Chapter 28
Conventional Climate Change Economics: A Way to Define the Optimal Policy?

Jordi Roca and Emilio Padilla

28.1 Introduction

Among the earliest economic models for the integrated assessment of climate change was the Dynamic Integrated Climate-Economy (DICE) model (Nordhaus, 1993). This models the links between macroeconomic developments, greenhouse gas emissions, climate change, and their economic costs. It was proposed as a model for the world as a whole and has had several subsequent revisions, the last one being in 2018 (Nordhaus, 2018a). This line of research has led to many other integrated assessment models (IAMs) that aim to contrast the economic costs of different policies against climate change with those of not acting.

28.2 The DICE Model and Its Results

The DICE model is a normative model that maximizes an objective function, the present value of the sum of current and future utility of "extended consumption" (i.e., consumption minus the effects of climate change on well-being, valued monetarily). The utility in each moment depends on this consumption according to a function in which the marginal utility of consumption is decreasing. The impact of climate change caused by greenhouse gases is considered to reduce utility, in terms of its direct effects both on well-being and production. A simple quadratic function

J. Roca (✉)
Department of Economics, University of Barcelona, Barcelona, Spain
e-mail: jordiroca@ub.edu

E. Padilla
Department of Applied Economics, Autonomous University of Barcelona, Bellaterra (Cerdanyola del Vallès), Spain

S. Villamayor-Tomas, R. Muradian (eds.), *The Barcelona School of Ecological Economics and Political Ecology*, Studies in Ecological Economics 8,
https://doi.org/10.1007/978-3-031-22566-6_28

is assumed for the relationship between temperature change and economic damage. In the initial model, the possibility of extreme events was ignored, while later versions assume this possibility assigning probabilities that are deemed "reasonable" or using other ad hoc procedures. However, mitigation policies also have an economic cost, reducing the possibilities of consumption. Adopting this cost–benefit approach, Nordhaus estimates that the climate change "optimal policy" is – in the Pigouvian tradition – to establish a global carbon tax equal to the "marginal social cost of carbon." The model assumes that the economy always moves along a path of investment-consumption that maximizes well-being, and so it calibrates the model, with the exception of an externality – the damage of climate change – that is necessary to consider to achieve the optimal path (Goulder and Williams III, 2012). Nordhaus does not explicitly make the extravagant – though popular in macroeconomics – assumption that human society is equivalent to a representative agent who lives infinitely, but his model only seems consistent with this assumption.

The application of the DICE model in the 1990s recommended little deviation from the scenario without mitigation policy (Nordhaus, 1993, 1994). Nordhaus's results contrasted with the calls to act quickly at the 1992 United Nations Framework Convention on Climate Change, and influenced political decisions that legitimized the inaction of the US administration. Its most current version (DICE 2016) suggested limiting warming to around 3.5 °C by 2100 (Nordhaus, 2018b).

The Economics Nobel Prize award to Nordhaus was announced precisely the same day (October 8, 2018) that a special Intergovernmental Panel on Climate Change (IPCC) report (2018) was released. However, their conclusions regarding the intensity of the actions that need to be taken were radically different, so the so-called "economics of climate change" contrasts sharply with the dominant scientific opinion on what should be done. The report pointed to the need for a rapid and radical reduction in emissions to limit warming to 1.5 °C, to reduce risks, and to facilitate adaptation. Nordhaus' "economic optimum" implied an increase in emissions for approximately 25 years followed by a slow decrease (Nordhaus, 2018a, b). As Pezzey states, when projections such as Nordhaus' are made, "climate scientists typically express disbelief, derision, or dismay" (Pezzey, 2017, p. 3).

It is doubtful whether cost–benefit logic can show us how to tackle climate change. Although Nordhaus highlights an "optimal path", his model can lead to as many optimal paths as choices are made on certain controversial parameters so that by modifying them, virtually any level of reduction can be justified (Padilla, 2004). The quantitative results give an impression of being scientific, but they depend essentially on some nontransparent opinions of "experts" (Pindyck, 2017). In the rest of the chapter, we discuss the main problems with Nordhaus' proposals.

