The costs and benefits of mainstream economics: An environmental policymaker's perspective

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Abstract: This paper discusses some of the strengths, the limitations and the shortcomings of mainstream environmental economics, from a policymaker's perspective. Some attention is paid to divisions within the mainstream. The first part of the paper is on externalities and on environmental policy instruments. The second part is on environment in cost-benefit analysis. The author concludes that environmental economics has made some important contributions in the first field, whereas the evaluation of cost-benefit analysis is much more critical. Heterodox economists should address the question of sustainability and ask themselves how short term policy propositions can be made commensurable with long term survival and health of the biosphere and humanity.

What do policymakers do when they make policies?

Environmental policymakers basically have three different tasks: First, to investigate and evaluate the state of the environment, and to decide whether the state is satisfactory or bad and even deteriorating. Second, to propose a policy target, either in terms of an improved state or in terms of reduced impacts. And third, to propose a policy instrument or a mix of instruments to achieve the target. This is of course very schematic. The work is also not carried out in a vacuum. Ministries cooperate and fight, and colleagues have their backgrounds in different disciplines, including economics. Then there is a vivid public debate, where environmentalist voices are present, and also economists, as well as claims and arguments from different sector interests. A lot of the work is actually *policy defending* – building and presenting arguments for some proposed or established policy under attack or criticism.

In this paper I will discuss the strengths, shortcomings and flaws of environmental economics, addressing also some differences within mainstream. In the first part I will describe the main features of environmental economics. The discussion of pros and cons will be divided in two parts; the first part will be on policy instruments and the second on cost-benefit analysis. Externalities and pricing will be reoccurring themes. I will pay most attention to climate change, but will also touch upon the loss of nature and biodiversity and other environmental problems. Though I will discuss theoretical questions this is not first and foremost a theoretical paper. My perspective will be that of the policymaker. That is one reason why I will concentrate on micro and mostly neglect macro-questions. From a sustainability point of view this is not satisfactory, but macroeconomic policy simply is not on the table for environmental policymakers. Summing up, I will touch the role of heterodox schools, and I will issue a challenge.

The role of environmental economics

Frank Convery states the following in a paper on water policy: "There are two big ideas that economists can offer you as a policymaker: (1) benefit-cost analysis, and (2) water pricing and the creation of water markets." (Convery 2012). He could well have said the same about

1The author works in the Norwegian Ministry of Climate and Environment. This paper presents the views of the author and not those of the Ministry. I am grateful for some very useful comments and corrections from my colleague Øyvind Lone, who is not to blame for my views or for remaining flaws.

resource management and environmental policy in general, so cost-benefit analysis and economists' approach to policy instruments and regimes will be at the heart of my discussion.

The dominant economic approach to environmental problems and policy is *environmental economics*. Environmental economics is mainstream (neoclassical) microeconomics[2] applied to environmental problems. In a popular textbook Charles D. Kolstad describes the subject of the field like this: "Environmental economics is concerned with the impact of the economy on the environment, the significance of the environment to the economy, and the appropriate way of regulating economic activity so that balance is achieved among environmental, economic, and other social goals." (Kolstad 2000). Kolstad defines environmental economics as "an applied field", a field that "really took off in the 1970s and has been booming ever since." (Kolstad, op. cit.) By the late 1990's Michael Jacobs wrote about the "development of neoclassical environmental economics, which has gradually assumed a significant influence in the way environmental policy is perceived." (Jacobs 1997.) The 1990's represented a breakthrough for environmental economics.

There are several reasons for the boom. One obvious cause is the increase in environmental consciousness and conflicts from the 1960's and 1970's. Air and water pollution problems, such as widespread use of chemicals, acid rain and ozone layer depletion came to the attention of the public and politicians. Later on global warming has entered the stage, and traditional nature conservation has got a profoundly new dimension with the increased attention to biodiversity loss. The Brundtland Report from 1987 once and for all established sustainable development on the policy agenda. This opened up the field for environmental economics. An influential and timely contribution, originally written as a report to the British government, was the book "Blueprint for a Green Economy" (Pearce, Markandaya and Barbier 1989).

Main features in environmental economics have contributed to the boom. First, some core concepts – such as *externalities* and *common or public goods* – are easily understood as a tool for communication not just among economists but also between economists and other groups. Second, environmental economists have proposed several powerful instruments for *internalization*, such as green taxes and tradable emission schemes. These instruments have grown in importance not just (or mainly) because of a neoclassical/neoliberal turn in economics and policy, but because some persistent environmental problems, such as global warming, call for a different approach than local pollution and nature protection. Third, as a general point, the neoclassical focus on *resource scarcity* seems to fit quite well with environmental issues as the environment is finite and non-producible and increasingly scarce. In turn this makes the focus on efficiency appealing, because it offers an answer to the question of how production, income and welfare can keep on rising even when this scarcity is factored in.

Then there are also several problems with the conventional economics, some of which I will address in this paper. The main problem is that the conventional approach is basically a static and marginal one, obsessed with optimal solutions, whereas the major problems of our time are dynamic and systemic and call for robustness and sustainability. Many mainstream economists try to address these problems within the accepted framework, by adjusting the assumptions.

2I will use the term "mainstream" for economics that is accepted in the established journals, conferences and organizations, whereas "neoclassical" will be used in a more narrow sense, meaning economics that is based strictly on the neoclassical assumptions.

Environmental problems as "market failures"

In mainstream theory, externalities and common goods are part of a list of "*market failures*". Pollution of a river is an externality because the cost is born by someone else than the polluter. This cost will not be reflected in market prices. The clean river is a common good whose value is being reduced by the pollution. Several other failures can be listed, such as monopoly/market concentration, information asymmetry and principal-agent situations. Market failures are deviations from perfect competition, causing non-optimal solutions and calling for some type of corrective action.

This leads directly into the ideological debate about the role of government, so it should not be a surprise that economists of different shades hold different views on how to cope with market failures and even on the pervasiveness of market failures. The authors of a strictly neoclassical textbook write that even if imperfect markets are real and cause real problems, one must "be constantly wary of the insinuation that market failure itself justifies government intervention." (Bergstrom and Randall 2010.) One argument for this could be a belief that "coasian solutions" are widespread options[3], but the stronger one will probably be that regulation failures are perceived as being as large as market failures or even larger.

The absolute point zero

I will take a critical look at the reference in relation to which externalities and other market failures are defined – the *perfect competition* model. This model rests on some well-known assumptions[4]. Mainstream economists defend the model not as a realistic model, but as a system of reference. This choice of reference is not trivial, for reasons which I will discuss here and in more detail later.

