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Economics in policy-making **5**

Discounting and time preferences

Cost–benefit analysis (CBA), social CBA and Social Return on Investment (SROI) do not simply involve listing the costs and benefits of a project over time and adding them up. They also involve considering how much the future impacts of a project are worth to us now – which is often a very different matter.

What is discounting?

Broadly speaking, welfare economics works on the rule that individuals have a higher 'time preference' for the present than for the future. That is, people prefer to increase their "utility" (their welfare) sooner rather than later. Ask yourself, for instance, if you'd rather have £100 now or in a year's time?

Most people's answer to this question would be 'now' – unless there was some extra benefit gained by waiting. For instance, would you consider accepting the money in one years' time if it meant you would be given more? How much more would make it worth the wait?

All this points to the idea that the 'present value' (PV) of things (i.e. the value you put on them now) increases or decreases depending on how soon they will happen.

In order to take this into account, CBA involves the practice of discounting – which means devaluing future benefits and costs so as to represent their present value (PV). It is this *present value* of costs and benefits that CBA weighs up and presents so that decision-makers can determine whether a project or intervention should go ahead. Only when the present value (PV) of benefit outweighs the present value (PV) of costs should an action be taken.

The extent to which future cash flows are devalued is determined through the discount rate. To illustrate how this works, imagine a hypothetical investment which involves a cost of £50 today (input) and generates a benefit of £100 three years from now (output in year 3).

Table 1 (on the next page) shows how manipulating the discount rate affects the PV of that future £100 return.

Net Present Value (NPV) represents the net benefits of the project, after weighing up the PV of its costs and benefits – i.e. its discounted benefits minus its discounted costs.

Given that, in this example, the £50 costs of the project are borne today (in year zero); they are not influenced by the future discount rate. The £100 worth of benefits, however, are influenced by the discount rate – since they arise after three years. So the overall NPV of the transaction depends on the level at which this discount rate is set.

As Table 1 shows, *setting a 0% discount rate is the same as stating no time preference for the present*. The costs incurred today would be weighted the same as benefits accruing three years from now. So the present value of the future £100 cash flow would not be discounted, and the NPV of making the original £50 transaction would be £50 (£100–£50).

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www.neweconomics.org Tel: 020 7820 6300 Email: **chris.williams@neweconomics.org** Registered charity number 1055254.

Table 1: A discount rate application example

	Year 0 (now)	Year 1 (t = 1)	Year 2 (t = 2)	Year 3 (t = 3)	NPV 0% discount rate (£)	NPV 5% discount rate (£)	NPV 15% discount rate (£)
Costs	£50	0	0	0	£50 (£100-£50)	£36.38 (£86.38-£50)	£15.75 (£65.75-£50)
Benefits	0	0	0	£100			

By discounting future values by 5% per year, however, then the present value of gaining £100 cash three years in the future would work out at £86.38. This, in turn, would place the net present value of paying £50 today at roughly £36.38.

Finally, if applying a 15% discount rate to the transaction, the present value of future benefits would almost halve to £65.75 So the net present value (net benefit) will, in this case, be only £15.75 (£65.75–£50).

As you can see from the examples above, the choice of discount rate can critically influence the results of a cost-benefit analysis. The higher the discount rate, the higher the presumed time preference for immediate costs and benefits, and the lower the value placed on future benefits and costs.

In the example above we went from a net present value (NPV) of £50 to ~£16 simply by raising the discount rate to 15%. So you can see that, if the discount rate went above 20% (stating a very high time preference for the present) the net benefits (NPV) of the project would come out as zero or even a negative number. Such a result would imply that the initial investment is a bad, inefficient idea that should be abandoned.

Should we use discounting for social and public interventions?

There is wide consensus that discounting makes sense at a personal / household level, because people do tend to have a higher preference for well-being in the present rather than in the future. This is partly caused by fear of not being alive in the future to collect those well-being benefits. As such, we should expect discount rates at this micro level to be virtually always higher than zero. (Although the fact that people usually care about their children's future wellbeing can lower such discount rates, and partly explain why individuals tend to save money and assets).

Likewise if conducting a CBA for a private investment, discounting is sensible and can be set relatively high, depending on a variety of factors and the time preferences of the entrepreneurs in question.

But when it comes to public investment the matter is not so clear. Should we discount the future when carrying out CBA's of public interventions, when doing so would clearly favour short-term gains rather than public interest in the long-run? Or, is there a rate at which a society as a whole is willing to sacrifice current consumption or well-being in exchange for future consumption and well-being? Finally, are individuals capable of making this collective choice (i.e. capable of accurately foreseeing future public needs) or should the State impose time preferences?