28.3 Discounting the Future

Conventional economic climate change analysis gives less weight to what may happen in the future. The choice of the rate by which the future is discounted ends up determining the level of mitigation that is considered optimal. Nordhaus considers a rate around 4–5% to be adequate, while the influential Stern report (2007) used a rate of 1.4%. This largely explains their different conclusions regarding the appropriate level of mitigation. The choice does not depend on scientific enquiry, but is based on specific assumptions and value judgments.

When using a utilitarian function, as Nordhaus does, there are essentially two arguments that are employed to justify time discounting. The first is based on the assumption that people prioritize present over future consumption. This assumption, called pure time preference (or impatience), is applied to the social discount rate. However, it is not clear that it is the dominant human preference. Most people seem to prefer distributing their resources to sustain – or even improve – their well-being throughout life. It is also questionable as to whether impatience can be considered a rational preference (Strotz, 1956). Even Ramsey (1928), author of some of the first macroeconomic models of intertemporal maximization, wrote that discounting the future is "a practice which is ethically indefensible and arises merely from the weakness of the imagination" (p. 543).

However, the main criticism is that impatience for a person's own consumption should not be transferred to a social preference between the present and the future, when the decision affects other generations (Padilla, 2002). This would only be justified if the society were made up of immortal individuals. Is it ethical that we give more importance to the present at the cost of what happens to future generations? Nordhaus' answer is yes, because the time preference of present generations must be respected. Many authors have opposed this position. Solow (1974, p. 150) states that: "in social decision-making (…) there is no excuse for treating generations unequally (…) we ought to act as if the social rate of time preference were zero." Thus, Cline (1992) and Stern's (2007) climate change models reject pure time preference (except that due to the very small probability of human extinction in the near future).

The second argument for discounting future consumption – which is different from discounting future utility – is based on the decreasing marginal utility of consumption and the optimistic assumption that there will be a continuous increase in per capita consumption. A growth of around 2% per year, as predicted by Nordhaus, means that consumption will multiply by a factor of approximately 7 in 100 years. Despite climate change, the well-being of future generations (as measured by the much-criticized criterion of per capita consumption; Roca Jusmet, 2011) would be well above the current one. So, why should we worry about them? The basis of this argument is the blind belief in future welfare improvements, which would render superfluous any concern for sustainable development. This can lead to the problem of the "optimist's paradox" (Martínez Alier, 2002; Padilla, 2002): if we apply a high discount because we assume that future generations will be better-off, we might seriously jeopardize such an outcome by making decisions that damage their environmental resource base.

In a normative model, the use of a discount rate must be based on ethical criteria. However, the Nordhaus-type model calibrates the objective function as if the economy were effectively maximizing social welfare. So, the rate of return on market investments is considered as an indicator of social preferences between current and future consumption. However, this rate tells us nothing about the level of sacrifice people are willing to make to preserve climate stability. Moreover, a normative model would not have to share dominant current preferences (Llavador et al., 2015). Nordhaus uses the two aforementioned arguments (pure time preference and increasing consumption per capita) to discount the future, but ends up arguing that the discount rate cannot be very different from the market return on investments. For example, he criticizes both Cline (1992), arguing that his approach is philosophically satisfactory but inconsistent with actual social decisions on savings and investments, and Stern (2007), whose "unambiguous conclusions about the need for extreme immediate action will not survive the substitution of assumptions that are consistent with today's marketplace real interest rates and savings rates" (Nordhaus, 2007, p. 701). Thus, when deciding if a discount rate is "realistic" or not, the ultimate criterion for Nordhaus is what happens in the market.

28.4 Uncertainty

A problematic aspect of the DICE and similar models is the number of uncertainties associated with climate change and mitigation policies. Current evidence tends to suggest that there is no linearity in the relationship between temperature change and induced damage; rather, the latter will increase proportionately much more than the former, and there will be discontinuities in the relationship. The relationship is very complex, and after a certain heating threshold it becomes even more unpredictable. One issue that makes the modeling of the damage function difficult is the possibility of a positive feedback between the concentration rates of greenhouse gases and the temperature level. This becomes more likely as the rates increase. Furthermore, when we consider the damage that all this may cause to society, something even more uncertain appears: how will people react? (Pezzey, 2017).

