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Economics and Governance for Sustainable Development

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Introduction

In this chapter we assess the role of economics in governance for sustainable development. Firstly, we ask how has the 'mainstream' environmental and resource economics paradigm helped us understand the nature of sustainable development? We explain the context in which environmental and resource economics developed and the main propositions made during its formative years. These help us to understand the paradigm's approach to sustainable development or sustainability (we do not distinguish between these two terms, although some do). Taken to the limits of formalism, it culminates in the social planner's desire to optimise human welfare over all time and the drive to place monetary values on, and aggregate, all forms of wealth, including natural assets. This chapter then outlines the strengths and weaknesses of this approach by comparing it with an alternative set of approaches that has come to be known as ecological economics.

Our second question is how can economics inform governance systems for sustainable development? Thus the final section of the chapter reflects on the contributions that economics can make to the policy process, using two high-profile motivating examples: the Copenhagen Consensus, devised by the 'skeptical environmentalist' Bjørn Lomborg (Lomborg 2001), and the Stern Review on the Economics of Climate Change (Stern, 2007). Although economic analysis has much to offer (for example in the design of policy instruments for delivering sustainable development), we caution firmly against a reliance on formal modelling to prescribe a single, optimal path of policy. Instead we must draw upon a broader range of evidence, in which such formal approaches are nevertheless useful. We emphasise the need for economic research on sustainable development to take serious and explicit account of its ethical implications, of uncertainty about the consequences of depleting the natural environment, and of the possibly essential and non-substitutable role of the natural environment in sustainable development.

Before proceeding, we should define what we mean by sustainable development and governance. Across disciplines and perspectives, most would agree that a theory of sustainable development should first engage with equity, both across and within human generations (if not further between humans and non-humans), and second comprise three pillars; economic, environmental and social. In this context, the approach to sustainable development that we follow is strongest in its focus on intergenerational (human) equity and on environmental sustainability. In particular, we focus on sustaining the world's capacity to meet human needs and provide human welfare. A much trickier task is defining what constitutes capacity as we discuss later in the chapter.

We define governance for sustainable development as the sum of decision-making structures and principal guidelines for shaping the process of policy-making in ways that support sustainable development. In this chapter, we ask what input economics should make to the design of these governing arrangements. We avoid a lengthy discussion of what is a suitable institutional design for sustainable development.

Economic approaches to the sustainability challenge: an introduction

When, in the 1960s, a new wave of environmental concerns emerged in popular, political and social-scientific consciousness, economics responded by opening its existing analytical toolbox. This toolbox exemplified so-called 'neoclassical' or 'marginalist' economics, and its application to contemporary problems of natural resource depletion and environmental degradation gave birth to environmental and resource economics as we recognise it today.

Neoclassical economics is a remarkably self-contained – some would say introspective – theory of the economy involving a high degree of abstraction and mathematical formalism. Based on the technique of optimisation, whereby producers and consumers behave as if they optimised a function, thus comparing their private benefits at the margin (that is, incentives resulting from incremental changes) with their private costs at the margin, it explains the value of goods, services and factors of production in terms of an exchange between supply and demand. That is, the value of something is reflective not just, as classical economists such as Smith, Ricardo and

Marx postulated, of how much it costs to make, but moreover of how much consumers are willing to pay for it. In particular, in assuming that both producers and consumers are driven by the rational desire to maximise their own lot, it shows that, given other key assumptions, an equilibrium price exists where supply and demand intersect. This arises because to both parties, the cost of producing and consuming one more or one less unit of something is greater than the benefit. In any given market, this equilibrium represents the most efficient allocation of scarce economic resources. The notion of an efficient (thereby optimal) equilibrium attained naturally via the independent self-interested behaviour of economic agents is the *leitmotif* of neoclassical economics. Indeed, it goes right back to Adam Smith's 'invisible hand' of the market.

Modern neoclassical economics is an essentially microeconomic approach. This has two important consequences. Firstly, it emphasises the structure of economic activity and its allocative efficiency rather than its overall scale. Secondly, it is fundamentally a theory of resource scarcity in a static economy, lacking the long-run focus of classical economics. Although plenty of dynamic equilibrium models exist that do project decades into the future, the transition of the economy is represented in a very basic way. Another important feature of the economic mainstream is that welfare economics – the dominant normative theory – is usually grounded in a variant of utilitarianism that emphasises sovereign consumer preferences as the moral yardstick against which to make judgements about whether one allocation of resources is better than another. Although the theoretical limits to this approach have been intensively debated even within the discipline (for example the difficulty of making (cardinal) inter-personal comparisons of utility), the practical result is that such judgements are ultimately reduced to the question of which configuration of the economy produces the most utility or welfare on aggregate terms possibly after allowing for some weighting within and between generations.

