Journal of Integrative Environmental Sciences
Vol. 7, No. 1, March 2010, 23–52

Taylor & Francis
Taylor & Francis Group

An assessment of Lomborg's *The Skeptical Environmentalist* and the ensuing debate

Jeroen C.J.M. van den Bergh[a,b,c]*†

[a]*Department of Economics and Economic History and Institute for Environmental Science and Technology, Universitat Autònoma de Barcelona, Edifici Cn – Campus UAB, 08193 Bellaterra, Spain;* [b]*ICREA, Barcelona, Spain;* [c]*Faculty of Economics and Business Administration and Institute for Environmental Studies, VU University Amsterdam, The Netherlands*

(*Received 22 October 2008; final version received 7 December 2009*)

This article assesses the quality of the contents and the validity of the conclusions of the book "The Skeptical Environmentalist" by Bjørn Lomborg. First, the many reviews – both critiques and appraisals – are summarized and evaluated. Next, Lomborg's responses to criticisms are examined. Finally, the consistency of the book with certain insights from the field of environmental economics is investigated. This complements for an under-representation of environmental economists among the reviewers, even though the book addresses themes central to this field.

Keywords: criticism; environmental economics; environmental policy; environmental science; Lomborg

1. Introduction

Once in a while a book is published that attracts a great deal of attention. *The Skeptical Environmentalist: Measuring the Real State of the World*, written by Bjørn Lomborg, is such a book. In the opening of his book, Lomborg states that the general view people have of the environment is not correct. He calls this view "the Litany of our ever deteriorating environment" (Lomborg 2001a, p. 3). He regards it as being created by environmental organizations and the media, both of which he suggests have an interest in promoting bad news. He thinks that this will stimulate people to act out of fear, leading to a misallocation of resources.

Lomborg uses most of his book to measure "the real state of the world" and to show that the Litany is false. Data are presented on a wide range of environmental and developmental topics, including human welfare (health, food, and prosperity), natural resources (agriculture, forests, energy, non-energy resources, and water), pollution (air, acid rain, water, and waste), and "tomorrow's problems" (chemicals, biodiversity, and global warming). In his opinion, these data do not only show what the current state of human welfare is, but they also indicate whether observed trends are unsustainable, whether human welfare will be undermined by pollution of the environment, and whether welfare might be endangered by future threats. After

*Email: jeroen.bergh@uab.es
†Fellow of NAKE and Tinbergen Institute.

ISSN 1943-815X print/ISSN 1943-8168 online

DOI: 10.1080/19438150903533730
http://www.informaworld.com

having presented and analyzed all the data, he concludes that "mankind's lot has vastly improved in every significant measurable field" (Lomborg 2001a, p. 351), while noting that this does not mean things are good enough.

The Skeptical Environmentalist is more than a collection of data about the state of the world. It also presents policy recommendations. It proposes that we prioritize our resources by comparing problems, judging risks, and trading-off costs and benefits. This is regarded essential to achieve the best possible distribution of resources in society. The most important problems should be addressed first, before public resources are spent on problems that involve "lower costs". In Lomborg's opinion, this means that, in practical terms, we should spend our money on access to safe drinking water rather than on a stringent climate policy. In addition, he advises countries to stimulate economic growth, because he believes that this is the only way to solve environmental problems.

It is no surprise that *The Skeptical Environmentalist* generated much debate. Reactions to the book vary from being extremely negative to being extremely positive. This huge contrast makes it difficult for a superficial observer to judge the merits of the book. Without any detailed knowledge of the book and the responses to it, one might be tempted to think that the truth lies somewhere in between these opposite reactions or that the debate was all about politics (Pielke 2004).