Deviations from the model assumptions are the rule rather than exceptions[5] in real markets. The major problem is that the perfect competition model is a static one, whereas markets and the economy are evolving. Preferences and technology are obviously endogenous in this process, but treated as constant in the model. Budding economists are equipped with an idealized, static model which is totally unfit to describe the dynamic and rough processes of competition in real markets. And even if such markets were possible they are not in general the kind of markets we would want anyway. No serious innovation or other development can happen under such conditions. Perfect competition is an "absolute point zero" of neoclassical economics – a point of reference, but also a point where nothing can happen, which should make it virtually worthless as a reference.

And yet, the idea that environmental damage can be seen as external effects – not intended by the perpetrator, but nevertheless real and harmful for the victims – makes good sense not just to economists but to politicians, policymakers and the general public. Externalities is a robust concept which does not in my opinion depend on the assumptions in neoclassical micro theory. Here I agree with Jeroen van den Bergh, who has argued that the notion of externalities does not in general imply entering the domain of neoclassical economics (van der Bergh 2010).

3"Coase's theorem" states that provided property rights have been precisely defined, polluters and victims could negotiate emissions and payments and thus reach an optimal solution. Probably Coase's argument should be seen as an investigation into a hypothetical world without transaction costs, actually stating the improbability of such a solution to appear.

4Typically: A large number of suppliers and buyers, free access to/exit from market, full information, homogenous products, optimizing behavior, fixed preferences and techniques. Markets clear.

5The Arrow-Debreu solution, presented to me and my fellow students as a proof that a perfect competition general equilibrium is actually possible, should rather be read as an illustration of the implausibility of such a solution to ever come about.

From the externality concept flows the idea of *internalization*, the proposal to correct for or internalize the externalities. Again, this language resonates quite well with the thinking of people from different disciplines. But there can be very different opinions on how best to do this, depending on the nature of the environmental problem and of the sources of the negative impact.

Correcting for externalities: Regulation vs. incentives?

Environmental policy instruments can be divided into two main categories. We have the legal instruments, or direct regulation, and we have the economic instruments, based on incentives. Then there are voluntary agreements, and also information. These instruments differ in flexibility and in the degree of activism from government, and they are often used in combination.

Policymakers have some criteria. *Effectiveness* is crucial: Will the policy actually solve the problem? *Efficiency* requires the improvements to be reached at the least possible cost to the society. But also *fairness* and distributive effects will play a major role. The choice of instrument(s) will depend on the nature of the problem. We have global problems, such as global warming, where the impact of an emission is independent on where the source is. At the other end we have the potential loss of a specific ecosystem, or a point source emission into a particular lake. The latter situations call for some kind of direct and specific regulation, whereas global warming calls for general instruments including in particular price-based ones. This is off course very schematic. Between the purely global and the purely local there is a whole range, and many problems have both a local and a transboundary dimension. One issue of great importance is the degree of reversibility. The loss of a species and the accumulation of mercury in ecosystems are irreversible. Noise, on the other hand, disappears immediately when the source has been removed. (This not to suggest that removing sources of noise is easy.) Here I will stick to the question of how to solve or reduce an environmental problem, which instruments to use, and leave the issue of the ambition level till later. Economists will have views on both questions.

In Norway, environmental legislation, policy and institutions developed fast from the 1970's on. The Ministry of the Environment was established in 1972, laws were passed and regulatory authorities built up. Several pressing pollution problems were addressed, through direct regulation of industry and agriculture and development of modern wastewater treatment. To make a long and quite successful story short, direct regulation has continued to dominate the picture. But whereas the expertise in the 1970's was with the inspectors it is now with private firms, so regulation today is both stricter and leaves more decisions to the polluter. National parks and other types of area protection are dominant in nature management.

For a long time economic instruments played almost no part in environmental policy. A successful deposit return system for car hulks was introduced in 1978, apart from that we used some subsidies to "lubricate" regulation. From the 1990's green taxes have gradually been introduced, and since 2005 carbon emissions trading.

As we know, mainstream economists have strongly promoted economic instruments as means of internalization. Nationally there were initiatives from the Ministry of Finance. Internationally I will emphasize the role of OECD[6] which has had a long engagement in

6The Organization for Economic Cooperation and Development, with 34 member states including the most advanced capitalist economies.

environmental policy, and has been a strong proponent for the use of economic instruments. Green taxes are seen as complying with a "strong" version of the "Polluter Pays Principle"[7], whereas direct regulation corresponds to a "weak" version. Subsidizing polluters to make them reduce emissions will breach the principle (as will doing nothing). At times OECD has not only promoted economic instruments, but also been very critical of direct regulation. In OECD descriptions of environmental policy instruments green taxes and emissions trading have often been given a prominent place, whereas the vast array of regulations – regularly labeled "command-and-control" – have been given a brief and rather negative mention.

Although direct regulation is not in general the preferred option, a combination of externalities and transaction costs and/or uncertainty can offer a theoretical basis for choosing emission permits, standards and other types of direct regulation. Exactly because conventional theory is based on so strict assumptions, it can also allow for relatively sober discussions on instrument choice. For instance, in a much cited paper from 1974 Martin Weitzman discusses green taxation vs. direct regulation (Weitzman 1974). One point he makes is that, under uncertainty, when potential damage is great and reduction costs modest, direct regulation will be the preferred option.

Policies are meant to trigger an array of behavioural changes, from immediate adaptation to technology development. A traditional view has been that getting the prices right will induce sufficient research and development. There has been some discussion about the technology impact of green taxation vs. regulations, including setting future emission standards, and several studies have confirmed the usefulness of the latter approach. It has also become an established view within mainstream that there are spillover effects from companies' research and development, in fact *positive externalities*, that warrant financial support.

Pigouvian (green) taxes

Pigouvian taxes, or "green taxes", are environmental economics' most prominent contribution to the array of policy instruments. It was originally launched by Alfred Pigou in the 1920's, and taken up by economists in the 1960's and 1970's. In the 1970's Pigouvian taxes and emissions trading were still textbook phenomena in Norway. A tax on sulphur in mineral oils was introduced in 1970, and a carbon tax in 1991. Since then we have developed taxes on, i.a., waste disposal, pesticides and some chemicals in addition to taxes on fossil fuels and vehicles.[8]

What exactly does internalization mean? According to the textbook it means adding a tax rate per unit of emission equal to the marginal damage cost. In optimum the marginal damage cost must equal the marginal reduction cost. The adaptation to the tax rate will make sure that this marginal reduction cost will be equal among polluters, securing efficiency. As environmental goods are generally not provided in markets and no prices can be found, some kind of monetary valuation will be needed to find the costs of environmental damage. Most textbooks will take it for granted that such estimates can be found and will freely set up a diagram with two intersecting curves. (I will return to valuation methods in a later section.)

However, in practice this is not how green tax rates are determined. In most cases there already exists a target, sometimes coming from an international commitment, and the task will be to find some instrument or a mix of instruments to achieve the target. A tax rate can be

7The Polluter Pays Principle (PPP) requires that the costs of pollution be borne by those who cause it.
8Of course there have been excise taxes on fossil fuels, electricity and vehicles for a long time. What is new is the environmental motivation. The carbon tax is approximately 20 percent of the total excise tax on petrol, and there seems to be no good reason to believe that the incentive effect of an additional NOK 1 per litre will depend on the motivation and the name of the tax.

based on a policy decision. It does not require monetary valuation. On the other hand, monetary valuation does not imply an economic instrument.