The DICE model assumes that economic damage is a continuous quadratic function of the increase in temperature. It calibrates the parameters so that the damage – measured as a percentage of world GDP – is moderate, even when the changes in temperature are great. The possibility of catastrophic phenomena is forgotten or the event is given a low probability rating based on the opinion of "experts", even though these phenomena are not subject to the kind of experimentation that would allow us to assign them a probability. As a result, and also due to time discounting, possible future catastrophic events carry no significant weight in the evaluation.

Pindyck (2017) notes that "When it comes to the damage function, we know virtually nothing (…) developers of IAMs have little choice but to specify what are essentially arbitrary functional forms and corresponding parameter values" (p. 101). This is even more true given that the projected changes in temperature are well beyond the range of the last thousands of years. As Pezzey (2017) observes, the damage function of the future is not only highly unknowable but will continue to be so.

Weitzman (2012), along with other authors, takes into account the potential magnitude of climatic disasters. He states that it is not appropriate to apply conventional cost–benefit analysis to decide climate policies, and argues that the issue should be treated as a risk management problem. The main question is how much society is willing to sacrifice to insure against the risk of possible catastrophic effects.

28.5 Cost–Benefit Analysis and Commensurability

The DICE model is presented as the maximization of a sum of (discounted) utilities. Moreover, climatic damage is considered the equivalent of (negative) consumption, which requires it to be valued in monetary terms. In practical terms, the utility-maximizing model becomes simply the traditional formula of cost–benefit analysis, according to which efficiency is determined by the criterion of "potential compensation". Greenhouse gas reduction is appropriate only as long as the monetary value of mitigation "costs" is less than the (discounted) monetary "benefits" of the damage avoided. In such a setting, everything (e.g., health and environment) can be given a pecuniary value. However, there are many problems and controversies surrounding monetary valuation estimations, and these are particularly acute in the case of climate change. For instance, a 1995 IPCC report was based on an assessment that the value of life in developing countries was 15 times lower than that in developed countries, and this sparked comprehensible widespread protests (Martínez Alier & Roca Jusmet, 2013, p. 288). Martínez Alier strongly argued against the assumption of commensurability, defending a multicriteria approach and the existence of different languages of valuation (Martínez Alier et al., 1998; Martínez Alier, 2002).

The Nordhaus approach is alien to any consideration of environmental rights or justice: it is permissible to harm some people to benefit others as long as the benefit to the latter is greater than the harm to the former. Even human lives become compensable when they are given a monetary value. Climate change is characterized by deep inequalities, both in responsibilities and in impact. Nordhaus chooses functions with decreasing marginal utility with respect to the level of consumption; that is to say, he introduces theoretically the assumption of "inequality aversion." However, the DICE model compares global consumption at different moments in time, ignoring the distribution among individuals of the same generation. As we have seen, inequality aversion is used to justify discounting the future, and the discounting will be greater the greater the "inequality aversion". This aversion should, logically, be applied to the intragenerational inequality between individuals of the same generation, and greater weight should be given to the impact on the poorest (Azar & Sterner, 1996). Thus, the paradox is that concerns about inequality in the Nordhaus aggregate model are used to promote not more but less action against climate change. Intragenerational inequalities are forgotten, and aversion to inequality is introduced only to discount the negative impact on future generations caused by current generations. If we consider the great intragenerational inequalities between different countries, it is worth asking whether optimism is so high as to suppose that future generations of poor African countries will be better-off than current generations of countries such as the United States or those in the European Union. Otherwise, one of the arguments for discounting the future benefits of climate policy becomes meaningless.

28.6 Conclusions

In this chapter, we have analyzed the Nordhaus approach to climate change, which is based on the cost–benefit principle and is frequently presented as the way economics establishes the "optimal" policy. We – along with most ecological economists – do not think it possible to determine the optimal policy from economic analysis (Azar, 1998), because this depends on value judgments and an uncertain knowledge of the future. Instead, we believe that a number of useful principles should be applied.

The first is sustainability, or *inter*generational justice, which can be understood as meeting our needs without jeopardizing the welfare of future generations. The second is *intra*generational justice. It is not acceptable that the carbon-intensive consumption of certain populations should jeopardize the most basic needs of others. Ongoing uncertainties, the difficulties in modeling climate change and, most importantly, the potential magnitude of the impact of global warming on future generations have led to growing support for the view that mitigation policies should be also guided by the *precautionary principle*. We should make efforts to minimize the risk of catastrophic scenarios that threaten to last longer than the entire history of humanity up to this point (Pezzey, 2017).

