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Economic Appraisal of Carbon Emitting Projects and Global Warming

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Abstract

This article focusses on how carbon emissions from various sources which contribute to the climate change are evaluated in economics. It has been argued by some economists that in cost-benefit analysis empirically based discount rates are too high wiping out distant environmental costs of many projects to the detriment of the environment. To this effect the British Government recommended %3.5 declining discount rate over time in the economic appraisal of projects and in this way, it has been claimed, future generations would not suffer from environmental externalities.

Likewise Stern Review on climate change, published in 2006 which generated a good deal of controversy, also suggested the use of a low, but not declining, discount rate especially for projects with serious environmental consequences such as global warming. In this way the distant consequences of carbon emitting projects will have bearing in the current decision making process. This paper shows that neither Stern's low discount rate nor the British Government's declining figure will achieve their stated objectives because both like traditional models wipe out the environmental costs that will occur in the distant future. The paper instead recommends the use of intergenerational discounting criterion that places a substantial weight on future costs of all projects which are creating environmental externalities.

Introduction

Most investment projects in agriculture, industry, infrastructure, residential development and so on generate, to various degrees, environmental problems. It is now a widespread practice that in economic evaluation of these projects environmental issues must be identified, valued and discounted. The most widely used appraisal method is net present value both in public as well as private sectors.

Environmental problems created by investment projects were not treated robustly in the past but this situation has changed radically

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during the last few decades. Nowadays almost everybody accepts that issues such as deterioration in the quality of the environment is crucial both in developed and developing countries because they are firmly linked with human well-being. Cost benefit analysis, which is a branch of welfare economics, strives to capture environmental costs by using a number of environmental valuation methods.

In 2003 the British government published a mandatory cost-benefit manual for the use of civil servants, the Green Book (2003), who spent public money on all substantial investment projects. In this document the net present value method was recommended in their appraisal. In the European Union the same method is suggested in the economic analysis which is concerned with the social costs and benefits of the projects and requires the integration of externalities and the correction of market failures, European Commission (2008). One of the most important externalities is the discharge of the greenhouse gasses to the atmosphere which is the major contributor to the climate change. These costs are not directly reflected in the financial cash flow analysis of the projects but must be a part of the equation in the economic appraisal.

It has been well recognised that a positive discount rate used in net present value, or in other criteria for that matter, wipes out distant costs or benefits of investment projects and in this way long terms consequences, especially the environmental ones, do not play a part in decision making. As Samuelson (1976) puts it "*let us make no mistake about it, the positive interest rate is the enemy of long-lived projects."* For projects generating environmental problems heavy cost of which will intensify in future years the positive interest rate in fact becomes the enemy of future generations, (Kula 2012).

In the Green Book (2003) the British government by taking this point into account took a "moderating" step in its discounting policy. "*For individual time preference can be measured by real interest rate on money lent or borrowed. 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 rate. Society as a whole also prefers to receive goods and services sooner rather than later, and to defer costs to future generations. This is known as the social time preference rate. The*

discount rate is used to convert all costs and benefits to "present values" so that they can be compared. The recommended discount rate is 3.5%. Calculating the present value of the differences between the streams of costs and benefits provides the net present value (NPV) of an option. The NPV is the primary criterion for deciding whether government action can be justified", page 26, the Green Book.

This rate is quite low than many empirical estimates. For example Kula (1985), Evans and Sezer (2004) and *Evans (2005)* calculate ' much higher figures for the United Kingdom. In addition to that the British Government made a downward modification in the official rate by arguing that this rate should decline over time. "*Where the appraisal of a proposal depends materially upon the discounting of effects in the very long term, the received view is that a lower discount rate for the longer term (beyond 30 years) should be used. The main rationale for declining long term discount rates results from uncertainty about the future. This uncertainty can be shown to cause declining discount rates over time."* In the light of this evidence, it is recommended that for costs and benefits accruing more than 30 years into the future, appraisers use the schedule of discount rates provided in the table below.