By seeking – as far as is possible – to transfer neoclassical-economic axioms to environmental problems, environmental economics inherited a set of fairly restrictive assumptions, of which the following are the most salient (Weintraub 1985):

1. economic agents exist;
2. they have invariant, complete preferences over outcomes;

3. they optimise independently of each other over constraints such as the availability of production factors, technological possibilities and disposable income;
4. they have full, relevant knowledge of their decision problems;
5. their choices are made in fully integrated markets;
6. observable outcomes are fully coordinated and must therefore be discussed with respect to a general equilibrium.

Clearly, not all of these will hold when the economy-environment interface is brought into the equation. Indeed, it was precisely by focusing on the circumstances in which one or two of these assumptions might break down (primarily number 5) that environmental economics was best able to make a contribution. The point, however, is that environmental economics “concentrated on the development of auxiliary conditions in partial equilibrium settings which allow at least some features (for example, invariant preferences) of the standard paradigm to fit observed phenomena” (Crocker, 1999, p36). Hence the key outputs of the environmental-economics research programme from the 1960s to the 1980s included, most notably, the theory of missing markets, the attempt to place monetary values on the surpluses foregone when markets are missing (via environmental valuation), the design of allocation systems capable of realising foregone surpluses (e.g. Pigovian taxes, tradeable permits, the Coase theorem, etc.), and rules on the optimal depletion of renewable and non-renewable resources.

Environmental and resource economics approaches to sustainable development

Origins and key assumptions

The emergence of the sustainable-development agenda towards the end of the 1980s was bound up with the growing prominence of pervasive, global environmental problems such as climate change. Evidently the tripartite objective of long-term economic, environmental and social sustainability could not be realised without countering such problems. Yet as Siniscalco (1999) among others points out, up to this point environmental and resource economics had largely, though not exclusively, focused on environmental problems that were relatively limited in time and space (i.e. ones which were therefore presumed to be apt to analyse assuming a closed, competitive, full-information economy). The same could less confidently be said of sustainable development. It placed several more demands on environmental economics that are covered later on in this chapter.

In fact, environmental economics resisted the temptation to break with orthodoxy and applied the neoclassical theory of economic growth and its various models to sustainable development. These consider the optimal division of economic output, which is produced using labour and capital, between consumption and saving. The rule they seek to establish is how much to consume now and how much to invest in capital to increase consumption later. There are various types of model, of which the workhorse is highly aggregated, considering one representative economic agent or social planner making an economy-wide decision, where production, consumption, saving and investment are summed over all the economy's sectors. Suspending for the time being a particular concern for future generations, the model is traditionally solved by estimating the highest possible discounted consumption path over time: the optimal growth or so-called 'golden rule' path of human development.

In early models, production was specified as a function of produced or man-made capital (e.g. machinery and infrastructure) and labour. As the role of the environment and natural resources was embraced, the model was extended to account for natural resources – both non-renewable (fossil fuels and minerals) and renewable (e.g. timber) – as a factor of production (Dasgupta and Heal, 1974; Solow, 1974). These are considered to be forms of natural capital. The model can also be extended to include human capital (i.e. the knowledge and skills embodied in people) and, conceptually if not empirically, social capital (networks of shared norms and values that facilitate productive cooperation between people and groups). Crucially, these early studies assumed that natural capital was similar to produced capital and labour, and so could easily be substituted for them. This is the essence of what came to be known as 'weak sustainability' (Pearce *et al*., 1989).

The key question posed in these pioneering studies was whether optimal growth, as it is defined above, was sustainable in the sense of allowing non-declining welfare in perpetuity? This was shown to be unlikely in a model including an essential, non-renewable natural resource as a factor of production. The basic result was that, save for great optimism about how little the economy is constrained by the natural resource, consumption falls to zero in the long run (Solow, 1974). Therefore it became necessary to establish specific rules allowing non-declining welfare over all time based on some maintenance of the capital stock, including natural capital. This was addressed by Hartwick (1977), who derived the rule that the rents from non-renewable resource depletion should be reinvested in other forms of capital.

Later, Pearce and Atkinson (1993) and Hamilton (1994) built on the so-called Hartwick rule, by setting out a theoretical and empirical measure of net investment in produced and natural capital (and later human capital added by Kirk Hamilton) that has become known as genuine savings. Genuine savings measures net changes in produced, natural and human capital stocks, valued in monetary terms, in principle at their shadow prices. The aim of the sustainability planner is to keep genuine savings above or equal to zero. Hence it is closely associated with another of environmental economics' great research endeavours: the construction of environmental, or green, accounts, which attempt to add natural assets to the decades-old practice of compiling national economic accounts (see United Nations *et al*., 2003). The World Bank now regularly publishes a comparatively comprehensive set of genuine-savings estimates for over 150 countries, which it now calls net adjusted savings.

