Selecting discount rates for natural capital accounting[1]

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Valuation of environmental assets

Environmental assets provide a series of benefits to individuals and to society and, in principle, all of the benefits delivered by the environmental assets should be accounted for. However, to be consistent with the System of National Accounts (SNA), the scope of valuation is limited to valuing the benefits that accrue to economic owners. The System of Environmental-Economic Accounting Central Framework (SEEA CF) defines an economic owner as *the institutional unit entitled to claim the benefits associated with the use of an asset in the course of an economic activity by virtue of accepting the associated risks*. In the case of environmental assets, the government has a high degree of ownership or influence over the extraction of environmental assets. The valuation of these assets in monetary terms provides useful information for assessing future streams of income for government, for example, in the estimation of future government revenue from the extraction of oil and natural gas.

Approaches to the valuation of assets

Ideally, observable market prices should be used to value all assets. The ideal source of market price approximations are values observed in markets in which each asset traded is completely homogeneous. This allows a comparison against other assets in order to assess relative returns and overall national wealth. It also enables other similar types of analysis.

SEEA CF describes that an important principle to value environmental assets is to value them *in situ* – as far as subsoil assets are concerned, the asset itself as it is in the ground – rather than after its removal. For environmental assets which are extracted, the price of the output from extraction can normally be found in the market, but the market price of environmental assets *in situ* is not commonly available.

Since environmental assets *in situ* are not usually traded in the market, there are generally no observable prices for the value of the opening and closing stock for the capital and for the flows between these two time periods. Where market prices do not exist, an attempt should be made to estimate what the prices would be if a regular market existed and the assets were to be traded on the date to which the estimate of the asset relates.

[1] This paper has been written by ONS economists to inform discussions at the Seminar. It does not represent a firm analytical or policy position at this stage.

SEEA CF suggests two approaches that estimate the price of the asset in the absence of any regular markets:

1) Written down replacement cost

Generally, the value of an asset declines over time from when it was purchased, commonly known as depreciation. Theoretically, the value of an asset at any given point in time in its life is equal to the current purchase price of an equivalent new asset less its cumulative depreciation. When reliable market prices are not available, this approach gives a reasonable approximation of what the market price would be if the asset was offered for sale.

2) Discounted value of future returns

This approach, commonly known as Net Present Value (NPV), uses projections of the future returns of an asset and discounts them into today's money to reflect the value an investor would be prepared to pay for the asset in the current period. This approach provides reasonable proxies for observable market prices and is consistent with the SNA.

The written down replacement cost method does not appear to be suitable for two reasons. Firstly, there is no current *in situ* price of an equivalent environmental asset and, secondly, the value of subsoil assets, such as oil and gas, do not depreciate. The NPV method provides reasonable estimates for observable market prices for environmental assets which are extracted, as it uses projections of the future rate of extraction of the asset together with projections of its price to generate a time series of expected returns. These streams of expected returns are discounted to reflect the value an investor would be prepared to pay for the asset in the current period. The NPV approach is recommended by SEEA CF and was used by the ONS to value the UK's oil and gas reserves (Khan, J; Greene, P; Hoo, KW; 2013) and the UK timber resources (Khan, J; Greene, P; Hoo, KW; 2013).

Discount rates

If the NPV method is applied then discounting is required to convert the expected stream of resource rents into current prices. Discounting is based on the principle that, generally, people prefer to receive goods and services now rather than later. This is known as 'positive time preference'. For individuals, time preference can be measured by the real interest rate on money lent or borrowed in a perfect market. Amongst other investments, people invest at fixed low risk rates, hoping to receive more in the future to compensate for the deferral of consumption now. These real rates of return give some indication of their individual pure time preference rates. Society, as a whole, also prefers to receive goods and services sooner than later, and to defer costs to future generations. This is known as social time preference – the rate at which society values the present to the future.