Period of 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***

Pages 98-99, Green Book.

In 2005 Gordon Brown, the British Chancellor of the Exchequer, commissioned Nicholas Stern to conduct a study on the climate change to explore its economic and social consequences. The major participants were the economists at the Treasury plus some independent academics as consultants only. One year later a 700 page report was released with the name of Stern Review (2006).

The review argues that the climate change which largely results from burning of excessive amount of fossil fuel in combustion engines is the largest market failure ever occurred in human history. Although there are substantial economic benefits in burning fossil fuels but the costs greatly outweigh such benefits amounting to at least 5% of global GDP per annum in perpetuity. Major adverse impact is expected

to be in food production, health, water resources and in disrupted human settlements.

Basically, Stern Review was a kind of cost-benefit study of the global warming. Like in all cost-benefit analysis discounting featured a major role in the review. Stern contended that using a high discount rate reduces the benefits of remedial actions and thus recommended low discount rates in bringing costs and benefits into the present. A number of rates were used which were much lower than the figures estimated as a result of empirical investigations.

The purpose of this paper is to show that low discount rates suggested by the British Treasury and Nicholas Stern are totally ineffective in dealing with long term environmental problems including global warming. It recommends intergenerational discounting method with empirically based discount rate in dealing with the climate change as well as other environmental problems.

British Discount Rate and the Environment

In the Green Book the British government appears to be concerned about impact of investment projects, private and public, on the global climate. It is pointed out that impact of investment projects should be expressed in terms of carbon emissions or savings, as the case may be, identified as million tons of CO2 equivalent in cost-benefit analysis. Then monetary values should be placed on them. "*Key policy areas where climate change might be a particularly important consideration include; investment appraisal for long term planning and infrastructure projects, regulatory and planning frameworks, contingency planning and long-term policy frameworks," p.64, Green Book.*

For illustrative purposes let us assume that a long living project generates greenhouse gas emission during its life across generations. In year 200 alone the annual discharge is;

Year	**CO2 emission**
200	**1.5 million tons**

Now let us put a value on this environmental disturbance by considering the price of carbon. There is a substantial debate the social value of carbon discharged or sequestrated ranging from a notional

figure of £5.00 to £70.0. The top end is preferred by many environmental economists, Pearce (2003). On the other hand, a number of economists contend that the carbon value is likely to increase as the global warming becomes more pronounced and thus in cost-benefit analysis much higher figures should be used for future years, Brainard et al (2009). By using £70.0 for per ton of carbon we obtain the following cost figure for this project in year 200 alone;

Year	**Cost of CO2 emission**
200	**£105 million**

Discounted value of this costs at the official British rate of %2 for the year 200 becomes £1 million, about the price of a house in many districts of London!

The main reason for the British government's adoption of a low and declining discount rate was the plight of future generations who are likely to suffer most from environmental hazards created by us, such as global warming. In Oxera (2002), an Oxford based research group who did the preliminary research for the government's declining discount rate, it is argued that the a constant and high discount rate represents current generations' selfish attitude towards future generations. In this way distant consequences of many projects will be brought into present in a more effective way.

Despite such claims low and declining discount rate is self-defeating as the above example shows where colossal long-term environmental costs are reduced to a small present value. Therefore it is unconvincing to argue that distant costs play a substantial role in decision making by using the British model.

Another reason for the structure of the official rate is risk and uncertainty which inevitably leads to the declining discount rate, so does the government claim. This is a surprising argument for it is contrary to the well-established position in practice as well as in theory. In fact, risk and uncertainty is dealt with by way of increasing the discount rate, not decreasing it, Mishan (1988), Lumby and Jones (1994), Potts and Weiss (2012) and many others. One further problem is the time segments used in the declining rate which is completely arbitrary. It is always possible to come up with different intervals at various lengths.