This study attempts to reach a conclusion about the quality of the book's content and the validity of its conclusions by adopting an approach that comprises three lines of examination. First, the main arguments that have been put forward in the reviews of the book will be summarized. Next, Lomborg's responses to various reviews of his book will be analyzed. Finally, Lomborg's treatment of themes that are also addressed in environmental economics is briefly investigated against the background of the relevant literature in the latter area. The reason for this is that even though Lomborg deals with many issues that are at the core of modern environmental economics, environmental economists have formed a small minority among the reviewers of Lomborg's book. The three lines of examination together can be regarded as a sufficiently robust basis for evaluating the analysis, conclusions, and advice offered in *The Skeptical Environmentalist*.

The organization of the remainder of this article is as follows. Section 2 discusses the responses that *The Skeptical Environmentalist* has generated, including those following the publication of an earlier Danish version of this book. Section 3 presents an overview of the criticisms and positive judgements mentioned in the various reviews of Lomborg's book. Section 4 analyses Lomborg's response to a number of criticisms of the book. Section 5 briefly examines the consistency of Lomborg's treatment of two particular themes with the relevant literature in environmental economics. Section 6 concludes.

2. A brief history

According to Lomborg (2001a, preface), the idea for *The Skeptical Environmentalist* was born in February 1997 in a bookstore in Los Angeles when he was reading in *Wired Magazine* an interview with the American economist Julian Simon. Simon claimed that by analyzing official, publicly accessible statistics he had found that the standard doomsday conceptions of the state of the world were incorrect. This provoked Lomborg to undertake a similar assessment. He had always believed in an ever-deteriorating environment and, being a statistics teacher, thought it would be

easy for him to check Simon's sources. In the fall of 1997, he formed a study group with a few of his students. Contrary to what he expected, Lomborg claims, much of what Simon had concluded turned out to be correct. Lomborg wanted to share these insights with other people, and he contacted the editor-in-chief of the Danish newspaper *Politiken*, resulting in the publication of four articles at the beginning of 1998. These gave rise to fierce debate in newspapers as well as on radio and television.[1]

On 22 September 1998, Lomborg published the Danish book *Verdens Sande Tilstand* (*The True State of the World*), which contained 322 pages, about 1500 notes, and 600 references. It was presented as an opposition to the yearbook *The State of the World*, produced every year by the World Watch Institute. The Danish Ecological Council, an independent advisory committee on environmental matters, felt the need for a ''counter-publication'' and asked various experts who could be considered as impartial (e.g. not associated with environmental organizations) to contribute. The resulting book was published at the beginning of May 1999 and was called *Fremtidens Pris* (*The Price of the Future*). It included contributions from 18 authors coming from various disciplines, and these were critical on all kinds of aspects of Lomborg's methods, biology, environmental science, and social science approach.

In 2001, an English version of Lomborg's book was published. It was called *The Skeptical Environmentalist: Measuring the real state of the world.* Most of it was a direct translation from the Danish version, with a few modifications. Main differences were that the chapter on global warming had been greatly expanded, and that the amount of notes and references had increased to about 1700 and 3000, respectively. The book was published by Cambridge University Press (CUP), one of the world's most prestigious scientific publishing houses.

The publication of this English version provoked a debate on an even larger scale. Reactions to the book differed enormously. Praise came mainly from non-scientific media. In contrast, the scientific community and environmental organizations were primarily critical and produced mostly negative reviews, including ones by eminent scientists. Moreover, some of the criticisms were extremely harsh, both in content and tone. For example, Harvard biologist E.O. Wilson (2001, p. 1) accused Lomborg of ''willfull ignorance'', J. Harvey (2002, p. 1) said ''Much of the book has an undergraduate quality to it, but is this surprising considering that ecology is the most complex of sciences and that Lomborg has never done a shred of work in the field?'' and ''I would fail one of my undergraduate students if they were to write such trash'', and P.H. Gleick (2001, p. 1) stated that: ''There is nothing original or unique in Lomborg's book'', but ''what is new, perhaps, is the scope and variety of errors he makes''. The most famous review is probably the 11-page editorial *Science defends itself against The Skeptical Environmentalist* in the January 2002 issue of *Scientific American*. In this editorial, recognized experts assessed Lomborg's treatment of their fields: S. Schneider wrote on global warming, J.P. Holdren on energy, J. Bongaarts on population growth, and T. Lovejoy on biodiversity. One main conclusion was that Lomborg's book suffers from selective use of data. Other critical reviews appeared, among others, in *Nature, Science*, and *The Economic Journal*. The most extensive critical review of Lomborg's book that has been published is *Sceptical Questions, Sustainable Answers* (Ege and Christiansen 2002), the English version of *Fremtidens Pris*.[2] Surprisingly, this seems to have received quite little attention. A well-known critical review by an environmental organization is *Nine things*