Stylistic policy prescriptions

Before we can assess the positive contribution that environmental economics has made to the understanding and governance of sustainable development, as well as its weaknesses, we set out the stylistic policy recommendations that follow from its approach. At the outset, it must be stressed that environmental and resource economics does not advocate a neo-liberal, laissez-faire approach in which the free market is left to its own devices. A basic premise of environmental economics is that many environmental resources lack an appropriate price because of missing markets. Hence the environmental-economics doctrine is entirely compatible with interventionism. We must impute a price for environmental resources where the scarcity signal is absent and find the most efficient policy design that will re-allocate the economy's other resources around this price. Typically, economists prefer flexible and efficient instruments of governing, such as environmental taxes and tradable resource or emission permits, to inflexible and inefficient command-and-control instruments. Often, policy makers fail to heed the economist's advice: command-and-control regulation remains the instrument of choice in most national environmental policy systems. This has prompted some economists to wonder why the patient (i.e. policy makers) does not follow the doctor's (i.e. the economist's) preferred cure (Kirchgässner and Schneider 2003).

But not even the correct shadow-pricing of environmental resources would be sufficient to ensure intergenerational equity defined as non-declining utility, because optimal growth may well still be unsustainable. This is the extra condition (or 'rider') required by sustainable development. Instead, a policy maker following the prescriptions of environmental economics could set a macroeconomic constraint on investment, in which total net investment in all forms of capital (including natural capital) is forbidden to become negative. Following this rule would, without doubt, be of tremendous benefit in resource-rich developing countries, many of whom have an imprudent track record of resource management (see World Bank, 2006). Perhaps surprisingly then, environmental economics privileges an explicit ethical standpoint in favour of future generations, above the efficient allocation of resources in the present.

Environmental and resource economics: strengths and weaknesses

The positive contributions

Simply put, the key claim made in environmental-economics research is that the environment can and indeed should be given a 'parity of esteem' (we owe this phrase to Frank Convery) in managing the macro and the micro economy. Thus from the economic side of the sustainability problem, the great contribution of environmental economics has been to demonstrate, through flexible and powerful concepts such as the externality, that environmental degradation has an economic cost. Equally, environmental economics has sought to point out that there are opportunity costs to environmental protection. Although one can legitimately object on ethical grounds to placing monetary values on natural assets (see below), it is difficult to escape the reality that environmental sustainability will have to compete with other sustainability objectives and with 'extra-sustainability' objectives in securing scarce economic resources now. One of the greatest strengths of environmental economics is that it calls for these dilemmas to be addressed head-on.

In some respects the rigorous and (internally) consistent theoretical framework of environmental economics is also a strength, provided we suspend for now any lingering doubts about the validity of its assumptions. One can think of it as an analytical corset into which sustainability concerns are squeezed. To understand why this is a benefit, it is important to realise that the objective and even the science of sustainability has become deeply politicised (O'Riordan, 2004), due in large part to the flexibility of interpretation enjoyed by those wishing to wear the badge of sustainability. There can be little disagreement with the ultimate aim of development that lasts, but in trying to arrive at a more workable definition, it would not be an exaggeration to suggest that there are almost as many definitions as there are stakeholders. This is amply reflected in the measures of sustainability chosen by many governmental institutions. For instance, the UK Government set out no less than 68 indicators of sustainable development (20 framework indicators and 48 others) in its latest strategy (DEFRA, 2005).

If the purpose of this mix is managerial rather than communicative (MacGilivary and Zadek, 1995), then the problems are twofold. Firstly, for any given indicator, there is rarely an obvious, direct interpretation of a unit change vis-à-vis sustainability. For example, indicator number four in the UK's set is the amount of renewable energy generated as a percentage of total electricity. But how much renewable energy do we need to generate in order to move onto a sustainable path? Environmental economics argues that this puzzle cannot be solved, without considering many other indicators on a common numéraire. Secondly, what are we to make of a positive change on one indicator at the same time as a negative change on another? We are, for example, accustomed to seeing increases in greenhouse gas emissions (indicator 1) accompany increases in gross domestic product (indicator 32). The comparative meaning of this dichotomy is a question of their contribution to human welfare and the degree of substitutability permitted between them. Even if the objective of shadow-pricing these very disparate changes in the total capital stock is thought unrealistic, environmental economics has at the very least contributed a theory that forces us to confront such trade-offs.