In conclusion, models *à la* Nordhaus conflict with the principles of sustainability, environmental justice, and precaution. These principles do not offer *the* optimal climate change policy, but they are a good point of reference, and they each demand rapid and radical emissions reduction. In stark contrast to these principles, Nordhaus argues that "economic optimality" implies that emissions should continue to increase for several decades. Interpreting this result as the "scientific" answer of economics ignores the limitations and biases of the model. It is an example of the negative influence that a certain type of macroeconomic modeling can have on decision-making, and it also damages the prestige of economics among the disciplines that are looking for solutions.

We are not, in any way, optimistic about climate change. Unfortunately, future emissions will almost certainly be much greater than those recommended by the IPCC. However, being pessimistic about the future is very different than characterizing it as economically efficient or optimal.

References

Azar, C. (1998). Are optimal CO_2 emissions really optimal? *Environmental and Resource and Energy Economics, 11*, 301–315.

Azar, C., & Sterner, T. (1996). Discounting and distributional considerations in the context of global warming. *Ecological Economics, 19*, 169–184.

Cline, W. R. (1992). *The economics of global warming*. Institute for International Economics.

Goulder, L. H., & Williams, R. C., III. (2012). The choice of discount rate for climate change policy evaluation. *Climate Change Economics, 3*(4), 1250024.

IPCC. (2018). *Global warming of 1.5°C an IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. IPCC.

Llavador, H., Roemer, J., & Silvestre, J. (2015). *Sustainability in a warming planet*. Harvard University Press.

Martínez Alier, J. (2002). *The environmentalism of the poor. A study of ecological conflicts and valuation*. Edward Elgar Publishing.

Martínez Alier, J., & Roca Jusmet, J. (2013). *Economía Ecológica y Política Ambiental*., tercera edición. Fondo de Cultura Económica. (Primera edición 2000).

Martínez Alier, J., Munda, G., & O'Neill, J. (1998). Weak comparability of values as a foundation of ecological economics. *Ecological Economics, 26*(3), 277–286.

Nordhaus, W. (1993). Rolling the "DICE": An optimal transition path for controlling greenhouse gases. *Resource and Energy Economics, 5*, 27–50.

Nordhaus, W. (1994). *Managing the global commons: The economics of climate change*. MIT Press.

Nordhaus, W. (2007). A review of the stern review on the economics of climate change. *Journal of Economic Literature, 45*, 686–702.

Nordhaus, W. (2018a). Evolution of modelling of the economics of global warming: changes in the DICE model, 1992–2017. *Climatic Change, 148*, 623–640.

Nordhaus, W. (2018b). Projections and uncertainties about climate change in an era of minimal climate policies. *American Economic Journal: Economic Policy, 10*(3), 333–360.

Padilla, E. (2002). Intergenerational equity and sustainability. *Ecological Economics, 41*(1), 69–83.

Padilla, E. (2004). Climate change, economic analysis and sustainable development. *Environmental Values, 13*(4), 523–544.

Pezzey, J. V. C. (2017). Why the social cost of carbon will always be disputed. *WIREs Climate Change*. https://doi.org/10.1002/wcc.558

Pindyck, R. S. (2017). The use and misuse of models for climate change. *Review of Environmental Economics and Policy, 11*, 100–114.

Ramsey, F. P. (1928). A mathematical theory of saving. *Economic Journal, 38*, 543–559.

Roca Jusmet, J. (2011). El debate sobre el crecimiento económico desde la perspectiva de la sostenibilidad y la equidad. In A. Dubois, J. L. Millán, & J. Roca (coord.), *Capitalismo, desigualdades y degradación ambiental*. Icaria.

Solow, R. (1974). Intergenerational equity and exhaustible resources. *The Review of Economic Studies, 41*, 29–45.

Stern, N. (2007). *The economics of climate change: The Stern review*. Cambridge University Press.

Strotz, R. H. (1956). Myopia and inconsistency in dynamic utility maximization. *Review of Economic Studies, 23*, 165–180.

Weitzman, M. L. (2012). GHG targets as insurance against catastrophic climate damages. *Journal of Public Economic Theory, 14*(2), 221–244.