journalists should know about The Skeptical Environmentalist, written jointly by the World Wildlife Fund (WWF) and the World Resources Institute (WRI). Finally, another series of critical reviews appeared in the environmental magazine *Grist Magazine*. Critical reviews were also published on the Internet. The Union of Concerned Scientists, for instance, gathered contributions on their website from experts in a wide range of fields, and environmental writers, academics and activists in Oxford, UK, set up an anti-Lomborg website with an overview of much of the criticism that had been given.[3]

Lomborg responded to several of the critical reviews. For instance, he wrote a letter to *Science*, wrote rebuttals to *Skeptical Questions, Sustainable Answers*, to the editorial in *Scientific American*, and to *Nine things journalists should know about The Skeptical Environmentalist*, and corresponded with T. Burke in *Prospect Magazine*. His response to *Scientific American* received much attention. Lomborg was allowed to write a one-page response to their editorial about his book for the May issue. Lomborg, however, wanted to react sooner and in much greater detail. Therefore, he wrote a 32-page response, which he put on his own website before his one-page response was published by *Scientific American*. *Scientific American* reacted by demanding that Lomborg removed this response from his website, arguing it was an infringement of their copyright and would interfere with their business of selling the article. Lomborg consequently removed his response. Next in May 2002, J.P. Holdren and J. Rennie, the editor-in-chief of *Scientific American*, both wrote a response to Lomborg's 32-page response. Holdren responded to Lomborg's reply to his review of the energy chapter, and Rennie addressed Lomborgs response to the other three parts of the editorial. Both these responses were put on *Scientific American*'s website together with Lomborg's 32-page response to the editorial.

The critical reviews did not only provoke responses by Lomborg but also by others. Bailey (2002, p. 1), for example, stated that Lomborg had become "the target of an intellectual hate campaign". Some supporters of Lomborg evaluated a number of critical reviews.[4]

In addition, complaints were submitted to Aarhus University, the Danish Committee of Scientific Dishonesty, and CUP. On 14 January 2002, S. Pimm, one of the authors of the review of *The Skeptical Environmentalist* in *Nature*, filed a complaint to Aarhus University, where Lomborg worked. He explained in a letter that Lomborg's claims were not reliable, and asked the university to examine this. Soon after this, E. O. Wilson, T. Malone, and K. Fog also sent letters of complaint to the university. However, these complaints did not have any consequences, as soon after Lomborg resigned from his post at Aarhus University and became Director of the new Danish Environmental Assessment Institute.[5,6]

In February and March 2002, several environmental scientists filed a complaint to the Danish Committees on Scientific Dishonesty (DCSD)[7], a body attached to the Danish Ministry of Research and Information Technology. In the complaints Lomborg was accused of acting in a manner considered scientifically dishonest. The filers of the complaints, S. Pimm and J. Harvey, used an extensive portion of the previously published criticism, including the *Scientific American* material, as a basis for their complaint. The DCSD took the complaints into consideration and invited Lomborg to write rebuttals. The filers of the complaints were invited to write counter responses, and Lomborg in turn could comment on these. In June the DCSD decided that the case should be decided by all the members and deputies of all the committees of the DCSD[8], and in December they reached a