Stern Review and Discount Rate

Discount rate is the price of time. Discounting is a process in which this cost is estimated over a given time horizon which makes it one of the most fundamental factors affecting policy decisions in many fields of economics. There is a substantial but controversial literature on the choice of discount rate in cost-benefit literature which goes back to the 1936 Flood Control Act in the United States of America. For a comprehensive review see Kula (1998).

Like in cost-benefit analysis in environmental economics too discounting occupy a prominent position. To this effect Nicholas Stern has made discounting a key point in his report on the climate change. In the end he recommended that a low discount rate should be used in the appraisal of projects that create substantial environmental externalities. Later on he took his argument to the extreme by suggesting that as consumption levels grow at the expense of environmental quality the discount rate would be negative (Section 2A, p. 52).

A negative discount rate has no support in the science of economics or psychology. If it did exist it would mean that environmental disturbances would be preferred sooner rather than later which is contrary to the well- established human behaviour. Fisher (1907) and Pigou (1929) contended a long time ago that individuals and societies postpone adverse effects rather than receiving them earlier on.

However, a negative private market rate of discount in real terms (after inflation), especially for those who save a part of their income, may become an unexpected reality for a while during a recession, as it happened recently in a number of countries. This was largely due to the implementation the monetary policy to boost spending to rejuvenate the economy which was in dire straits.

As for the zero discount rate the situation is the same that there is no support in the literature. It would mean that individuals or communities are indifferent between receiving a certain amount of benefit now and the same amount at a future date. Marshall (1899), a prominent thinker in economic literature, strongly ruled out not only the zero discount rate but also the negative one. Therefore, without a convincing evidence a case for negative or zero discount rates cannot be made in the climate change debate.

Pearce et al (1990) contend that a large burden of accounting

for climate change should not fall on the discount rate which is a little item and thus cannot carry too much weight. Furthermore, lowering discount rates in cost-benefit analysis would make more and more projects viable, thereby increasing the demand for scarce environmental resources on the one hand and exacerbate the environmental externalities, such as global warming, on the other.

In an interview with Stern the Financial Times criticised the use of low discount rates. Stern's answer to this was that, the use of high discount rates such as those often used in economic modelling of future costs would not properly reflect the cost of climate change to future generation, Financial Times (2007).

It has also been argued that national investment portfolio should contain shadow projects as moderating factor in the environmental damage. However, Mandelson (2008) contends that shadow projects that do not earn a positive rate of return are worth less to future members of the society than those money invested in the market place. Putting global warming before investment in projects such as health, education, transportation and security cannot be justified in the name of future generations. It is in everybody's interest that all projects should earn the same rate of return. Excessive spending on shadow projects with low rate of return is a weak argument which will not benefit the future members of humanity.

It is worth noting that the use of low discount rates is not a new argument in economics. Price (1984 and 1987), well before the global warming debate intensified, suggested the use of low discount rates in cost-benefit analysis. He limited his argument to afforestation projects which are long living ' involving a number of generations. In such projects the use of a low discount rate without its pure time preference component will achieve intergenerational equity and to this effect gives an example. However, Kula (1988) shows that Price's argument is flawed because in his example the forestry project never gets off the ground at a low %2.5 discount rate. In this way he kills the patient in order to cure the disease.

Going back to the above illustrative example of a project with carbon emission, its 1.5 million tons of CO2 discharge which was first valued at £105 million and then reduced to £1 million present value at a low discount rate of %2! So, it is difficult to argue that policy

recommendation in the Stern Review is the solution for the climate change. Then what sort of a discounting model should be used in economics to moderate the greenhouse effect of atmospheric pollution and other long- term environmental problems?

Carbon emission costs with intergenerational discounting

Intergenerational, or modified, discounting is a considerable improvement on both the low discount rate of the Stern Report and the British government's declining rate for long-term projects. This method eliminates inherent discrimination against future generations in traditional models by discounting future costs and benefits from the viewpoint of affected cohorts. That is, each generation discounts only its own utility or disutility but not that of others, Kula (1981).