Two contrasting views on these issues are salient:

1. On the one hand, a variety of mainstream economists consider that what is valid for individuals (i.e. relatively strong preference for the present) is also valid for society as a whole.

   According to this view, so-called "social" discount rates (i.e. discounting used for appraising public investment) should definitely be used, and should be based upon individual preferences (i.e. collective preferences are perceived as the aggregation of individual / private preferences).

   This view takes an empirical, rather than normative stance. That is, instead of asking whether we should discount, it asserts (in a "consequentialist" rationale) that *because private individuals discount the future, we should also discount for public investment*.

2. Other scholars think that the question of discounting public investment is an essentially philosophical one, relating to how much a given society should value the future (including the well-being of future generations) relative to the present. According to this stream of thought, social discount rates cannot be based on the evidently high time preferences of individuals, and should be set sensibly lower. There is also evidence that individuals are very bad at computing time for example, which makes the focus on 'time preferences' paradoxical.

In practice, discount rates for social projects and public interventions are set differently in different countries. Despite the debate outlined above, many countries opt to set their public discount rates lower than private discount rates (as illustrated below). As you can see below, there is a trend towards using lower discount rates for public interventions.

The UK requires all social projects' costs and benefits to be discounted at a rate of 3.5% per year – except for projects happening 30 years or more into the future, for which lower discount rates are chosen (see section below for an explanation).

Of course, a government's decisions to impose specific discount rates are not without criticism. Aside from the general lack of consensus on the matter, discounting the future has numerous implications – particularly for environmental sustainability.

Country/Agency	Discount Rate
Australia	8% (1991): rate annually reviewed
Canada	10%
People's Republic of China	8% of short and medium term projects; lower than 8% rate for long-term projects
France	Real discount rate set since 1960; set at 8% in 1985 and 4% in 2005
Germany	1999: 4% 2004: 3%
India	12%
Italy	5%
New Zealand (Treasury)	10% as a standard rate whenever there is no other agreed sector discount rate
Norway	1978: 7% 1998: 3.5%
Pakistan	12%
Philippines	15%
Spain	6% for transport; 4% for water
United Kingdom	1967: 8% 1969: 10% 1978: 5% 1989: 6% 2003: 3.5% Different rates lower than 3.5% for long-term projects over 30 years

What are the implications of discounting the future?

The debate about discounting the future in public investment has been accentuated by environmental problems like biodiversity loss, ecosystem disruption and climate change. All of these problems are bound to have long-term impacts which will affect us, as well as future generations.

By and large, public investment for mitigating these impacts and preventing further environmental destruction is considered necessary for the well-being of future generations. But how much should our current generation invest? Should we sacrifice part of our well-being for the benefit of future generations? This is dependent, among other things, on the inter-temporal preferences (and thus discounting of public investment) of the current generation.

If we choose to discount investments in biodiversity conservation and climate change mitigation, the benefits that our investments deliver for future generations will automatically appear smaller in present value terms. This would foster a state of "low inter-generational equity", where the wellbeing of different generations – including those yet to be born – would be unequally valued.

Imagine a situation whereby action could be taken to restore a particular fish stock. A £200 million investment is required today in order to stop the stock being fished to extinction over the next fifty years. (This investment might include compensation for fishermen in return for not fishing the endangered species, or, funding to allow the fisherman to re-train and take up other professions).

After fifty years of protection, the replenished fish population is predicted to be worth £1 billion in actual market value – five times the value of our original £200 million investment.

But, if the UK's prevailing social discount rate of 3.5% was applied, that £1 billion benefit, due 50 years down the line, would generate a present value of just £179 million[1] And – given this amount is less than the £200 million cost of the project – the investment would not be made.

As you can see, a high discount rate can be a major impediment when it comes to making our economic system more environmentally sustainable. It can also devalue the well-being of future generations, which is ethically questionable. Can we really suggest, for example, that a coral reef is "worth" less to a person fifty years into the future than to a person living today?

What are the alternatives to future discounting?

One way of tackling this problem of inter-generational bias is to reject future discounting. This would mean that costs and benefits accruing to present generations would be considered equal to those accruing to future generations.

Beyond ethical discussions, a 0% discount rate could have the perverse effect of favouring over-investment in the present (to mitigate higher costs in the future) and thus spur further environmental and natural resource degradation. The perversity is that this would enhance what "0%" discount rate proponents aim to avoid: the reduction of the stock of natural capital available to future generations.