I have been involved in numerous debates on instrument choice with colleagues in our Ministry of Finance. These debates have become less theoretical and more pragmatic over the past two decades. One reason for this is practical experience. Several proposals for green taxes have been suggested and then abandoned not for "ideological" reasons but for practical ones. Either a feasible tax base cannot be defined, or systemic costs have proven too large. To have the desired efficiency impacts, the tax should be per unit of emission, but emissions can be costly to measure. As a proxy the polluting input could be taxed, but then there will be no incentive to increase efficiency or for to install cleaning equipment. Often there will also be strong opposition from the affected parties. Green taxes are definitely more difficult in the real world than in textbooks.

In the same period the resistance and skepticism to green taxes has more or less vanished on the environmentalist side. It has become accepted wisdom that incentives can work and be very useful. Very few now describe green taxes first and foremost as wealthy people's means to purchase a license to pollute.

Distribution and fairness will be an issue in a "green tax reform", shifting taxes from incomes to pollution. The rationale for a tax shift is that income or payroll taxes are regarded as distortive, causing a deadweight loss for the economy, whereas green taxes correct for externalities remove distortions. Possibly a green tax reform can create a "double dividend", in terms of environmental improvements as well as increased GDP. The Norwegian Green Tax Commission from 1996 did not rule out the possibility of a "double dividend", but model analysis suggested that a carbon tax would also eventually show up as a "price wedge" in the labour market causing the same type of distortion as a tax on wages. (Norwegian Official Commission 1996:9)

I will not go into the large and highly controversial issue of possible welfare losses from taxation[9]. Green taxes should primarily be judged on their usefulness as environmental policy instruments. Green taxes, broadly defined, make up about 5 per cent of the tax revenue in Norway, close to the average in OECD[10]. They are significant, but far from dominant, and will probably never be. If green tax increases are used to reduce progressive income taxes the net impact could obviously be regressive.

Tradable permits – creating markets

An emissions trading scheme could give the same solution as a pollution tax in terms of total emissions and the distribution among polluters, whether emission permits are sold or handed out for free. But whereas the emission level is uncertain in a tax regime, there is an uncertainty about the permit price in the trading scheme. Such trading could in principle be constructed from direct regulation, by allowing firms to trade their individual emission permits. In principle, if emissions do approximately the same damage wherever they occur, this is not a problem. Problems arise, however, if the impacts of emissions and other activities depend on where they take place[11].

9In cost-benefit analyses carried out by or for public bodies in Norway, 20 per cent of the net need for government funding must be added to the overall cost of the project analyzed, to compensate for the alleged loss.
10For a comprehensive overview, see OECD database for instruments used for environmental policy: http://www2.oecd.org/ecoinst/queries/Default.aspx#.
11Traditionally, Norway has had a "recipient-oriented" pollution control, where regulation of the polluter depended on the state of the recipient – which is actually in line with conventional economics. However, we have now taken a lot of EU regulation, which is based not on states of the recipients but on a level playing field

It will not be fair to judge the tradable permits instrument solely on the experience of the EU trading scheme for carbon emissions (EU ETS). The recession has contributed to the very low price on the emission quotas. Some significantly more positive stories can be told. The North American trading scheme for sulphur emissions, introduced in 1990, has often been emphasized as a success. Cato (2011) describes the practical outcome of this scheme as impressive, although ”it is a difficult exercise to value (…) the reductions that might have been brought about through a system of regulation.” (Cato 2011). The idea to issue a cap – a maximum emission level – and then to allow polluters to trade could make it possible to keep a tight cap with reference to the trading option. But in most cases, except for greenhouse gases, the location of the emission will influence on the environmental impact. This is also a problem for the use of so-called “offsets” (“ecological compensation”) in nature protection. If a developer of a project in a certain ecosystem can get a permit by offsetting (protecting a different area) one must be sure that this area has at least the same environmental value (and that the offset is real). There can be a trade-off between effectiveness and cost reductions. There is a risk that schemes basically developed for pollution control will have unintended effects when transferred to the management of diverse nature areas.

Payment for ecosystem services

Providing an environmental good for the benefit of the society-at-large or for some group of people could be seen as a positive externality, raising the question of whether and how such an externality will be maintained without a policy intervention. If preserving the biodiversity of a forest requires the owner not to log, or to log in a costly way, one should expect that a regulation and/or an economic compensation be necessary. ”Payment for ecosystem services” has become the label of a group of economic instruments.

The concept of ”ecosystem services”, which was more or less unknown a decade ago, describes the direct and indirect contributions of ecosystems to human well-being. Most often four main categories are used[12]: basic life processes (also called supporting services or ecosystem functions), regulating services, provisioning services and experience and knowledge services (also called cultural services). The concept was central in Millennium Ecosystem Assessment (MA)[13] from 2003 and since 2007 in the TEEB project[14]. The focus of the MA was to document the decline in major ecosystem services on a global basis, whereas the focus in TEEB has been more on valuation of the services and integrating those values in economic decisions. Goméz-Baggethun et.al. (2010) has documented the origins of the concept in the 1980’s and the development from pedagogical use to a discussion of payment schemes and market creation.

The “ecosystem services” approach fits well in neo-classical cost-benefit thinking, and in a ”capital approach” to nature (where ecosystem services can be seen as capital yields, or flows from the capital stocks, depending on the state of the capital). An ecosystem service is closely linked to an “environmental good”, which used to be the key concept in environmental economics. Whereas the traditional approach and the new one describe different features, both these concepts focus on benefits from nature to humans. Several writers, such as Clive Spash (2008) and Martin Sharman (2011), are very critical. One major criticism is that the new “ecosystem services paradigm” focuses on the benefits to humans at the expense of the idea of our responsibility to nature independent on the benefits. My biggest worry is that

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for all competitors (BAT = Best Available Technology).
12Cf. Official Norwegian Report NOU 2013:10 Summary
13Millennium Ecosystem Assessment 2005 (http://www.maweb.org/en/index.aspx)
14TEEB (2010).

environmentalists can have false expectation about the eye- and door-opening effect of this approach.

Some words on behavioural economics

Behavioural and experimental economics is of potential interest to policy makers because these bodies of work deviate from the "context-free" conventional theory and offer ways to improve on policy instruments. Several results are worth noticing, such as the risk that a green tax could "crowd out" ethical motivation. Likewise it is interesting to see how households can be motivated to reduce their energy consumption through comparison with the neighborhood average a.s.o. The prospect of substantial gains from simple tricks is what lies behind the establishment of a behavioural insights team ("Nudge Unit") within the UK government[15]. Other countries have followed suit.

