of environmental quality

Whatever value the discount rate has, future cost and benefit items, for instance, future environmental damage, should be valued in real future prices. The future prices may be much higher than present prices. This is illustrated in Figure 1. As argued above, at point I the 'price' of environmental quality is given by the slope of the indifference curve at I. As time passes, material consumption will typically grow due to economic growth.

1: Weitzman M. L.: "Why the far-distant future should be discounted at its lowest possible rate." *Journal of Environmental Economics and Management* 36 (1998): 201–208.

2: Weizman M.L.: "Gamma discounting." *American Economic Review* 91 (1) (2001), 260–271.

This will not usually be the case for environmental quality. It will at best be constant or increase only slowly, or even decline, as illustrated by the red curve in Figure 1. At a future date, we may therefore be at point F in Figure 1. At this point, the indifference curve is considerably steeper than at point I. This means that the price of the environment has increased over time. This has important implications for evaluating policies that affect environmental quality in the distant future. If the valuation today of a specific environmental change is V_0, the relevant price at a future date t is $V_t = V_0(1+p)^t$ where p is the expected rise per year in the real price of environmental quality. Discounting this term to the present gives the expression $V_0(1+p)^t(1+r)^{-t}$. Even if r is positive and on the magnitude of 5 per cent, the combined effect of discounting and the relative price increase on environmental quality implies that the environmental impact of current actions may be of significant importance even if the impact only occurs in the distant future. This is explored in more detail in Hoel and Sterner (2006)[3]: Using realistic values for key economic variables and parameters, we show that that term $(1+p)^t(1+r)^{-t}$ may be close to one – or even larger than one – even for large values of t. In particular, we show that this term may exceed one if climate change causes 'catastrophic change', implying that the effects of climate change should be given strong emphasis in the evaluations of alternative current policies, even if the most severe climate changes occur in the quite distant future.

3: Hoel, M. and T. Sterner: "Discounting and relative prices: assessing future environmental damages". *Resources for the Future Discussion Paper* 06–18.