The Case for Declining Long-Term Discount Rates in the Evaluation of Flood-Defence Investments

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6.1 Introduction

Debates about discounting have always occupied an important place in environmental policy and economics. Like all other investment, investment in the environment involves incurring costs today for benefits in the future. Whether a public investment is efficient or not is determined by social cost benefit analysis (CBA). In a competitive economy, the socially efficient level of investment is attained by investing in projects where the net present value (NPV), determined by discounting costs and benefits at the social discount rate (SDR) over the time horizon, is greater than zero. It follows that the level of the SDR is critical in determining whether an individual public investment or policy will pass a CBA test.

A common critique of discounting is that it militates against solutions to long-term environmental problems. The question arises: What is the appropriate procedure for such long-time horizons? There is wide agreement that discounting at a constant positive rate in these circumstances is problematic, irrespective of the particular discount rate employed. With a constant rate, the costs and benefits accruing to generations in the distant future appear relatively unimportant in present values terms. Hence decisions made today on the basis of CBA appear to tyrannise future generations and in extreme cases leave them exposed to potentially catastrophic consequences. Such risks can either result from current actions, where future costs carry no weight, e.g., nuclear decommission, or from current inaction, where the future benefits carry no weight, e.g., climate change. The intergenerational issues associated with discounting have puzzled generations of economists. Pigou (1932) referred to the deleterious effects of exponential discounting on future welfare as a 'defective telescopic faculty'. More recently Weitzman (1998) summarises this

[1] *The Economist* (1991), March 23, p 73.

puzzle succinctly when he states: ‘to think about the distant future in terms of standard discounting is to have an uneasy intuitive feeling that something is wrong, somewhere’.

Discounting also appears to be contrary to the widely supported goal of ‘sustainability’ which by most definitions implies that policies and investments now must have due regard for the need to secure sustained increases in per capita welfare for future generations (Wald Commission on Environment and Development 1987, Atkinson et al., 1997). Also, by attaching little weight to future welfare conventional discounting appears to ignore any notion of intergenerational equity.

A recently proposed solution to this problem is to use a discount rate, which declines with time, according to some predetermined trajectory, this raising the weight attached to the welfare of future generations. It is immediately obvious that using a declining discount rate (DDR) would make an important contribution towards meeting the goal of sustainable development.

So, what formal justifications exist for using a DDR and what is the optimal trajectory of the decline? This chapter provides a brief non-technical review of recent contributions addressing these two issues in different ways. We tie together the different approaches – some deterministic, others based on uncertainty, some based upon intergenerational equity, others on considerations of efficiency – and we illustrate through a case study on investment in flood defences the effects of using DDRs in public policy. We believe that this work has important implications for the implementation of the EU Water Framework Directive and should be integrated in the economic aspects of such an implementation at the local, regional, country and EU level.

6.2 A Non-Technical Review of the Relevant Theory

In the last decade, the nature of the problem with long-term discounting has become clearer. Four recent theoretical approaches, represented diagrammatically in Fig. 6.1, conclude that this ‘awkwardness’ can and should be resolved by employing discount rates that decline over time.

First, experimental evidence shows that people discount the future at a declining rate, roughly approximated by a hyperbolic function (Cropper et al., 1999). Results imply discount rates that decline rapidly over the first five to ten years, but start at a surprisingly high level that seems inconsistent with market evidence.

Second, Heal (1998), Chichilnisky (1996, 1997) and Li and Löfgren (2000) present ethical reasons, based upon avoiding a ‘dictatorship of the present over the future’, which lead to a declining utility discount rate. The main disadvantage of this approach is that it requires estimates of several parameters that would be contentious and possibly also arbitrary.

Third, Gollier (2002) shows that when future consumption growth is uncertain the appropriate discount rate is falling over time. However, Gollier’s basic model