On a different level it is worth discussing if the results, by dismantling the idea of rational, self-serving agents, could actually threaten the basis of conventional microeconomics. Behavioural economists in general seem to present their work as nuances and complements and not a challenge to the neoclassical version (see Heukelom 2011). In a working paper written for OECD, Jason Shogren discusses the relevance of behavioural economics for environmental policy and he has two conclusions: "Re-establishing a new upper behavioural economic baseline (….) will require more evidence on robustness and more structural theory." (Shogren 2012.) By a new "baseline" he means a new reference behaviour to replace the rational "homo oeconomicus" from the perfect competition model. "In the meantime, behavioural economics does offer up some straightforward lessons on how to design more effective environmental policy for real people." (Shogren, op.cit.)

Some preliminary comments on externalities and internalization

Conventional economics puts a certain pressure on environmental policy makers to think about efficiency and not just effectiveness. (There is not necessarily a conflict between the two.) Green taxes and trading mechanisms have proved useful additions to the toolbox of policy instruments. The main problem with the conventional economic approach to environmental policy instruments is the tendency to take as point of departure the textbook world of perfect competition and not actually existing markets.

This problem is by no means special to environmental policy, but it affects economists' thinking in this field too. For one thing, there is the concept of "the right price", the idea that one can isolate an environmental externality and correct for it. But in a second-best world there will be no optimal solution. When all prices in the economy must be expected to deviate from an imagined perfect competition solution, and to varying degrees, we do not even know that equalizing marginal reduction costs across sectors will improve the overall welfare in any formal sense. Economists should take a much more humble attitude to the efficiency criterion.

I can take voluntary agreements as an example. In general economists are skeptical about this policy instrument. There is of course the risk of regulatory capture, and it is not easy to evaluate the impacts of agreements as it is difficult to establish a counterfactual baseline, but then this will always be a problem in policy evaluation. Focused on formal efficiency economists will often neglect the potential for sharing knowledge and building consensus through dialogue – which could lead to real efficiency gains as well as loyal implementation.

A second example is the attitude towards instrument mixes, and in particular adding regulatory instruments when economic ones are already in place. In Norway, we are closely

15See http://www.theguardian.com/society/2013/feb/05/david-halpern-government-nudge-unit: "The head of the government's 'nudge unit' plans to save the state billions by getting us to change our behaviour."

linked to a Nordic energy market and to the EU ETS. Does it make sense to make efforts to reduce emissions within the EU ETS cap, beyond what is already triggered by the present and expected quota prices? Traditional economic analysis says no. Such measures could even have a negative impact by putting additional downward pressure on the prices of quotas. But the future EU emissions cap will be subject to huge debates and conflicts, and in this "dynamic" perspective the additional effort can influence the future cap and thus make good sense after all. By assuming a fixed cap the analyst chooses to be exactly irrelevant.

A preliminary comment also on payments for ecosystem services. To me such schemes are not controversial *per se*. A rough payment scheme has been part of Norwegian agricultural policy for some years (and before "payments for ecosystem services" were known). Vatn et. al (2011) has estimated that globally, more or less all such payments are government funded, which is not a huge surprise given the public good feature of the ecosystem services in question. There is a long way from describing and even valuing an ecosystem service to implementing a payment scheme, most policies to protect the ecosystem services will be regulatory. And there is a long way from a payment scheme to the establishment of a market. The "offset" approach lies closer to a market and could develop into markets. On the other hand, an offset scheme could come close to a "Polluter Pays Principle", whereas payment schemes could become bottomless sinks for government money.

The environment in cost-benefit analysis

Cost-benefit analysis is a method in applied welfare economics. It is an approach to weighing conflicting concerns and finding the optimal level of ambitions in environmental policies, and in general the optimal inclusion of environmental concerns in other projects or policies. All expected costs and benefits of a proposed investment or policy reform should be taken into consideration, in principle according to their monetary values. When market prices are missing, shadow prices should be estimated. Future values are discounted according to some chosen interest rate, and the net present value of the whole project is the key decision or ranking criterion. The distribution of costs and benefits among people does not affect the present value[16], which means that distributional effects must be reported explicitly.

A cost-benefit analysis could involve the environment in two different ways. The analysis could focus on an environmental issue, putting a shadow price per unit on the potential environmental improvement, and thus be used to determine *the optimal level of regulation*. It could also focus on a particular development project, such as a potential road investment, with consequences for the environment. In this last case the question will be if these consequences can be expressed through shadow pricing or not. Either way, the worry is that environmental impacts will not be given an appropriate weight in the analysis. When environmentalists and non-economists are skeptical towards environmental cost-benefit analysis, they will often question the principle of monetary valuation, and the discounting, which seems to make the distant future worthless[17]. I will focus on these two issues, and on the question of optimality vs. precaution.

Let me comment on the role of cost-benefit analysis in decision-making in Norway. The formal basis of such analyses is the requirement to present a systematic assessment of the

16A Kaldor-Hicks criterion is normally applied, according to which it is sufficient that winners can potentially compensate losers (even when such compensation will not actually take place). There is a lot to be said about the ethical basis of CBA, cf. i.a. Nyborg (2012), but on this limited space I will prioritize other issues.
17For a very critical assessment, see Heinzerling and Ackerman (2003). For an updated version of the mainstream, see Pearce, Atkinson and Mourato (2006).

potential impacts from a policy decision. Even though the Ministry of Finance promotes the use of cost-benefit analysis, this is not the only type of impact assessment available, and it will be part of the background material for a decision and not the sole basis. Studies have indicated that politicians put limited weight on present value figures. We do not in general perform cost-benefit analysis to decide on the level of regulation, even though an assessment of costs will always take place. The harsh criticism from Heinzerling and Ackerman (2003) is clearly triggered by the proposals to apply a strict cost-benefit analysis to all environmental regulation in the US.

Cost-benefit analysis I: The question of valuation

Environmental economists have contributed to the overall body of mainstream theory, primarily "in the area of nonmarket evaluation, i.e., methods for measuring demand curves for goods when there is no market." (Kolstad 2000.) This contribution also includes the development of some "value categories" of particular relevance to the environment. Krutilla (1967) argued that pristine environment has an intrinsic value, and a non-use value including an option value (of possible uses in the future). Arrow and Fisher (1974) analyzed a potential development of a nature area under uncertainty, stating that there is a "quasi-option value" in postponing the investment and wait for new information. Fisher and Krutilla (1975) analyzed the impact on optimal resource management if the value of pristine nature is assumed to increase in the future relative to the price level of other goods. The basis for this assumption is the fact that ordinary goods and services can be produced, whereas nature cannot, and will thus become increasingly scarce with growing population and economic activity.