A similar argument, put forward in Dubourg and Pearce (1996), is the question of what is the appropriate scale at which to target sustainable-development policy?

Increasingly, policy discourses focus on meso- or even micro-units such as the sustainable business sector, the sustainable city or the sustainable household. But ensuring that every one of these units is potentially sustainable is unlikely to be efficient. Instead, such policies could restrict welfare to a level below that actually possible on a sustainable path. For environmental economics, the appropriate point of policy intervention is rather the macro level, supported by environmental accounts that can lead to economy-wide sustainable investment decisions.

On a more practical level, the environmental policy maker's toolbox is certainly richer for several decades of research into economic policy instruments, such as environmental taxes, tradable pollution or resource permits, incentives for innovation and so on. These may not always be suited in a simple and unfettered manner to the policy issue in question, but they are likely to be a key component in the eventual mix of instruments that does work.

The weaknesses

Unsurprisingly, the unbending cost-benefit logic of welfarist approaches to sustainable development, in which policies to preserve the environment are only justified if the monetary benefits of environmental degradation are smaller than the monetary costs, is as much a weakness as a strength. First, the preference-satisfaction brand of utilitarianism on which welfare economics is founded precludes incompatible systems of ethics and conceptions of equity. In other words, as much as we can praise environmental economics for what it includes, we must recognise what it excludes. Second, in order to ensure tractability, complex and unpredictable natural and social phenomena are usually forced to take on a relatively simplistic form that may be a poor and, critically, misleading representation of reality. Of course, science often proceeds on the basis of theories and models that simplify reality. The key is to accept this in a transparent fashion and place caveats on any policy recommendations that are made. This point is not always embraced and we elaborate in the section below.

As a consequence of the first point, environmental economics relies upon a narrow theory of ethics and equity. In some sense this is a facile critique, since favouring one particular theory of moral philosophy usually results in the exclusion of others (the efforts of Amartya Sen being a notable exception – see Sen, 1999). Yet the extensive demands of the sustainable-development agenda compel environmental economics to address much greater inequities than it is familiar with, including those between human generations and between human beings and non-human beings. On the one hand, environmental economics is wary of any conception of environmental preservation that is not directly based on economic values. For example, the bioethical principle that humans should preserve other species because they possess an intrinsic value and hence moral standing – even if they create a net economic benefit when they are pushed to extinction – is anathema to the mode of utilitarianism that focuses on the satisfaction of human preferences. On the other hand, this comparison reveals a further limitation to environmental economics, because it reflects elements of both consequential and procedural equity. Utilitarianism is a consequentialist theory of moral philosophy, whereby the moral worth of a policy is determined solely by its consequences. This differs from procedural or deontological theories, according to which it is the policy process itself that makes the resulting action right or wrong. Hence environmental economics is also difficult to reconcile with a procedural approach to sustainability (see, for example, Chapters 2, 7, 8 and 9), in which the primary objective is equitable participation in the decision-making process. Accordingly, a fair process that results in a below-par outcome may still be judged a success.

On the other hand, it is true that environmental economics has done much to invigorate the debate on intergenerational fairness to human beings through debates about discounting future benefits and costs (see Pearce *et al*., 2003). And indeed what is implicit in the environmental-economic analysis of sustainable development in particular is a commitment not to diminish the opportunities of future generations. The early work on optimal growth and sustainable development, sketched above, found that a welfarist approach, based only on the consumer preferences of the current generation, would not guarantee sustainable development. Thus the interest in sustainable development from environmental and resource economics is ultimately rooted in some explicit ethical commitment to future generations that comes from beyond its traditional normative basis, such as a commitment based on rights or obligations. Nevertheless, in other respects it has a limited amount to say on the role of equity in sustainable development. Where intra-generational concerns are addressed, they tend to be reduced to the objective of increasing total consumption (more for everyone) or weighting the overall social welfare function in such a way that extra consumption is worth more to low-income groups.

Turning to its representation of natural and social phenomena, we focus on the treatment of the natural world in environmental economics, especially the ‘weak sustainability’ assumption that natural capital is infinitely substitutable. It is often claimed (most famously by Daly (1977)) that natural capital has no easy substitutes, which is the basis of the rival ‘strong sustainability’ paradigm (Pearce *et al*., 1989). It is highly unlikely, for instance, that there are substitutes for basic life-support systems (Barbier *et al*., 1994). Most generally, this means the global environmental and ecological system that provides us with the basic functions of food, water, breathable air and a stable climate. The prescription that follows is precautionary: preserve critical natural capital in physical terms so that its functions remain intact. Although the capital approach to sustainability may thus continue to be valid, the overall cost-benefit calculus of environmental economics must be pared back, because the shadow price of critical natural capital is, by definition, infinite.