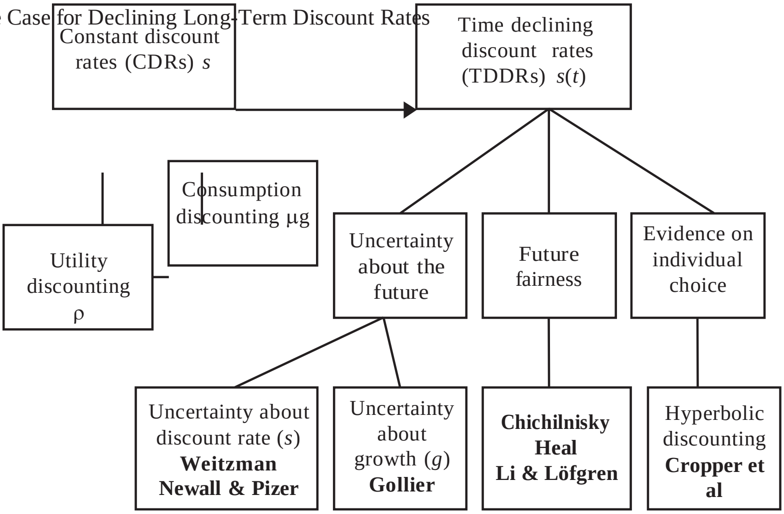

Fig. 6.1 Different discounting approaches

Table 6.1 Proposed step schedule of discount rates

Time from present	Marginal discount rate (%)
1–20 years	3.5
21–75 years	2.0
76–300 years	1.0
More than 300 years	0

assumes a zero risk of recession, a more realistic model leads to considerably more complex results. His approach, while theoretically elegant, proves to be difficult to apply to policy questions.

Finally, Weitzman (1998) shows that any uncertainty in the discount rate leads to a declining discount rate over time. Newell and Pizer (2000, 2001) specify the discount rate uncertainty by running simulations of future interest rates using US interest rate data. Weitzman (2001) specifies the discount rate uncertainty by conducting a survey of over 2000 economists. The responses approximately follow a gamma distribution, leading to a steadily declining discount rate over time. This approach is theoretically sound, simple and of general application.

On balance, it is concluded that the approach in Weitzman (1998) is the most attractive. Moreover, the Weitzman (2001) survey results in a discount rate schedule, shown in Table 6.1 below, consistent with the current Treasury guidelines. As the marginal discount rate is 3.5% for the first 20 years, projects with short time-horizons can be evaluated using conventional methods. Projects with time-horizons over 20 years could employ sequentially lower discount rates.

6.3 Illustration: Flood Defenses

In this section, the discounting theories presented in Section 6.2 are applied to a water-management policy question, with the aim of showing how the use of declining discount rates will affect the appraisal of relatively long-term government policies, programmes, and projects. In particular, this section provides a specific illustration in the area of flood defences investment. The following six discounting regimes are compared:

- A flat discount rate of 6%
- A flat discount rate of 3.5%
- Gamma discounting (with mean discount rate 4% and standard deviation 3%)[2]
- Gamma discounting, step schedule
- Hyperbolic discounting
- Li and Löfgren[3]

Declining discount rates may also have an effect on the economics of flood protection. Over the last ten years, flood-defence investment has been characterised by annual expenditure that has been assumed to offset significant damage—a cost–benefit ratio much greater than unity.

We use a stochastic model by Binne, Black & Veatch designed to assess the costs and benefits of investment in a particular cell (protected area) of flood defences for Shrewsbury for the Environment Agency. The model determines the net benefit of investment by comparing the damage suffered in a 'do nothing' scenario, with damages in the case where 100-year flood defences have been constructed. The benefits can then be compared with the costs of constructing and maintaining the defences.

Source: Shrewsbury FAS project estimates and OXERA calculations.

Employing a 6% discount rate implies that flood defence investment does not pass the cost–benefit analysis. However, a cost–benefit ratio (CBR) of approximately 1.2 is obtained with a 3.5% discount rate, as shown in Fig. 6.2. Furthermore, flood defences are more attractive under all declining rate regimes than under either a 6% or 3.5% fixed-rate regime. The CBR increases by about 17% when the step schedule of discount rates is employed instead of a flat 3.5% rate.

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[2] This is a declining discount rate when discount rate uncertainty follows a gamma distribution with mean 4%, and standard deviation 3%. See Weitzman, M. (2001), 'Gamma Discounting', *American Economic Review*, 91(1): 261–271.

[3] This is a weighted average of undiscounted cash flows, and cash flows discounted at 6%. Li, C,-Z. and Löfgren, K.-G. (2000), 'Renewable Resources and Economic Sustainability: A Dynamic Analysis with Heterogeneous Time Preferences', *Journal of Environmental Economics and Management*, **40**, 236–250.