TEEB (The Economics of Ecosystems and Biodiversity) has proposed a solution to this problem by suggesting that different social discount rates should be used for different purposes. A 0% discount rate could be used for investment in environmental sustainability only, while higher discount rates would be used for other forms of public investment. This proposal avoids the problems associated with using a zero discount rate (see the first point above).

Finally, other research has suggested a so-called "hyperbolic" discount rate. The discount rate would be high for short term impacts, in order to represent the time preferences of the current generation (for their own income stream), but would gradually decrease over time to enhance inter-generational equity. Put simply, medium to long-term impacts would be discounted less than short-term impacts.

Now that we have seen what discounting is and why it matters, these two brief summaries provide some further discussion on the ethical and practical issues surrounding discounting.

The first comes from the *Stern review on the economic impacts of climate change* and the second comes from the Crown Estate *Valuing the marine estate and the UK seas.*

The subsequent (*hypothetical*) case study (3) shows what happens when different discount rates and time horizons are used to assess the costs, benefits and Net Present Value (NPV) in numeric and graphical ways.

1. The Stern review, conducted by Nicholas Stern (Head of the Government Economic Service and Adviser to the Government on the economics of climate change and development), on the 'economic impacts of climate change'[2] considers the economic costs of the impacts of climate change, and the costs and benefits of action to reduce the emissions of greenhouse gases (GHGs). Evidence gathered by the review led to a simple conclusion: the benefits of strong, early action on climate change considerably outweigh the costs. The effects of our actions now on future changes in the climate have long lead times.

The Stern review also discussed the use and ethics of discount rates:

'We have also considered how the application of appropriate discount rates, assumptions about the equity weighting attached to the valuation of impacts in poor countries, and estimates of the impacts on mortality and the environment would increase the estimated economic costs of climate change'.[3]

Why was this review (presented in 2006) so significant?

1) The Stern review was one of the first studies to use a lower discount rate in its analysis.

2) The rationale for doing so was due to the realisation that we can no longer assume that future generations will always be richer than the current generation.

3) This sparked an academic debate (which is very widely referenced) about what discount rate to use.

2. The Crown Estate[4] acknowledges, a similar point in a marine context in Table 6 below:

The extract choice of discount rate is a source f perpetual debate. The ofiicial UK policy on discounting (from the Green Book) states that the recommended discount rate is 3.5%. However, for projects with long-term impact - over 30 years - the guidance requires use of a declining discount rate, primarily as a way of accounting for uncertainty about the future (see Table 6).

Table 6: UK public sector discount rates

Period (years)	0-30	31-75	76-125	126-200	201-300	301+
Discount rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%

Note that discounting is not connected to inflation. All costs or benefits in economic appraisal should be expressed in 'real terms' ('constant' prices), rather than 'nominal terms' (current prices). Generally the most convenient and intuitive base year is the year of the study. Published GDP deflators should be used to update values from earlier years (correcting for the impact of inflation), and any future price estimates that include inflation should have this removed.

3. The case study: what is the impact of different time frames and discount rates?

Let's assume that setting up a network of Marine Protected Areas (MPAs) will have a one-off cost of £100 to set up the network and £50 per year for enforcement, monitoring, etc.

Assuming the future benefits in terms of fish stock recovery or carbon sequestration by habitat recovery will take 10 years to materialise, let's assume that from year 10 onwards the benefits are £200 per year.

Tables 1–3 and Figure 1 show what would happen to costs and benefits using three scenarios;

- Using a 0% discount rate had been used (as Stern and TEEB – The Economics of Ecosystems and Biodiversity- suggest) over 20 years?[5]
- Using a 1% discount rate had been used over 20 years?
- Using the UK HMT Green Book recommended time horizon of 20 years and a 3.5% discount rate.

Table 1: The first ten years (note how by year 10 the NPV is £136 vs £106 when comparing 1% to 3.5%)

Year	0	1	2	3	4	5	6	7	8	9	10
Benefit	**£0**	**£0**	**£0**	**£0**	**£0**	**£0**	**£0**	**£0**	**£0**	**£0**	**£200**
Cost	**£100**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**
Net benefit (NB) = Benefit - Cost	-£100	-£50	-£50	-£50	-£50	-£50	-£50	-£50	-£50	-£50	£150
Discount Factor (DF) at 0%	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Net Present Value at 0%	-£100	-£50	-£50	-£50	-£50	-£50	-£50	-£50	-£50	-£50	£150
Discount Factor (DF) at 1%	1.000	0.990	0.980	0.971	0.961	0.951	0.942	0.933	0.923	0.914	0.905
Net Present Value at 1%	-£100	-£50	-£49	-£49	-£48	-£48	-£47	-£47	-£46	-£46	£136
Discount Factor (DF) at 3.5%	1.000	0.966	0.934	0.902	0.871	0.842	0.814	0.786	0.759	0.734	0.709
Net Present Value at 3.5%	-£100.00	-£48.31	-£46.68	-£45.10	-£44	-£42	-£41	-£39	-£38	-£37	£106