Even if natural capital were in principle substitutable, it can have two further complicating features that environmental economics is fundamentally ill-equipped to deal with: (1) risk and uncertainty attached to the way in which natural processes such as the global carbon and biogeochemical cycles work; and (2) the threat of large-scale, discontinuous and irreversible losses of natural capital.

Environmental economics regards risk as a situation in which the set of all possible states of the world, the probability distribution over this set and the resulting welfare effects can be objectively known. Uncertainty differs from risk in that no objective knowledge exists, merely subjective beliefs. The standard response of economics has been to use option and quasi-option values. Option value is the expected value of refraining from an action that leads with some objective or subjective probability to irreversible environmental damage, in order to keep the option open of using the environmental resource in the future. Quasi-option value is the value of delaying irreversible environmental damage in order to acquire the improved knowledge that would facilitate a better-informed decision in the future. The problem with this approach is that, in cases of severe uncertainty, we cannot rely on estimates of option and quasi-option value.

This would not matter so much if all environmental damage were local and reversible. However, the sustainability problem highlights that mankind has initiated many processes that lead to large-scale, often global, potentially discontinuous and often irreversible environmental change. Global climate change and biodiversity extinction are the most prominent examples. What are the option and quasi-option values connected with keeping greenhouse gas emissions within the limits of the absorptive capacity of the atmosphere? What are the option and quasi-option values connected with preventing large-scale biodiversity extinction? Probably we cannot give an acceptably precise answer, perhaps even to within a 'ball park'.

Ecological economics: a brief summary

Starting in the late 1980s – but with roots going much further back – a new paradigm began to coalesce in the form of ecological economics. It aspires to build on some of the strengths of environmental economics, while at the same time overcoming some of its major limitations. For example, it dismisses neither the idea of allocative efficiency nor the policy prescription to internalise environmental externalities. However, it super-imposes on efficiency considerations the idea that the overall scale of the economy matters (Daly, 1977). It also affords much more prominence to issues of equity and fairness.

Contrary to environmental and resource economics, ecological economics is a more diffuse paradigm. In large part, this reflects the challenge of bringing together diverse perspectives in developing an ecological-economic identity, including elements of economics, ecology, thermodynamics, ethics etc. At its heart lies a recognition that ecosystems and ecological processes are of utmost importance to humankind, are highly complex and sometimes vulnerable to perturbations and as a result (and most importantly of all) are difficult to monetise. It is premised on a precautionary approach towards the idea of substituting natural capital for other forms of capital. Indeed, most ecological economists would subscribe to the idea of strong sustainability, which Neumayer (2003) believes involves two main schools of thought. One requires that the value of natural capital be preserved. The second strand requires that a subset of total natural capital be preserved in physical terms so that its functions remain intact. This is so-called critical natural capital. In dealing with risk and uncertainty, ecological economics rejects option and quasi-option values, instead calling for the application of a less formalised precautionary principle. This requires the preservation of critical natural capital, unless the costs of preservation are demonstrated to be unacceptably high. Whichever the interpretation of strong sustainability, the size of the economy relative to the ecosystem becomes relevant, which partly explains why scale has reasserted itself as a legitimate economic concern.

The application of a less formalised precautionary principle, balanced against a criterion of excessive cost, has been rather obviously criticised by environmental and resource economists, because it represents an arbitrary substitution of natural capital for other forms of capital. In essence, they argue that unless one uses a formal cost-benefit framework, the outcome is likely to be inefficient and therefore undesirable. Yet this tends to ignore the difficulties that we have already highlighted in pinning down what is an efficient level of environmental protection. Therefore economics cannot give society a definitive answer, a point to which we return below. Some have rightly argued that the precautionary principle is vague (Turner and Hartzell, 2004). Yet this feature could also be regarded as a strength: the principle has to be applied flexibly, its meaning depending on the context in which it is used (see Chapters 10 and 11).

Hanley *et al*. (2001) doubt that environmental and ecological economics are really so different, 'merely stressing different aspects of the same problems' (Hanley and Atkinson, 2003: 102), and that this false distinction is neither useful nor productive. They remind us that many of the same people responsible for founding environmental economics went on to found ecological economics, although this seems to deny the possibility that minds (and with them allegiances) can change. They also recall that some ambitious valuation exercises in ecological economics have sought to monetise ecosystem functions (e.g. Costanza *et al*., 1997), although we would argue that the true thrust of ecological economics remains the idea of limited substitutability of natural capital. They go on to point out that few environmental and resource economists would unequivocally endorse weak sustainability and that recent advances in the monetary valuation of environmental assets have emphasised qualitative inputs (e.g. Kenyon *et al*., 2001) and competing, non-economic criteria (as incorporated in multicriteria analysis). We commend this move, but point out that it is often with the aid of, rather than in spite of, work in complementary disciplines that horizons are broadening. The development of a more pluralistic environmental economics in certain key areas is thus something to be welcomed.