In order to understand this clearly let us assume a single person society with a life expectancy of, say, 40 years. When the living individual dies it is replaced immediately by a new comer who expects to live 40 years and so on. Let us also assume that in order to protect the environment each living individual spends £1 one year after its birth. And all those after him do the same. Let us say that the discount rate is %5, and the discounted values by way of net present value criterion becomes;

Person 1 $1/(1.05)^{1} = 0.95$

Person 2 $1/(1.05)^{40} = 0.14$

Person 3 $1/(1.05)^{80} = 0.02$

Person 4 $1/(1.05)^{120} = 0.00$

and so on.

Since we argued above that discount rate is the price of waiting the discrimination against future individuals must be obvious because all individuals wait one year after their birth to incur their cost.

In the intergenerational discounting method discounting is conducted from the viewpoint of each generation involved. In order to obtain an operational formula we assume a hypothetical project which provides £1 benefit, or cost, over its lifetime which is divided equally between

individuals who exist at the time. Also assume that each individual has a certain life expectancy which does not change much over the years. Then intergenerational discount factors, IGDF, can be calculated by using

$$IGDF = \frac{1}{n}\left[\frac{1}{(1+s)^t}(n+1-t)+\sum_{i=1}^{t-1}\frac{1}{(1+s)^t}\right]$$

when $t \leq n$ and

$$IGDF = \frac{1}{n}\sum_{i=1}^{n}\frac{1}{(1+s)^t}$$

when $t > n$ where

n = constant life expectancy which also represents population cohorts

t = the age of the communal project which may go on indefinitely

s = the social discount rate.

The difference between intergenerational and conventional discount factors at %2 and %5 rates is stark as shown below.

Years	Conventional Discount Factors		Intergenerational Factors	
	%5	%2	%5	%2
1	1.00	1.00	1.00	1.00
20	0.38	0.67	0.44	0.71
40	0.21	0.45	0.30	0.57
60	0.05	0.30	0.27	0.71
80	0.02	0.20	0.27	0.71
100	0.00	0.13	0.27	0.71
200	0.00	0.01	0.27	0.71

It must be clear that unlike ordinary factors intergenerational ones do not become zero and thus when used in the economic evaluation of projects distant costs, or benefits, do not get wiped out. Both Stern's 'low' discount rate and the British governments declining rate wipe out distant environmental consequences of projects which are contributing the climate change.

In the intergenerational model the discount factors become constant when the relationship between the project and the population becomes stabilised. This is due to the fact that the model is taking into consideration the death in the society overtime and including the newcomers in their place who both will be effected by projects. In this way, one generation is not discounting costs or benefits that belong to other generations.

There is a substantial debate in economic and environmental literature on various aspects of Kula's intergenerational model; for a review see Kula (1998).

Going back to the above example of the project's carbon cost in year 200 we get the following results by way of the usual as well as the intergenerational methods. The conventional model captures both

the British Government's declining discount rate and the low rate in the Stern's model.

Year	CO2 cost	disc. rate	model	disc. factor	discounted cost
200	**£105 mil.**	**%2**	**usual**	**0.1**	**£1 mil.**
200	**£105 mil.**	**%2**	**intergeneration**	**0.5**	**£52.5 mil.**

Conclusion

As emphasised in the economic literature the social discount rate and method of discounting are immensely important in the economic evaluation of projects especially the ones creating environmental externalities such as the greenhouse effect of atmospheric pollution.

Some recent debates on discounting considered the interest of future generations because almost all projects impact upon them to various degree either positively or negatively. One viewpoint is that in the economic analysis of long-term projects a different and much lower discount rate should be used than the ones adopted in conventional studies. To this effect the Stern Review recommended a low discount rate in cost benefit analysis and in this way future environmental impact of investment projects, especially those contributing to climate change can be brought effectively into net present values. As this paper has demonstrated it does not.

Unlike what has been proposed by the British government and Nicholas Stern the intergenerational discounting model does address the future environmental issues. It does this by treating all generations in the same way. That is, in the process of discounting there is no discrimination practiced against any generation.

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