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Discount rates, equity weights and the social cost of carbon

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Abstract

Equity weighting has been proposed as a way of allowing welfare equivalents to be included in the social cost of carbon since a dollar to a poor person is worth more than a dollar to a rich one. Here we use the PAGE2002 integrated assessment model to show that the social cost of carbon is higher without equity weights (an elasticity of marginal utility with respect to income of 0) than with them.

This might seem counter-intuitive, but it comes about because of the logical link between equity weights and discount rates; as the elasticity goes from 0 to −0.5 to −1.0, the social rate of time preference rises, and the drop in present values that results far outweighs the small increase in impacts that equity weights bring.

Keywords: Climate change; Integrated assessment; Equity weights; Social cost of carbon

1. Introduction

The social cost of carbon is the increase in future damage, discounted to the present day, that occurs if current emissions of carbon dioxide are increased by 3.67 tonnes. An increase of 3.67 tonnes of CO_2 emissions involves emitting an extra tonne of carbon, hence the name, although it must always be remembered that any values quoted only apply if the carbon is emitted as CO_2, not in any other form.

After surveying the literature, two Defra economists proposed a value of $105 (£70) per tonne of carbon (in year 2000 prices) for the social cost of carbon (Clarkson and Deyes, 2002). They also proposed using upper and lower values of $52 (£35) and $210 (£140) per tonne. The year 2000 exchange rate was almost exactly £1 = $1.50 (Taxcentral, 2004).

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The proposed value of \$105, and the range of \$52 to \$210, are higher than most other estimates in the literature. For instance, Tol (1999) states that 'the FUND model finds marginal costs of \$9–23/tC, depending on the discount rate. If the aggregation of impacts over countries accounts for inequalities in income distribution or for risk aversion, marginal costs would rise by about a factor of 3.' Tol (2005) found that studies that are peer-reviewed have lower estimates and smaller uncertainty ranges. Guo et al. (2006) find that discount rates that decline over time increase the social cost of carbon. 'Although the range of plausible estimates is large, using declining discounting schemes in FUND 2.8 in most cases does not yield values at the £70/tC [\$105/tC] level suggested by UK DEFRA'. Pearce, 2003, concludes that the social cost of carbon has been set far too high in Clarkson and Deyes (2002).

In particular, published results from the PAGE95 model gave a 5 to 95% range for the social cost of carbon of \$12–60 per tonne, with a mean value of \$26 (in 2000 prices; converted from 1995 prices in the original) (Plambeck and Hope, 1996), and more recent results from the PAGE2002 model gave a range of \$4–51 per tonne, with a mean value of \$19 (in year 2000 prices) (Hope, 2006).

The difference between the recommendations from Clarkson and Deyes (2002) and the results from PAGE, and other results in the literature is, *prima facie*, a cause for concern.

In this paper we perform PAGE2002 runs with a unit 'impulse' of C as CO_2 to calculate the social cost of carbon under uncertainty with different discount rates and equity weights, and discuss the surprising results that we find.

2. Methods and data sources in Clarkson and Deyes

Clarkson and Deyes (2002) recognise that an Integrated Assessment Model (IAM) is needed to make estimates of the social cost of carbon (Section 3.4–Section 8 all section numbers here relate to Clarkson and Deyes, 2002). Their recommended value of \$105 is based largely on the Eyre et al. (1999) ExternE study, which they call 'the most sophisticated of the published studies reviewed' (Section 9.11).

In many IAMs, 'damage modules are often no more than ad hoc extrapolations around the $2\times CO_2$ benchmark' (Tol and Fankhauser, 1998). Eyre et al. is not explicitly based upon an estimate of $2\times CO_2$ damage, but it does consider a broad range of impact categories (Section 8.4). It uses a Social Rate of Time Preference (SRTP) of 3% per year (Section 9.11). It takes no account of the probability of climate catastrophe (Section 9.14), and socially contingent impacts are omitted (Section 9.10).

One of the more contentious methods in Eyre et al. (1999) is the use of equity weights, with an elasticity of marginal utility with respect to income of −1.0 (Section 9.11), to increase the importance given to damages in poorer regions of the world. Pearce (2001) criticises applying equity weighting only to climate change in Eyre et al. (1999), arguing that 'we should either equity weight all measures that have an effect on poor countries or we should not equity weight any of them. Isolating global warming and ring-fencing it as if it is unique is not a tenable proposition'. He also comments that even if equity weighting is accepted, it is not at all clear that adopting a marginal elasticity of utility of −1.0 is consistent with the way that we behave towards poor countries.

Clarkson and Deyes (2002) claims that equity weighting gives marginal damage at least a factor of two higher than if regional damages are not equity weighted (Section 8.9). The Eyre et al. (1999) study shows an increase in damage values over time of about \$1.5 per tonne per year (Section 9.8).