How should economics engage in governing for sustainable development?

Having discussed the strengths and weaknesses of environmental and ecological economics, we would like to explore the role of economic analysis in sustainable governance. We focus on the overarching analytical questions, rather than detailed questions about which policy instruments to apply in which circumstances. To this end, we consider two recent, high-profile motivating examples. The first is the so-called Copenhagen Consensus (www.copenhagenconsensus.com), which in our view offers a salutary lesson in the role it should *not* play. The second is the Stern Review on the Economics of Climate Change (Stern, 2007). Much has been written in support and in opposition to the Stern Review. Even these two authors have aired their differences (compare Dietz *et al*., 2007 – Dietz worked on the Stern Review – with Neumayer, 2007). We reconcile our positions to argue that the Review takes a broader and more suitable approach than the Copenhagen Consensus, but begs some unresolved questions about the relationship between formal economic modelling and other methods of assessing the worth of policy intervention.

The Copenhagen Consensus event was organised by the self-proclaimed skeptical environmentalist, Bjørn Lomborg. He invited a panel of eminent economists to set priorities among a very broad range of global public-policy problems, from hunger and malnutrition through to trade reform and climate change. For each problem, the panel was asked to consider a ‘challenge’ paper, which was commissioned to estimate the net benefits of various policy proposals within a welfarist, cost-benefit framework. In addition, two further economists were commissioned to review the challenge paper. By monetising the net benefits of each proposal, it was in principle possible to compare policies across the entire list of global problems drawn up. The overall question thus represents perhaps the logical extreme to economic inquiries about public policy: how can the world best spend its scarce financial resources to improve human wellbeing? The answer is a ranking of 17 policies, based on the size of their net present benefits. Table 11.1 reproduces the ranking from Lomborg (2004).

Table 11.1 here

We focus on the ranking of climate-change policy. The three climate-change policies considered in the exercise – an optimal carbon tax, the Kyoto Protocol and a value-at-risk tax designed to protect against low-probability and high-damage risks – were ranked lowest of all public-policy options and branded 'bad' in absolute terms. The challenge paper for climate change was written by William Cline (2004) and adapted the formal cost-benefit model of Nordhaus and Boyer (2000). Cline attempted to monetise the global costs of reducing greenhouse gas emissions and the global damage costs of climate change over a period of several centuries, with the ultimate aim of prescribing the optimal path of emissions reductions that would maximise utility. Although he argued that there were large net benefits to emissions reductions in each of the policies he considered, the review papers (Manne, 2004; Mendelsohn, 2004) and later the Consensus panel doubted these. Strong action on climate change was considered a bad idea.

The Stern Review on the Economics of Climate Change (Stern, 2007) was commissioned by the UK Prime Minister and Chancellor of the Exchequer to provide a wide-ranging economic assessment of climate change. It was led by Nicholas Stern, who was then adviser to the UK government on the economics of climate change and development, and head of the UK Government Economic Service. The Review had a narrower focus than the Copenhagen Consensus, considering only climate change. But it took a broader methodological approach, comparing the costs of reducing greenhouse gas emissions with the risks thereby avoided using a mixture of physical/natural scientific and economic studies. There was notably no attempt to calculate the optimal climate policy within a single cost-benefit model, although such models were considered in various parts of the review. It arrived at a radically different conclusion to the Consensus panel (but similar of course to Cline, 2004) that strong and urgent reductions in greenhouse gas emissions should be a global policy priority.

What explains the different conclusions of these two economic analyses? One important explanation is their treatment of intergenerational equity, which is at the heart of sustainable development. In formal economic analysis, this debate revolves around the discount rate, which is clearly of tremendous significance when the costs of reducing greenhouse gas emissions are relatively immediate yet the benefits occur with a lag of several decades.

In standard cost-benefit analysis of climate change, it is conventional to use a discount rate approximately equal to the opportunity cost of investment i.e. to market interest rates. This is known as a 'descriptive' approach to discounting and would typically lead to a discount rate of, say, five per cent per year. The discount rate used should not diverge from the opportunity cost of investment since, it is argued, using a lower rate would channel scarce resources away from investments that provide the future with a higher real rate of return. In the Copenhagen Consensus exercise, Cline (2004), however, set a lower discount rate of two or so percent per year (variable) on the grounds of intergenerational fairness. This is known as a 'prescriptive' approach. Stern (2007) similarly set his rate to around one and a half percent per year. Cline was strongly rebuked for this by the Consensus reviewers and panel on the grounds that it leads to inconsistent conclusions and inefficient choices. Largely for this reason, climate change was ranked so low. Stern was similarly criticised (Nordhaus, 2007, is the best example).