Although a relatively simple concept in economic theory, the issue of discounting is something that the environmental economics literature has wrestled with. The literature is far from a consensus on which discount rate to apply. Despite the controversy, most participants in the debate about what constitutes an appropriate discount rate for environmental valuation acknowledge that a good starting point is the so-called Ramsey formula. This holds that the discount rate should be equal to the sum of two factors - the pure rate of time preference and the *product* of the growth rate of consumption and the elasticity of the marginal utility of consumption. Most of the literature has not included a catastrophic risk rate or have mixed this with the pure time preference rate as part of the Ramsey formula. However, the HM Treasury Green Book (2003) has separated these two out and has included the catastrophic risk rate in addition to a pure time preference rate to derive the discount rate.

The main source of contention regarding at what level the discount rate should be set is the pure rate of time preference. The pure rate of time preference measures the extent to which future welfare is discounted. Most of the literature and empirical studies have assumed social time preference as opposed to individual time preference to derive the discount rate. This is because social discount rates place a higher relative importance on income earned by future generations and is the rate that the government would choose in allocating resources across generations. On the other hand, market discount rates are typically higher than social discount rates, as individuals (or enterprises) tend to demand a quicker return from their ownership of an asset. The use of a market discount rate also provides a stronger comparison across different types of assets and the trade off between assets can be considered.

UK experience

The Stern Review (2006), the first major official economic report to give climate change a prominent place among global problems, used a pure time preference rate of 0.1% and an elasticity of marginal utility of consumption of one. When combined with an assumed per capita growth rate of 1.3%, Stern arrived at a relatively low discount rate of 1.4%.

One way to judge discount rates is to compare the assumptions made with observable market variables, for example, interest rates and saving behaviour. Nordhaus (2007) notes that the resulting discount rates set out in the Stern Review do not match the observed market interest rates. Similarly, Dasgupta (2006) argued that the values of the pure time preference rate and the elasticity of marginal rate of consumption assumed by Stern would not be compatible with observed savings rates.

However, Sterner and Persson (2008) dismissed these arguments on two points. First, real market complexities make it far from obvious which values the discount rate should match. The market rate used should be the risk-free rate and an average rate over a very long time period should be used, especially if the discount rate is to be used over an extremely long time period. As noted by Cline (1999), this could well imply a discount rate that is close to zero, matching that of the historical real rate of return on treasury bills. Secondly, Sterner and Persson (2008) argued that using observable real market rate variables as a benchmark

is not appropriate because a discount rate should be based on an ethical or normative judgement, not on simply observing the markets.

In the UK, the HM Treasury Green Book (2003) provides guidelines on what discount rate to use when applying the NPV method. The Green Book has recommended using a pure time preference rate of 0.5%. In addition, it has allowed for an exogenous catastrophic risk of 1%[2]. This risk relates to typical public expenditure projects and includes unforeseen changes in social and political objectives and priorities and to possible wider changes in the economy, society and technology, which are not part of the endogenous risk assessment.

The Treasury Green Book also assumed the marginal utility of consumption as 1.0[3] as assumed by the Stern Review and used a growth rate of 2.0%[4] to derive the social time preference rate of 3.5%. Hence, the Green Book recommended using 3.5% as a discount rate to convert all future costs and benefits to present values.

International experience

The World Bank in its reports, *Where is the Wealth of Nations (2006)* and *The Changing Wealth of the Nations (2011*), used 1.5% as the pure time preference rate. By using 1.0 as the marginal elasticity of consumption and 2.5% as the growth rate, the World Bank applied 4% as the social discount rate to estimate the natural capital in their wealth accounts. The recently published *Inclusive Wealth Report (2012)* utilised a 5% discount rate for a number of worked examples of natural capital valuation – including for agricultural land, fish and timber. The report also used a discount rate of 10% to value coastal protection in Thailand (Chapter 8: Barbier; Inclusive Wealth Report 2012).

The OECD[5] suggested that discount rates should be based on long-term bonds and provided 5% as an example. In an application of NPV to woodland valuation by Eurostat a consultation of forest experts was used to ascertain a discount rate. An admissible range of 0.5% to 3.5%[6] was found as appropriate for use as discount rates.

Other reports such as *The Economics of Ecosystem and Biodiversity (TEEB, 2010)* recommended that zero or negative discount rates could also be applicable when valuing environmental assets.