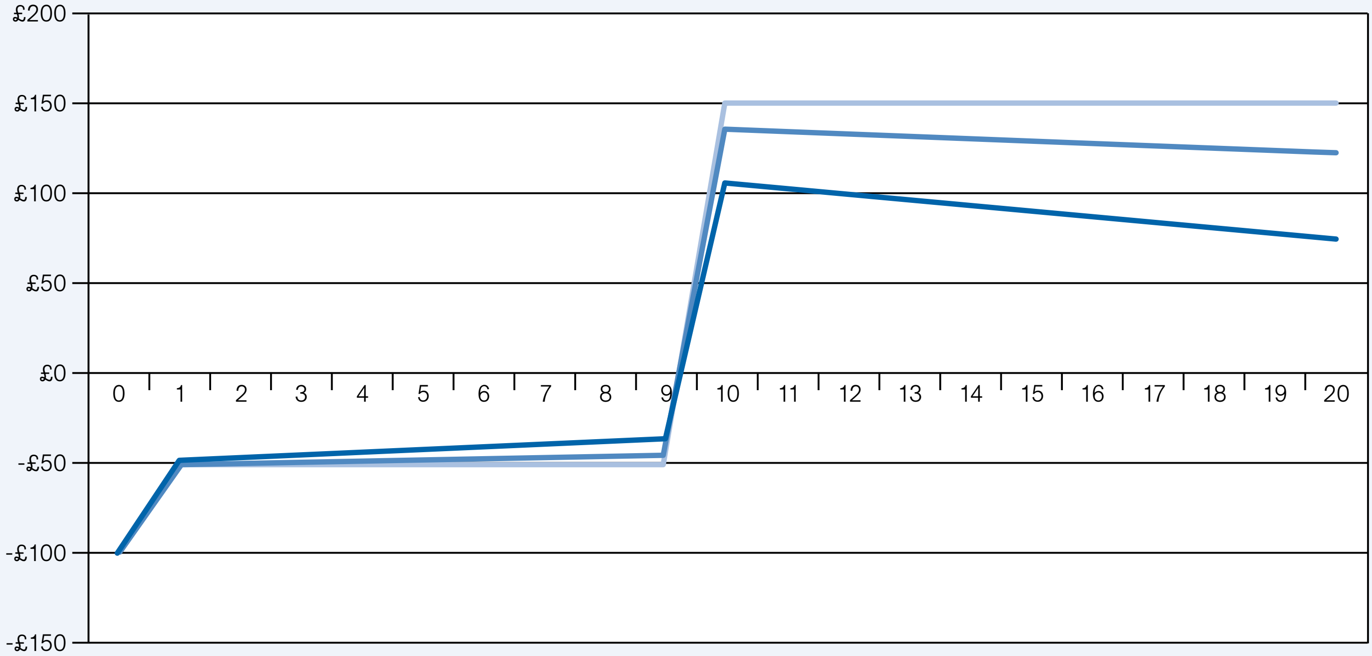
Table 2: Years 11–20 (note that the 0% DR remains unchanged over time; comparing the 1% to the 3.5% DR, the NPV at 1% over 20 years is nearly double)

Year	11	12	13	14	15	16	17	18	19	20
Benefit	**£200**	**£200**	**£200**	**£200**	**£200**	**£200**	**£200**	**£200**	**£200**	**£200**
Cost	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**	**£50**
Net benefit (NB) = Benefit - Cost	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150
Discount Factor (DF) at 0%	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Net Present Value at 0%	£150	£150	£150	£150	£150	£150	£150	£150	£150	£150
Discount Factor (DF) at 1%	0.896	0.887	0.879	0.870	0.861	0.853	0.844	0.836	0.828	0.820
Net Present Value at 1%	£134	£133	£132	£130	£129	£128	£127	£125	£124	£123
Discount Factor (DF) at 3.5%	0.685	0.662	0.639	0.618	0.597	0.577	0.557	0.538	0.520	0.503
Net Present Value at 3.5%	£103	£99	£96	£93	£90	£87	£84	£81	£78	£75

Table 3: Now let's look at the total NPV after 20 years (the sum of NPV for each year).