This debate is a revealing example of the problems that can be created by the narrow ethical basis of environmental and resource economics, especially when that ethical basis is largely implicit. Opponents of Cline and Stern insist that economists should look to existing market data in order to set a discount rate for climate-change policy. Anything else would in fact be 'unfair', they would argue, because applying a lower discount rate to climate-change policy than to other policies will be contrary to people's revealed preferences (recall the doctrine of consumer sovereignty) and divert scarce resources away from their most socially productive uses. This is the *modus operandi* of the Copenhagen Consensus. But Cline and Stern would object that ethical decisions across many generations cannot simply be made by recourse to market interest rates, which are the result of a complex interaction of private decisions by consumers. With a discount rate of, say, five per cent per year, even fairly catastrophic consequences of today's emissions of greenhouse gases in one or two hundred years would be essentially worthless, which is an illustration of why optimisation from the perspective of the private, market behaviour of the current generation might not be sufficient to guarantee sustainable development.

To put this another way, there is at least one sense in which the outcome of the Copenhagen Consensus – that in comparing short-term with long-term policies the former win – was pre-programmed. In this case, an additional rider would be required to try to secure the endowment of a stable climate system for future generations. It so happens that Cline and Stern sought to do this through the discount rate, although elsewhere it has been suggested that sustainable climate policy could be brought about with a market discount rate, subject to some safe maximum stock of greenhouse gases in the atmosphere (see Weyant, in press). In the end there may not be much difference between the outcomes of these approaches. Which is more tractable will depend to a large extent on what sort of evidence is available to answer their key questions.

But Neumayer has argued that discounting may be beside the point (1999, 2003, 2007). The assumption that the costs and benefits of climate policy can be discounted in respect of the real rate of return elsewhere in the economy is only justified if all forms of capital are truly substitutable i.e. if one subscribes to a weak sustainability paradigm. Drastic action can be justified if climate change causes irreversible and non-substitutable damage to and loss of natural capital, i.e., damage and loss that cannot be compensated by building up manufactured and human capital resulting in consumption growth. Sterner and Persson (2007) similarly show that strong action on climate change can be justified even with conventionally high discount rates by assuming sufficiently large future increases in the relative prices of environmental goods and services, which would dramatically raise the non-market damages from climate change and counteract the effect of discounting the future.

This points us towards a second important pivot on which the cost-benefit modelling of climate policy balances: how can we sensibly represent the full set of complex relationships that links the growing world economy with greenhouse gas emissions, greenhouse gas emissions with increases in temperature, increases in temperature with climate change, climate change with environmental impacts, and environmental impacts with socio-economic responses? Formal economic models comprise a very small number of simple equations to capture these processes. This would not in itself be a problem, provided these are a good representation of reality. However, tremendous uncertainty characterises every stage. As a result, estimates of the marginal damage cost or social cost of greenhouse gas emissions, which are an alternative expression of the modelling problem to the optimal path, are hugely uncertain. A recent analysis of the uncertainty behind such estimates, in relation to carbon dioxide in particular, shows a range spanning at least three orders of magnitude (Downing *et al.*, 2005).

In making bold and ambitious comparisons between 'chalk and cheese' policy problems, the Copenhagen Consensus panel believed that narrow economic formalism can give a fairly definitive indication of how systems of governance should prioritise their resources. But uncertainty of the sort besetting climate-change policy renders their conclusions hugely unstable. To begin with, Cline (2004) conducted most of his modelling using best guesses, so that it did not even presume to assess climate change from the perspective of risk. Moreover, we know that it is very restrictive to model climate change as a risk, in the sense of a complete set of outcomes with associated probabilities. Hence the benefit-cost ratio feeding into the Copenhagen Consensus ranking could be orders of magnitude higher, propelling the policy to the top of the table. By contrast, the Stern Review presented the larger part of its analysis on multiple metrics like the consequences of climate change for food security and water availability. This required fewer assumptions and presented decision makers with a more transparent picture. However, its formal modelling dominated the popular and academic conversation. While it made some improvements on the previous literature, notably in extensive modelling of risks, this formal component was nevertheless subject to most of the same limitations, normative and positive, as any other such study. Thus the intention was to draw on the wider set of evidence presented in the Stern Review, particularly where the formal economics was weakest. The problem was, however, that the Review left the relative role of formal economic analysis, compared with other modes of analysis, open to interpretation.