decision. This was announced in public on 7 January 2003. The DCSD had decided that *The Skeptical Environmentalist* was "deemed to fall within the concept of scientific dishonesty", because the book was based on a systematically biased choice of data (DCSD 2003, p. 19). However, the DCSD did not feel able to judge that Lomborg had misled his readers deliberately or with gross negligence, because of his lack of scientific expertise on the themes treated in the book. Therefore, he was acquitted of the accusations of having acted in a manner considered scientifically dishonest. The DCSD concluded instead that the publication was "deemed clearly contrary to the standards of good scientific practice" (DCSD 2003, p. 19). This decision provoked a protest campaign initiated by a group of Danish social scientists. They wrote a declaration in which the DCSD's methods in the case were criticized. This declaration was signed by 308 scientists, many of whom were from the social sciences, and it was published on 18 January 2003. As a reaction to this, another group of Danish scientists wrote a declaration in support of the DCSD. By 4 February 2003, this had been signed by more than 600 scientists who came almost exclusively from the medical and natural sciences (Fog 2006, p. 10).

On 13 February 2003 Lomborg filed a complaint to the Ministry of Science, Technology and Innovation against the DCSD's decision of 7 January 2003. On 17 December 2003, the Ministry reached a decision on the case. It stated that the DCSD had made a number of errors in the treatment of the case and remitted the case to the DCSD. This implied that the DCSD's decision of 7 January 2003 became invalid. On 12 March 2004, the DCSD decided not to re-examine the case. The main reason given was that it had already concluded that Lomborg had not acted with intent or gross negligence. Therefore, it did not consider it reasonable to start a new investigation.

Finally, various scientists have pressured CUP through letters and emails to withdraw *The Skeptical Environmentalist* from publication. These stated, among others, that the book was "likely to be abused by corporate interests" and that "it had clearly not been subjected to a proper peer review process" (Harrison 2004, p. 358). In July 2002, many complaints were summarized in a letter to CUP signed by 12 American scientists, including E.O. Wilson. This letter asked CUP to set up a scientific panel to review the book to identify all errors and misrepresentations in the text, to add errata sheets to all copies of the book, and to evaluate CUP's internal procedures so as to assess how a book could have slipped through that is essentially a political statement. CUP responded by stating that the book had been through the same procedures as any other Cambridge book, and that it would be wrong to abandon an author who had satisfied the requirements of their peer-review system. In addition, CUP invited the authors to submit a book proposal in which an opposing argument would be presented. In an issue of *Time Magazine* of 2 September 2002, the authors repeated their claim that the book had not been subjected to peer review. Consequently, CUP decided to publish an article to clarify the editorial decisions that gave rise to publishing the book as well as CUP's resistance to organized pressure to withdraw it from the market. The article was entitled "Peer review, politics and pluralism" and was written by Dr. Chris Harrison, Publishing Director of social science publishing for CUP. In this article, Harrison emphasized that the book did not bypass "the usual Cambridge peer review process" and was not "cynically spirited through the system by an ignorant social science editor". Of the four referees, three were chosen from a list of referees provided by CUP's environmental science publishing programme rather than from the list of

social science referees. Of these three, one was a climate scientist; one was a specialist in biodiversity and sustainable development, and one an economist with expertise on the economics of climate change. To Harrison's surprise all referees recommended publication of the book (see Harrison 2004, p. 357–358).

3. Reviews of The Skeptical Environmentalist

In this section a critical examination is offered of the published reviews of *The Skeptical Environmentalist*? An overview and summary is presented of the main elements and statements in the reviews of Lomborg's book, both those containing criticism and those making positive judgements. The arguments mentioned in the reviews will not be evaluated in full detail here, simply because this would occupy enough space to fill a book, given that the number of criticisms – as opposed to the number of positive evaluations – is extremely large. Criticisms and positive judgements are summarized in Section 3.1 and Section 3.2, respectively.