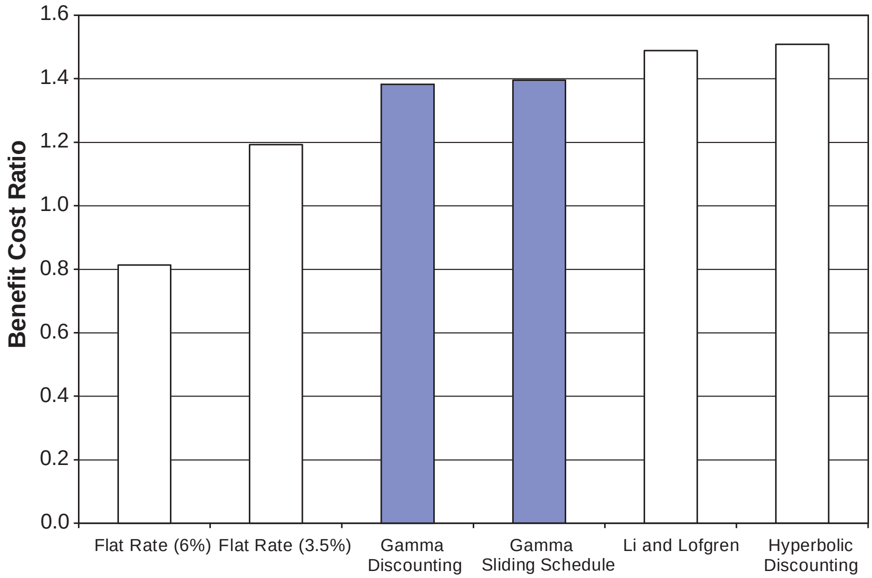

Fig. 6.2 Cost–benefit ratio for a particular cell of flood defences in Shrewsbury

6.4 Policy Implications

The central conclusion from the illustration considered in Section 6.3 and a number of other application of DDR on public policy investment appraisals, namely climate change, biodiversity loss and nuclear waste (see OXERA et al., 2002), is that the impact of declining discount rates depends upon the time-horizon of the project. The longer the time-horizon, the higher the potential magnitude of the effect of declining rates. This dependence is summarised in Table 6.2.

For short-term projects with time-horizons of less than 30 years, declining discount rates have only minimal impact. However, for projects with time-horizons over 30 years, employing declining discount rates may have a significant impact upon the preferred policy. In the road and air examples, shifting from a 3.5% flat rate to the step schedule of rates resulted in an increase in NPV of 8% and 40% respectively.

When time-horizons exceed 100 years, the potential impact is even greater. As Table 6.2 illustrates, it is estimated that the effect could be an increase or decrease of up to approximately ±100% of NPV. For projects with costs and benefits accruing over a 200–400 year time-horizon (such as climate change mitigation), the step schedule of declining discount rates might have an impact of up to approximately ±150% on NPV, relative to discounting at 3.5% constant rate.

Table 6.2 Effect of shift from flat 3.5% to the step schedule of discount rates

Project time horizon	Potential effect on project NPV
0–30 years	Small, generally insignificant
30–100 years	Significant (±50%)
100–200 years	Large impact (±100%)
200–400 years	Major impact (±150%)

6.5 Conclusion

Recent advances in the economic theory of discounting have potentially extremely important implications for policy on energy and on the environment. Whereas the conventional view has always been that there is a unique social discount rate – the value of which has been disputed over thirty years or so of debate – new work suggests powerful reasons why the discount rate is not a single number, but a number that varies in a declining fashion with time. This result emerges from several approaches: from an analysis of how people actually discount the future (hyperbolic discounting); from the implications of uncertainty about the future (the Weitzman and Gollier approaches); and from an explicit attempt to replace the traditional 'present value' maximand of policy appraisal with one that incorporates that goal along with a sustainability requirement. That any one of these approaches could be wrong cannot be doubted, but it seems unlikely that all three arguments can be rejected. Moreover, there is a 'political' argument in favour of the acceptance of time-varying discount rates: in one swoop, they help to resolve the long standing tension between those who believe the distant future matters and those who want to continue discounting the future in the traditional way.

We propose that the conclusions of this chapter and the implications of the theory of DDR, are important for the implementation of the economic aspects, in general, and the investment appraisal, in particular, of the EU Water Framework Directive.

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