Dressing these insights up in a basically neoclassical framework, introducing new concepts and assumptions, has led to different results from a traditional analysis. The various elements of nature value are brought together in the term "total economic value", which includes both use and non-use values including option value. The term may make us think of a figure for the whole value of nature or a part of nature[18]. But in a neoclassical analysis the established method is to analyze marginal changes in the value components – even though a marginal change may actually be the loss of a complete habitat or ecosystem.

In the absence of market prices, economics offers a range of methods to calculate shadow prices. In principle these should reflect the aggregate willingness-to-pay of the affected population. Estimates can be made based on interviewing a sample of the population, to find their valuation of, *i.a.*, a certain species, a site or improved air quality. Estimates can also be derived from property prices, based on the assumption that these prices reflect environmental qualities such as noise and pollution. They can be deduced from travel costs, based on the assumption that people's valuation of a natural site is reflected in the cost they take on to visit the site. The production function method captures the contribution from a certain environmental good or service to the market value of production. Replacement costs can be estimated, as well as defensive costs. Because willingness-to-pay estimates are expensive to establish, the feasibility of benefit transfers is a hot topic. Finally shadow prices can be calculated based on policy targets, the political decision then taken as an estimate of aggregate willingness-to-pay.

This list is very brief. Any book on environmental economics, or on environmental cost-benefit analysis, will offer a description of different methods[19]. They all have their strengths

18Costanza et.al.'s attempt to value the world's ecosystem services at USD 33 trillion a year (about twice the size of global GDP, and mostly outside the market) has been heavily criticized by economists and environmentalists alike. (Costanza et.al. 1997.)
19See, *i.a.*, Bergstrom and Randall (2010).

and weaknesses, both from a principle and practical point of view, and even from a mainstream theoretical perspective. Going into all problems will require a new paper. Let me just comment on "stated preferences", *i.e.* the method of asking people about their willingness to pay for a certain environmental good or service. A principle criticism is that people are often asked to attach a price tag to values that cannot be measured in money, such as a species' right to exist. A more prosaic argument is that people cannot be expected to put a monetary value on things they are not used to purchase. We "learn" the value of milk or laptops in the shops, it is not in our genes. Therefore this approach can give very different estimates depending on context[20], and people in general tend to attach much the same value to one square km of wetlands as ten square kms. They also claim a much larger compensation to accept the loss of an environmental good than they are willing to pay to protect an identical good.

These are some of the problems with one often used method. I have little confidence in estimates based on stated or revealed individual preferences, because the valuation concerns common or public goods which will never be sold in markets. Probably such studies can be regarded as a type of polls, which can be of some interest as part of the background to policy debates. There is, among else, a problem of scope. It is meaningless to calculate individual willingness to pay for such things as biodiversity, ecosystem resilience and reduced global warming. If the good in question is a particular site or a species, there will be a problem with the relationship between the part and the whole. The sum of marginal decisions based on valuation of single sites could be the total loss of a certain ecosystem. All these arguments point in the direction of collective processes, preferably on overall plans and not limited to single sites or species. In Norway we have developed some comprehensive management plans*, i.a.* for ocean areas and for rivers and waterways. A related point is that valuation, and cost-benefit analysis, will not capture the future impacts of infrastructure choices, be it for transport or for energy provision. Comprehensive plans are needed.

I feel more comfortable with estimates based on replacement costs or defensive costs. If the loss of a wetland area makes it necessary to establish a water purification plant, or some flood-protective measure, these are concrete examples of economic values. It also makes sense to have an estimate of the contribution from wild insect pollination to agricultural production. Such estimates can be used as stand-alone arguments or illustrations, without full cost-benefit analysis, and they do not imply that wetlands or bumblebees have been reduced to ecosystem service producers. Decision makers as well as the general public need to be told that nature is not only a nice system out there, but a basis for our survival and wellbeing. Some robust figures can be illuminating[21]. That is a far cry from asking for price tags on everything.

A recent expert committee found that rather few valuation studies have been done in Norway (NOU 2013:10). But globally, numerous valuation studies are being carried out, every year and month. My impression is that most of them are made for a strictly academic purpose, most of them are not part of a cost-benefit analysis, and very few are actually linked to a decision process. There is a risk that the sheer number of studies will gradually convince policymakers and decision-makers of their validity. Likewise it is tempting for a policymaker to trust a monetary value estimate if the figure can support a proposed policy action. Pragmatism can easily develop into opportunism. But there is quite some skepticism in many quarters, including among mainstream economists.

20Dan Ariely has done a lot of work in this field. Cf., *i.a*., Ariely, Loewenstein and Prelec (2006).
21For numerous examples, see Juniper (2013).

Cost-benefit analysis II: The question of discounting the future

Cost-benefit analysis can be regarded as private investment analysis extended to the societal level. But a private investment will most often have a limited scope, both in size and time. So will a lot of policy proposals, too, but then there are the most crucial decisions, those with huge impacts, some into the distant future. How should these impacts be made comparable with impacts today? The mechanism for this is discounting, but there are different views on the choice of discount rate. A recent Norwegian expert committee said that discounting is a "systematic and transparent way" of making impacts at different times comparable. They also reported a huge span of recommended rates in different countries (NOU 2012:16). The Stern review's recommendations of a gear shift in global climate policy is to a large extent based on a discount rate lower than normally used (Stern 2006.) This has triggered criticism, *i.a.* from William Nordhaus who has built some of the most famous climate impact assessment models. Stern uses a real discount rate of 1,4 percent p.a. whereas Nordhaus uses 5,5 percent (Nordhaus 2007), the higher rate causing the so-called "climate policy ramp" with modest emission reductions in the near future. Our expert committee recommends a discount rate of 4 percent for the first 40 years, 3 percent for the next 35 years and 2 percent for the subsequent years (NOU 2012:16)[22].

Discounting rests on some basic assumptions. One is pure impatience. Individuals can be very myopic, but economists disagree on whether individual impatience should influence decisions partly affecting future generations. (Stern is basically dismissive.) One other assumption is growth in productivity and per capita income, and added to that an assumption that the marginal benefit of consumption decreases when the income level rises.[23] To invest a certain amount today the society will demand a return in the future, reflected in a social discount rate. The rate is used to discount every future cost and benefit to find its present value. If the net present value of the project (or a policy change) is positive it is deemed socially profitable.

Some argue that the effects of discounting will, at least to some extent, be neutralized by an increase in the relative value of environmental goods (or ecosystem services)[24]. There are two mechanisms by which this can happen. For one thing, through increased scarcity. There is some intuitive sense in this, as population, production and consumption are rising – cf. the reasoning behind the discount rate – and ecosystems and natural cycles cannot be constructed (and often not reconstructed, once destroyed). Secondly, through an increase in the willingness to pay, because the environment consists of "luxury goods". This could make sense for such things as scenic views and exotic species, but not for regulating and life-supporting functions and services. Nevertheless, this thinking lies behind the concept of an "Environmental Kuznetz Curve", describing environmental degradation as an increasing function of income when incomes are low, and then decreasing above a certain income level[25].