3.1. Criticisms

This section presents an overview of the published criticisms of Lomborg's book. The selection of criticisms in the summary means that they were judged as valid based on the availability of good examples or logical argumentation in the original reviews. Weaker, less well supported criticisms are not mentioned here. All sources and examples in support of criticisms are presented in the longer version of this article (see acknowledgments). The criticisms are organized in seven categories: methodological issues, conceptual issues, theoretical issues, data problems, statistics, form and style, and use of references. A summary of the criticisms that have been most frequently mentioned in the reviews of Lomborg's book will be provided in Table 1.[9]

3.1.1. Methodological issues

- The overall methodological principle applied by Lomborg is a form of simple falsification to dismiss competing theories and simple verification to accept his own hypothesis. This approach yields predetermined results (Jespersen 2002, p. 6).
- He selectively chooses to address issues and problems that support his optimistic views and to ignore other issues (Gleick 2001, p. 2). Sometimes this means that he does not focus on the key issues, but on the side issues (or even non-issues) (Cole 2003, p. 377).
- He is selective in his skepticism: Lomborg appears far more accepting and less critical of "contrarian" findings compared with findings that are often widely accepted within the scientific community (Cole 2003, p. 378).
- He often conducts a partial analysis instead of a general, complete analysis. This allows him to ignore environmental threats arising from multiple, cumulative and interactive stresses, driven by a variety of human activity (Dernbach 2002, p. 461). In addition, this allows him to conclude that a certain problem has been solved when in fact it has only shifted from one area to another.
- He neglects regional trends in favor of highly aggregated or global trends (Cole 2003, p. 377). Global averages, however, are misleading indicators of the real

Table 1. A summary of the most frequently mentioned criticisms.

Criticism	Count
Methodological issues	
He neglects regional trends in favor of highly aggregated or global trends.	15
He extrapolates positive trends for decades into the future.	9
He selectively chooses to address issues and problems that support his optimistic view and to ignore other issues.	7
He often conducts a partial analysis instead of a general, complete analysis.	6
He makes sweeping generalizations.	9
He is inconsistent.	7
He is selective in his skepticism.	6
Conceptual issues	
He created the concept of the Litany by selecting extremely pessimistic statements – often made long ago, by a few individuals – which do not well represent the environmental movement of today.	15
Lomborg does not give enough credit to environmental policies – in part inspired by environmentalists – as a cause of environmental improvement.	13
He fails to discuss the specific problems associated with irreversible physical and biological processes.	8
He does not seem to understand the political economy of environmental protection. Environmentalists are not the only ones who influence policy; industry influences policy as well.	7
Theoretical issues	
The precautionary principle is not an alternative to, but part of a rational economic prioritization in the case of uncertainty in combination with extreme consequences and irreversibility.	12
His false claim is that research shows we can "grow out" of our environmental problems.	11
He misrepresents or does not understand basic environmental science concepts.	6
Data problems	
Selective use of data.	36
Errors of fact.	10
He combines data sets that are incongruent.	8
Statistics	
He often ignores uncertainty.	11
Form and style	
The bibliography contains many secondary sources relative to the number of primary sources. In addition, he often cites articles that have not undergone scientific peer review.	9
His book is a polemic.	7
Use of references	
Lomborg often writes things that are not in accordance with the original sources.	21

The longer version of the article (see acknowledgements) reports all the associated references for each count. The total number of critical reviews included here is 65.

state of the world. They are not usable for the analysis of regional and local problems of environment or poverty. Additionally, averaged developmental trends, even for a region, are informative only if the region is quite homogeneous in ecological terms (Jespersen 2002, p. 9).

- He regularly makes sweeping generalizations (Hammond 2001, p. 1).
- Often he chooses to let his figures "speak for themselves" (Jespersen 2002, p. 6). Treatment of numbers, however, is not enough. One has to offer a meaningful analysis (Davis 2001, p. 1).