Total NPV	
At 0%	£1,100
At 1%	£894
At 3.5%	£510

Figure 1: Graphical representation of the NPV (y axis) at 0% (light blue), 1% (mid-blue), and 3.5% (dark blue) discount rate (DR) over 20 years (x axis) for the hypothetical MPA network described in the case study.



The benefits of the MPA network at 0% are more than double the benefits if using the Green Book recommended 3.5%.

As you read earlier: 'The UK requires all social projects' costs and benefits to be discounted at a rate of 3.5% per year – except for projects happening 30 years or more into the future, for which lower discount rates are chosen'. So why was this not applied to the MPA network (MCZs) around the UK?

Figure 1 shows these differences graphically over the 20 year timeframe.

It is worth considering what would happen if the same three discount rates were used for a 50- year timeframe.

The NPV by year 50 using a 3.5% discount rate would have nearly disappeared, whereas the 0% DR line would not have changed at all (as the future is not discounted) and would remain at £150 net benefit in perpetuity.

If you imagine the continuation of the three lines on the graph over time, the light blue (0%) line would remain constant as the future is not discounted, whereas the dark blue (3.5%) line would have disappeared by year 50, and the mid-blue (1%) line would be at about half the NPV by year 50.

So, as we can see, the subjective choice of discount rates can make a major difference to how future costs and benefits are valued. For marine protected areas, where benefits are slow to accrue but then remain in perpetuity, there is a strong case for using a 0% (or very close to zero) discount rate to ensure that the long-term benfits of conservation (which will benefit future generations) is properly taken into account.

Further reading and useful resources

TEEB: Discounting, ethics, and options for maintaining biodiversity and ecosystem integrity
http://evolution.binghamton.edu/evos/wp-content/uploads/2010/01/Gowdy-2009.aspx.pdf

Climate Change and Discounting the Future: A Guide for the Perplexed
http://www.hks.harvard.edu/m-rcbg/cepr/Online%20Library/Papers/Weisbach_Sunstein_Climate_Future.pdf

Asian Development Bank: Review of theory and practice of discounting
http://www2.adb.org/Documents/ERD/Working_Papers/WP094.pdf

Valuing future life and future lives: A framework for understanding discounting
http://faculty.som.yale.edu/ShaneFrederick/Future%20Life%20and%20Future%20Lives.pdf

The **Marine Socio–Economics Project** (MSEP) is a project funded by The Tubney Charitable Trust and coordinated by **nef** in partnership with the WWF, MCS, RSPB and The Wildlife Trusts.

The project aims to build socio-economic capacity and cooperation between NGOs and aid their engagement with all sectors using the marine environment.

Note: A "discount factor" is the amount by which any future value must be multiplied to convert it into present value

= 1 / (1+DR) ^ t

Economics in Policy-making briefings:

1. An overview of economics
   Sagar Shah
2. How economics is used in government decision-making
   Susan Steed
3. Valuing the environment in economic terms
   Olivier Vardakoulias
4. Social CBA and SROI
   Olivier Vardakoulias
5. Discounting and time preferences
   Olivier Vardakoulias
6. Multi-criteria analysis
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9a Finance and money: the basics
Josh Ryan-Collins

9b What's wrong with our financial system?
Josh Ryan-Collins

10 Property rights and ownership models
James Meadway

11 Behavioural economics – dispelling the myths
Susan Steed

1 i.e. 1billion / (1 + 0.035) ^ 50 (1 billion, divided by 3.5% to the power of 50 years) = 179,053,337.

2 A summary can be found here: **http://www.hm-treasury.gov.uk/d/Executive_Summary.pdf**

3 Stern, N. (2006) 'Climate change – our approach' in The Stern Review. Retrievable from **http://www.hm-treasury.gov.uk/d/Chapter_2_Economics_Ethics_and_Climate_Change.pdf**

4 Saunders, J., Tinch, R., and Hull, S. (2010). *Valuing the Marine Estate and UK Seas: An Ecosystem Services Framework.* London: HMSO, The Crown Estate.

5 The actual time discount rate used in the Stern Review is 0.001 yr–1

Written by: Olivier Vardakoulias

Edited by: Chris Williams

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www.neweconomics.org Tel: 020 7820 6300 Email: **chris.williams@neweconomics.org** Registered charity number 1055254.