The normal procedure in a cost-benefit analysis is to assume constant prices throughout the analysis period. A change in relative prices can obviously affect the present value of a project. The aforementioned expert committee proposed a "real price adjustment" of the shadow price

22This social discount rate has recently been adopted in the rules for cost-benefit analyses in Norway.
23Compared to Nordhaus, Stern assumed lower future growth, and also no decrease in the (non-observable) "marginal utility of consumption" with increasing income.
24For an illustration, see Sterner and Persson (2007). The authors argue, as a comment to the Stern Review, that "taking relative prices into account can have as large an effect on the economically warranted levels of abatement as can a low discount rate."
25The idea of such a mechanism has inspired the optimistic idea that environmental problems will automatically be reduced with affluence. For a critical assessment, see Carson (2010).

on time savings[26] and that has, by one stroke, hugely increased the present value of transport projects in densely populated areas. But for most environmental impacts there is no price to begin with. Without shadow prices there is nothing to discount. We cannot discount the loss of a wetland area 50 years from now, or a certain level of cadmium in the soil. Aware of that, the expert committee stated: "Factors that influence the future scarcity and importance of affected environmental goods should be presented and discussed in the economic analyses, irrespective of whether calculation prices are available and used." (NOU 2012:16)

This is all well, but we are left with a dilemma. If shadow prices are missing, how do we then give appropriate weight to non-priced impacts in a basically monetary analysis. If environmental goods are represented through their monetary values only this requires substitutability, they to be interchangeable with each other and with any other resource. If such substitutability is rejected, the only shadow price thinkable for an environmental good will be one which is calculated on the basis of a sustainable level of the good for the future – a price derived from a physical target as opposed to a physical level determined by a price.

Much as I find the discount rate debate intriguing, I reject the idea that an optimal level of climate mitigation can be calculated. Global warming is a challenge far beyond the scope of a cost-benefit analysis and the search for an optimal policy path. The deep uncertainty and the possibly disastrous future scenarios call for a very different approach, based on precaution.

Cost-benefit analysis III: The question of optimum vs. precaution

The precautionary principle, though not necessarily an operational decision rule, plays a large role in debates on environmental policy[27]. A precautionary approach is meant to shift the burden of proof away from the environment. In mainstream (neoclassical) cost-benefit analysis the basis for precaution is "*quasi-option value*", the value of postponing a development project with irreversible impacts, and wait for new information. In one sense, because the future is fundamentally not known, and because there is some degree of irreversibility in all action, there will always be quasi-option values linked to decisions. The degree of irreversibility and possible gravity of the different impacts will be of great importance. (As the "quasi-option value" cannot be estimated, what one can say is that in such cases a positive net present value will not be sufficient to deem a potential project profitable.) In a case of persistent pollutants, or irreversible climate change, the environmental side will use the precautionary principle to trigger swift action, but could also be met by arguments based on similar thinking against a premature scrapping of existing production equipment.

Jonathan Aldred has argued that the neoclassical fundament for the precautionary principle is flawed, as the (quasi-)option value argument "is shown to misrepresent both uncertainty and irreversibility". (Aldred 2013.) One argument is that the (quasi-)option argument implies that new information will turn up and a Bayesian[28] correction of beliefs will take place, whereas the precautionary principle does not presuppose new information. A different argument is that the (quasi-)option value argument does not distinguish between environmental and other impacts, whereas the precautionary principle is directed at the environment only.

26The shadow price of time use or savings is derived from wages. "Real price adjustment" means that this shadow price will increase with the expected growth in GDP per capita, and thus grow in comparison to the general price level. The proposal has been made part of the official rules for cost-benefit analyses.

27In the Rio Declaration on Environment and Development from 1992, it is said in Principle 15: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

28This means that agents learn from experience in a way that gradually will make their expectations about future outcomes correct. It is one of those many assumptions in economics made not for its realism but for the convenient solutions.

I agree with Aldred that the "neoclassical" argument for precaution is limited and limiting. It is true that the conclusion to "keep options open" can also imply that existing carbon-intensive capital equipment should not be scrapped. (This line of reasoning contributes to the so-called "climate policy ramp" mentioned earlier.) But the profound difference between nature and produced capital is that nature is basically irreplacable. Martin Weitzman has been in a debate with Nordhaus (among others) on the calculation of optimal levels of global climate policy. Weitzman (2009) has argued that strong uncertainty about future outcomes, including unknown but non-negligible probabilities of disastrous developments, makes such optimization impossible in the climate change field. Instead he calls for precaution, or a "safe minimum standard". One major point in Weitzman's argument is that economists' belief in normal distributions of probabilities is flawed. In many cases the probability distribution of outcomes has "fat tails", which means that basing decisions on expected values within a normal probability function will grossly underestimate the danger.

There is a, by the way, a quite interesting parallel here, in the discussion on how to regulate financial markets. In several papers and speeches, Bank of England's Andrew Haldane has argued that the financial sector produces systemic risk as an externality, and also that the appropriate regulatory approach is to have simple, structural rules aiming at robustness instead of fine-tuned rules meant to secure optimality (Haldane 2010). Like Weitzman he criticizes the reliance on risk and normally distributed probabilities in a system full of chaotic processes and strong uncertainty.

Some preliminary comments on cost-benefit analysis

From an environmental point of view there are some profound problems both with monetary valuation and discounting, and with the combination of the two. Integrating basically non-monetary values in analyses which are based on pricing is a considerable challenge. If we do not assume environmental resources to be substitutable we cannot expect pricing based on willingness to pay to ensure sustainability. Shadow prices must then in principle be derived from safe minimum future levels of each critical resource, taking the discount rate into consideration.

The probably most debated shadow price is the "social cost of carbon", the carbon price to be used in cost-benefit analysis. The basic approach could be to have a global growth model , including emissions, then include damage costs and a cost curve for emission reductions, and calculate an optimal carbon price path. Everyone can see that there are huge uncertainties on all sides here, including the possibility of runaway processes such as the melting of the Greenland ice sheet. A different approach, closer to the one described in the paragraph above, would be to derive a carbon price path from the 2°C target[29]. But there is a long way from such an exercise to defining the appropriate carbon price path for national analyses. The Norwegian expert committee discussed this at length, arriving at several possible conclusions, depending*, i.a.,* on whether Norway has established a national reduction target. If not, a hybrid path was proposed, starting on EU permit prices and ending up in a "2°C"-path (NOU 2012:16). The choice of a price path is ultimately a political decision. Basing analyses and proposals on short time market expectations will favour investments which lock in high-carbon patterns (possibly confirming the low price expectations).