[2] Newbury (1992) estimates this as 1.0%; Kula (1987) as 1.2%; Pearce and Ulph (1995) as 1.2%; OXERA (2002) as 1.1% currently and 1% in the near future.

[3] Pearce and Ulph (1995) estimate a range from 0.7 to 1.5 with 1.0 being considered defensible; Cowell and Gardiner (1999) estimate μ as being just below or just above one; OXERA (2002) estimate a range from 0.8 to 1.1.

[4] Based on work by Maddison (2001) on the 1950-1998 UK average growth rate.

[5] OECD, 2012, p16

[6] Eurostat, 2000

System of Environmental Economic Accounting (SEEA)

In contrast to the social discount rate, the SEEA CF recommends the use of market discount rates in order to align the valuation with the SNA. However, the SNA does not deal with discount rates in respect to environmental assets directly. For instance, the SNA 2008 discussed discount rates briefly in terms of financial assets, though it has used the term *suitable* discount rate without elaborating what *"suitable"* actually means. SNA 2008 states that *"... for some financial assets, particularly those with a face value applicable at some point in the future, the present market value is established as the face value discounted to the present by the market interest rate. In principle, therefore, if a reasonably robust estimate of the stream of future earnings to come from an asset can be made, along with a suitable discount rate, this allows an estimate of the present value to be established*". As an example, SNA 2008 used a 5% discount rate for illustrative purposes.

Eurostat (2011) suggested that the International Accounting Standards aim for 'high-quality corporate bonds' as the ideal discount rate[7]. It was suggested that where such markets are underdeveloped, government bond yields should be used. This might suggest that Eurostat has provided some indication of using a social discount rate in the absence of any high quality information on a market discount rate. In relation to pensions, Eurostat has recommended using a 3% real discount rate (5% nominal) across Europe, which is based on European government real bond yields over a 10 year period. If these principles are applied to environmental assets, it could be argued that they should also be discounted using a social discount rate.

The SEEA CF highlights that the discount rate can be seen as an expected rate of return on non-produced assets and in a perfectly competitive market, these two should align and simply reflect businesses' time preference for receiving returns. However, it also recognises that social discount rates can be supported regarding environmental assets (SEEA CF, 2013, p145).

Choosing discount rates for natural capital and ecosystem accounting

The above discussion shows that there is little consensus on the discount rate that should be used for valuation of environmental assets. However, we think there could be a consensus if we establish the objective of the whole exercise because the threat comes from confusion about the purpose of the exercise. If the purpose of the exercise is sustainability of natural capital and ecosystems, the discount rate used will be different to the one that is used for accounting purposes – where the objective is to extend national accounting to incorporate environmental considerations.

[7] Eurostat, 2011, p45

There are three options to consider:

1) Social discount rate

The social discount rate should be used if the purpose of the exercise is sustainability. This approach was taken by most of the studies including the World Bank (2006 and 2011). The Treasury Green Book is based on the concept of well-being and therefore it recommends the use of a 3.5 % social discount rate. We would like to know your thoughts on using 3.5% or any other social discount rate.

2) Market discount rate

The market discount rate should be used if the purpose is to extend the national accounts. This rate is suggested by the SEEA because of its consistency with the principles of SNA. However, it is not clear what market discount rate should be applied for individual assets.

3) Use a uniform discount rate regardless of the purpose of the exercise

In the UK, the Treasury Green Book has recommended a social discount rate of 3.5%, which could be used for both sustainability and accounting purposes. This approach makes sense because there is no single market discount rate that could be used across all the natural capital and ecosystems. Using different market discount rates could cause an inconsistency across natural capital and could cause a real challenge in choosing the discount rate. This is because capital markets may exhibit imperfections which may distort interest rates and also that the individuals (and investors) are myopic and might not make the right decisions.

Conclusion and the discussion points

There are three options for choosing discount rates for natural capital and ecosystem accounting. Either social or market discount rates should be used depending on the purpose of the valuation, or a uniform discount rate as given in the HM Treasury Green Book should be used for all assets regardless of the purpose of the exercise.

We welcome comments on the above three options.

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