Economic research undoubtedly has much to offer the sustainability debate. However, we need to avoid relying on catch-all answers that purport to tell us what sustainable development is and what should be done to achieve it. This reminds us of the chronically overworked super-computer Deep Thought, which appeared in Douglas Adams' *The Hitchhiker's Guide to the Galaxy*. Deep Thought had been commissioned to provide the ultimate answer to life, the universe and everything. After 7.5 million years of deliberation, it arrived at the eminently useless number of 42! When challenged to provide a better answer, Deep Thought responded: 'I think the problem, to be quite honest with you, is that you've never actually known what the question is.'

In looking for better questions and answers we need to draw upon diverse economic perspectives that seek to provide a richer understanding of the process of formulating sustainable-development policy, as well as the detailed directions, if not the precise distances, in which such policies may take us.

Conclusions

Environmental and resource economics has offered important insights for sustainable governance. At the practical level, it has given us a set of policy instruments, including taxation and tradable permit systems, that seek to harness the efficient forces of markets. At the theoretical level, it has given us the notion of opportunity cost and the consequent imperative of valuing natural assets based on their multifunctional contribution to human welfare. Although one can legitimately object on ethical grounds to placing monetary values on natural assets, it is difficult to escape the reality that environmental sustainability will have to compete with other sustainability objectives (as well as 'extra-sustainability' objectives) in securing scarce economic resources now. Because sustainability has become a political concept – used by many organisations as a legitimising tool for essentially business-as-usual policy – as much as a rigorous scientific one, the consistent theoretical basis on which environmental and resource economics depends can only be considered a strength, if the set of assumptions that underpin it hold true. But this is a very big 'if'.

Indeed, we would argue that the nature of the sustainability problem stretches the credibility of narrow economic formalism, mandating a wider variety of approaches and a less ambitious overall objective. Large-scale environmental problems such as climate change and biodiversity loss are characterised by complex and novel ethical quandaries, by significant risk and uncertainty, by the threat of major, discontinuous and irreversible changes and often by the fundamental irreplaceability of many assets. None of these elements has been adequately or fully addressed by environmental and resource economics thus far. In many cases, relevant research has been undertaken from alternative economic standpoints, including ecological economics.

We argue strongly that the Copenhagen Consensus provides a salutary lesson in how not to use economics to govern for sustainable development. This involved a select group of economists, including several Nobel laureates, being asked to prioritise on cost-benefit grounds tremendously disparate global public-policy problems, including climate change, education and migration. The suggestion, for instance, that trade reform is 'very good' but the Kyoto Protocol is 'bad', has received backing from a number of very reputable commentators, including *The Economist* magazine (although not any longer). This stance betrays the fact that, even if many environmental and resource economists recognise the limitations of economic models of climate change, other interested parties may not. This form of hubris is not supported by the theoretical and empirical state-of-the-art. The Stern Review approached its task with more humility. Indeed the task itself was considerably less ambitious. But in pursuing a multi-track analysis, with formal economic modelling presented alongside physical and natural science and so on, it raised some important questions about the significance of the different sources of evidence, which it did not definitively answer.

We argue that economics has much to offer governance for sustainable development, but it is not and never will be able to give a definitive answer to the ultimate question of what is the optimal path to sustainable development? Boundaries need to be set and a more pluralistic economics should be encouraged. Pulling back from the ideal of maximising global utility will lead us to engage better with the true needs of national and international policy-making, which include debating the merits and demerits of specific policies to achieve sustainable development.

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Table 11.1. The ranking of environmental and development problems in the Copenhagen Consensus.

Project rating	Rank	Policy problem	Policy remedy
Very good	1	Diseases	Control of HIV/AIDS
	2	Malnutrition	Providing micro nutrients
	3	Subsidies and trade	Trade liberalisation
	4	Diseases	Control of malaria
Good	5	Malnutrition	Development of new agricultural technologies
	6	Sanitation and water	Small-scale water technology for livelihoods
	7	Sanitation and water	Community-managed water supply and sanitation
	8	Sanitation and water	Research on water productivity in food production
	9	Government	Lowering the cost of starting a new business
Fair	10	Migration	Lowering barriers to migration for skilled workers
	11	Malnutrition	Improving infant and child nutrition
	12	Malnutrition	Reducing the prevalence of low birth weight
	13	Diseases	Scaled-up basic health services
Bad	14	Migration	Guest-worker programmes for the unskilled
	15	Climate change	‘Optimal’ carbon tax
	16	Climate change	The Kyoto Protocol
	17	Climate change	Value-at-risk carbon tax

Source: Lomborg (2004)