Discounting the future as such is even more difficult. Of course the assessment of costs or benefits will in part depend on when they occur. But comparability through discounting is a

29Scientists say that some ugly scenarios could be avoided if this target were met (approx. 450 ppm of carbon equivalents in the atmosphere), but it may be optimistic to call it a "safe minimum standard."

technical solution to a complex problem, "transparent" only to the insiders. The whole point of the operation is to reduce countless impacts over a long period to one measure – the net present value. This can make sense for a private investment focusing on monetary value, or for marginal public projects or policies. But if the issue in question is a major policy change, or if significant impacts are non-monetary, the situation is very different. Then there is no way around the tough exercise of simulating, describing and assessing, future states. The "present value" perspective must give way to a perspective of "future values": Where do we want to go? Decisions on infrastructure pose a particular challenge. Such decisions lock in certain technologies and transport modes for a very long time, and will in general go beyond the scope of cost-benefit analysis.

The very fact that future outcomes count so little in cost-benefit analysis should be a warning of the limitations. Decisions with irreversible consequences must be made, often under deep uncertainty, but within the method we see that uncertainty (as opposed to calculable risk) and irreversibility make the present value criterion worthless. One additional and profound problem, rarely discussed, is the question of preferences. Let me pick up on my comment in the valuation subsection that our willingness to pay has been learnt. In a dynamic society, we should also regard preferences as constantly created and recreated. How needs can be met is something we learn, from our surroundings and from the options presented to us, which means that the initiative will systematically be on the supply side. But this means that shaping the future also includes shaping future preferences. The measuring rod will change.

Summing up – concluding remarks on benefits and costs

Let me take a step back and reiterate my position. I am an economist working as an environmental policy maker, and I am obviously speaking for myself and no one else. I have been critical about neoclassical economics from the start, and it has been my job both to know it and to use it and to point out the flaws and shortcomings when used to shape environmental policy. Mainstream economists will argue that a lot has happened in economics since I graduated more than three decades ago. The answer to that is yes and no: A lot of refinement has been done, some of it promising, some of it pretty hopeless and quite a lot of it without any significance at all, positive or negative. What is important for me and my colleagues is the version we meet in our work, and that has not changed very much in a generation.

There is a pure neoclassical story about the economy and the environment, in which the government creates or mimics markets, and policy decisions simply "fill in the gap" where markets cannot be made to work. Some of my discussion has been on differen-ces within mainstream, between those who stick to this full story and those who modify the assumptions to try and grasp real world problems. Stern, Sterner and Weitzman are examples in the climate policy field. They all escape the "climate policy ramp" by changing a crucial assumption, still staying firmly inside the mainstream. These are useful reminders of how apparently clear conclusions depend on the assumptions.

There is a lot of pragmatism and ambiguity in this thinking. Getting policy results requires pragmatism. One needs to be eclectic, to cherry-pick the useful stuff, to include mainstream concepts and approaches as elements in a story which is basically non-neoclassical because sustainability is about something completely different. The challenge is to not get captured in an all-compassing neoclassical version of the world. It is possible to regard the natural capital concept as positive because it draws our attention to maintaining the productive basis of our welfare, at the same time discarding the idea of substitutability and marginal conditions. We

can use the concept of externalities and internalization, and appreciate the power of price incentives, without buying into the idea of "the right price".

In a speech from 2006, revisiting the famous and then fifty years old "Second-best Theorem", Richard Lipsey reiterated the basis and consequences of the theorem, which roughly says that if there is already one market failure ("distortion") in the economy, correcting a different one will not necessarily bring the system to a better state (Lipsey 2006). It is obviously his view that deviations from perfect competition assumptions are widespread – in the speech he quotes a list of 17 types – and he says that the one distortion in the theorem represents "…the vast number of 'distortions' that could not be removed,…" (Lipsey, *op. cit*.). He finds no way to establish some kind of "second-best optimum" (which will of course be the instinctive response from a neoclassical perspective). Instead he says: "In what follows, I will argue that a lot of our policy advice will have to be based on appreciative rather than formal theorizing." (Lipsey *op. cit*..)

I spend some time on this because it seems to me that important insights have been lost. Lipsey (2006) points out that this view of the economy was common sense in welfare theory books in the 1950's, but has since been forgotten. In my own economics curriculum there was a book by J. de van Graaff, with a panegyric foreword by Paul Samuelson, where the welfare theory was both presented and more or less executed: "And it seems to me, therefore, that the possibility of building a useful and interesting theory of welfare economics – i.e. one which consists of something more than the barren formalisms typified by the marginal equivalences of conventional theory – is exceedingly small." (van Graaff, 1957). He then goes on to recommend studies of how the economic system actually works in practice.

The sad thing about the neoclassical approachis that it keeps students from studying that intriguing, evolving system called the economy, and instead to fickle with a set of theoretical assumptions and deviations from them. Economists are taught a model which is not an abstraction, in the way a map is an abstraction from the terrain, but an idealization based on convenient assumptions. But the real economy, where environmental policy must be shaped, is complex and sometimes messy. Technology changes, sometimes in big leaps. People interact in so many ways. Our welfare doesn't depend on our own real incomes alone, but also on other people's incomes and actions. Our preferences are constantly shaped and reshaped – endogenous preferences and endogenous technology are two prominent "distortions" in Lipsey's list (Lipsey 2006). In this second-best world conclusions are not straightforward. Maybe mainstream economists are victims of their own (self-constructed) reputation – that of always being able to come up with a precise answer. That answer can easily be precisely irrelevant.

The point is to avoid the neoclassical/mainstream "straightjacket", to allow the approach to be determined by the problem and not vice versa. For instance, mainstream theory will tell you that if you want to reduce a particular emission you should tax or regulate the emission as such, and not an input or the technology. The reason is sensible. By going for the emission we leave the options open: To reduce the activity level, to change technology, to replace the input and so on. But when it comes to climate change or biodiversity loss, we are actually fighting a battle. Then it will not be enough to tinker on the margins. We must make some strategic decisions. There will still be ample space for economists' advice, for prices and markets, only the overall direction will already have been set.

In his paper "Excessive Ambitions", Jon Elster examines the economics discipline, and he concludes by citing Keynes: "If economists could manage to get themselves thought of as humble, competent people on a level with dentists, that would be splendid." And then Elster adds: "The competence of economists may not be in question, but their humility is. *Or perhaps humility properly conceived is part of competence*." (Elster 2010.)

A final word on heterodox economics

What then about heterodox economics? It is next to non-existing in my everyday work. I know there is ecological economics, which in its non-neoclassical version expresses many of the views and criticisms of the mainstream that can be heard from non-economist colleagues: The unrealistic representation of nature in the models, the belief in substitutability, the obsession with marginal conditions. The same can probably be said about institutional economics. In Norway Arild Vatn is a prominent institutionalist economist who has done a lot of work on the environment and environmental policy, offering analysis where context matters (cf. Vatn 2005). One criticism of the mainstream approach is that it "tends to look at the economy and the environment as two disparate spheres" (Vatn 2005), whereas ecological economics perceives the economy as an open subsystem of the biosphere. This may be correct, though I think there is now a general trend towards a more holistic or "humble" view of the human/nature relationship. In the end I guess what matters is how you model and analyze the concrete interchanges between human activities and the ecosystems.

Obviously there are some linkages between my criticism of mainstream/the orthodoxy and the positions of several heterodox schools. The emphasis on strong uncertainty and ignorance. The emphasis on evolutionary processes as opposed to statics. The critical attitude towards "efficiency" as a neutral concept whereas distribution is politically laden. But such linkages will not by far be enough to make a heterodox school relevant to me as a policymaker. That is a pretty serious problem, because what I am talking about is the very future of the biosphere on which humanity's future depends. How can a heterodox school flourish in the 21th century without addressing the challenge of sustainability? So either you should all take on environmental questions or some new approach should emerge. I have seen attempts to connect post-Keynesianism and ecological economics (Kronenberg 2010), I have read Molly Scott Cato's bottom-up approach in "Green economics" (Cato 2011), and I am eager to see more.

References:

Aldred, Jonathan, 2012. Climate change uncertainty, irreversibility and the precautionary principle. *Cambridge Journal of Economics* 36 (5), 1051-1072.

Ariely, Dan, George Loewenstein, and Drazen Prelec, 2006. Tom Sawyer and the construction of value. Jourlan of Behavior & Organization. Vol. 60 (2006) 1-10.

Arrow, Kenneth and Anthony Fisher 1974. Environmental preservation, uncertainty and irreversibility. *Quarterly Journal of Economics* 88, 313-319.

Bergstrom, John C. and Alan Randall 2010. *Resource Economics*. Edward Elgar: Cheltenham, UK, Northampton, MA, USA.

Carson, Richard T. 2010. The Environmental Kuznets Curve: Seeking Empirical Regularity and Theoretical Structure. *Review of Environmental Economics and Policy*, volume 4, winter 2010, pp. 3-23.

Cato, Molly Scott 2011. *Environment and Economy.* Routledge: London and New York.

Convery, Frank 2013. Reflections – Shaping Water Policy: What Does Economics Have to Offer? *Review of Environmental Economics and Policy*, Volume 7, issue 1, winter 2013, pp. 156-174.

Costanza, Robert et. al. 1997. The Value of the World's Ecosystem Services and Natural Capital. *Nature* 387: 253-260.

Elster, Jon 2009. Excessive Ambitions. *Capitalism and Society*, Volume 4, Issue 2, Article 1.

Fisher, Anthony and John Krutilla 1975. Resource Conservation, Environmental Preservation and the Rate of Discount. *Quarterly Journal of Economics*, 358-370.

Gómez-Baggethun, Erik et.al. 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. *Ecological Economics*, 69 (2010), 1209-1218.

Graaff, J. de V. 1957 (reprint 1975). *Theoretical Welfare Economics*. Cambridge University press, London.

Haldane, Andrew G. 2010. *The $100 billion question*. Comments made at the Institute of Regulation & Risk, Hong Kong, 30 March 2010.

Heinzerling, Lisa and Frank Ackermann 2002. *Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection.* Georgetown Environmental Law and Policy Institute, Georgetown University Law Center, Washinton D.C. 2002.

Heukelom, Floris 2011. Building and Defining Behavioral Economics. *Research in the History of Economic Thought and Methodology*, Volume 29-A, 1-29. Emerald Group Publishing Limited.

Jacobs, Michael 1997. Sustainability and Markets: On the Neoclassical Model of Environmental Economics. *New Political Economy*, Vol. 2, No. 3.

Juniper, Tony 2013. What Has Nature Ever Done For Us? How Money Really Does Grow On Trees. Profile Books.

Kolstad, Charles D. 2000. *Environmental Economics*. Oxford University press, NY.

Kronenberg, Tobias, 2010. Finding common ground between ecological economics and post-Keynesian economics. Ecological Economics 69 (2010) 1488-1494.

Krutilla, John 1967. Conservation reconsidered. *American Economic Review* 57, 777-786.

Lipsey, Richard G. 2006. *Reflections on the general theory of second best at its golden jubilee*. A key note presented to the 62nd Congress of the International Institute of Public Finance.

Medema, Steven 2013. "*Finding his own way: Ronald Coase*."

Millennium Ecosystem Assessment 2005 (http://www.maweb.org/en/index.aspx)

Nordhaus, William, 2007. *The Challenge of Global Warming: Economic Models and Environmental Policy*. Yale University 2007.

Norwegian Official Commission 1996:9 *Green Taxes – Policies for a Better Environment and High Employment*. An English Summary of The Norwegian Green Tax Commission. Oslo, Norway 1996.
Nyborg, Karine 2012. *The Ethics and Politics of Environmental Cost-Benefit Analysis*. Routledge 2012.
Official Norwegian Reports NOU 2012:16 *Cost-Benefit Analysis*. Oslo, Norway 2012.
Official Norwegian Report NOU 2013:10 *Natural benefits – on the values of ecosystem services. Summary.* Oslo, Norway 2013.
Pearce, David, Anil Markandaya and Edward Barbier 1989. *Blueprint for a Green Economy.* Earthscan Publications Ltd., London
Pearce, David, G. Atkinson and S. Mourato (2006). *Cost-Benefit Analysis and the Environment. Recent Developments*. OECD 2006.
Shogren, Jason 2012. *Behavioral Economics and Environmental Policy Design.* OECD Environment Working Papers 49. OECD Publishing 2012.
Spash, Clive 2008 . How Much is that Ecosystem in the Window? The One with the Bio-diverse Trail. *Environmental Values* 17 (2008): 259-284.
Stern, Nicholas 2007. *Stern Review on the Economics of Climate Change*. HM Treasury, London.
Sterner, Thomas and Martin Persson 2007. *An Even Sterner Review. Introducing Relative Prices into the Discounting Debate*. Discussion Paper, Resources for the Future, July 2007.
TEEB 2010. *The Economics of Ecosystems and Biodiversity. Ecological and Economic Foundations*. Earthscan, London 2010.
Turner, Kerry 2005. *The Blueprint Legacy – a review of Professor David Pearce's contribution to environmental economics and policy*. CSERGE Working Paper PA 05-01.
van der Bergh, J.C.J.M, 2010. Externality or sustainability economics? *Ecological Economics* 69, 2047-2052.
Vatn, Arild 2005. *Institutions and the Environment*. Edgar Elgar Publishing, Cheltenham, UK, Northampton MA, USA.
Vatn, Arild et. al. 2011. *Can markets protect biodiversity? An evaluation of financial mechanisms*. Norad Report 19/2011.
Weitzman, Martin L. 1974. Prices vs. Quantities, *Review of Economic Studies*, 41: 477-91.
Weitzman, Martin L., 2009. On Modeling and Interpreting the Economics of Catastrophic Climate Change. *The Review of Economics and Statistics*, 91 (1), 1-19.