- There is a lack of attention for complicating factors: his arguments are often very simplistic, and complications are mentioned only in passing or in endnotes, if at all (Cole 2003, p. 78). For example, Gleick (2001, p. 8) notes: ''Lomborg discounts water problems because 'basically we have sufficient water' at the global scale – a dangerous and meaningless simplification''.
- He extrapolates positive trends for decades into the future (Fitzroy and Smith 2004). But when current trends are in a negative direction, he often argues that we will do things differently in the future (Gleick 2001, p. 8). However, he does not have the theoretical basis needed to understand the development over the last 20–50 years, which is crucial for the projection of developmental trends another 50 years into the future (Jespersen 2002, p. 8).
- The Litany is a kind of methodological trick: individual, flawed, and outdated claims can easily be refuted which make his arguments seem strong (Bodnar et al. 2004, p. 60).
- He is inconsistent in his evaluation and qualification of data. Cole (2003, p. 377) notes that Lomborg is inconsistent because he criticizes someone for using global trends, while he himself makes ample use of these. Gleick (2001, p. 6) shows with an example that Lomborg is inconsistent since he uncritically uses uncertain data which support his hypothesis, while at the same time he criticizes the uncertainty surrounding comparable data that do not support his hypothesis.
- He sometimes misinterprets data, for example, on world grain production, water, and cancer mortality (Gleick 2001, p. 5–6; Bodnar et al. 2004, p. 62).
- He sometimes cites contradictory evidence. In trying to prove that the projection of extinction rates can not be based on the species-area curve, Lomborg gives three examples. These examples, however, actually disprove his claim (Harvey et al. 2001, p. 3).
- Lomborg uses the ''Nordhaus model'' (describing economic growth interacting with climate change) authoritatively (Gundermann 2002, p. 154). He does not evaluate model assumptions or compare with results from alternative models and policy analyses.
- He sometimes conceals weak statements by provoking meaningless discussions. Fog (2002b, p. 207) explains how Lomborg conceals the weakness of his claim (because it is based on dubious data) that total forest area is constant, by provoking a discussion about rain forest versus temperate forest.

3.1.2. Conceptual issues

- The Litany:
  He created the concept of the Litany by selecting extremely pessimistic statements – often made long ago, by a few individuals – which do not well represent the environmental movement of today (Percival 2002, p. 266). In this way, the extent of disagreement about environmental issues is misrepresented (Fog 2002a, p. 96).
  It is plausible that the environmental movement has overstated the magnitude of environmental threats. However, Lomborg has not seriously tested this hypothesis. This would require a systematic examination of the statements

that the leading environmental groups have made, showing the cases where they have overstated threats to the environment (Brown 2001, p. 1).
He attributes to the leaders of the environmental movement a power they do not possess. He also fails to understand that people may find the litany convincing because of their own experiences and interpretation of the evidence (Burke 2001, p. 16; Schulz 2001, p. 3).
He fails to recognize the diversity of the environmental movement; environmentalists have highly divergent views concerning priorities, policies and strategies (Percival 2002, p. 266).
He mixes "avoided danger" and "unjustified fear": when a predicted catastrophe does not take place, this does not necessarily mean that we got scared for nothing, it may also have been that the danger was avoided by a preventive measure, or that the disaster had not yet occured.
He does not show a good understanding of the political economy of environmental protection. Environmentalists are not the only ones who influence policy; industry influences policy as well (Czech 2002, p. 2). Lomborg does not discuss the balance that results from these opposing forces. Fitzroy and Smith (2004) note decades of deliberate deception by industries such as asbestos and tobacco.

- Irreversibility: Lomborg fails to discuss the specific analytical problems associated with irreversible physical and biological processes (Jespersen 2002, p. 11). Whereas deforestation and acid rain may be reversible, extinction and climate change are not (at least not within time horizons relevant to humans). When we are dealing with environmental problems characterized by irreversibility and uncertainty, we should take into consideration evidence that is less than definitive and consider applying a precautionary principle. Lomborg does not recognize this.
- Policy: Lomborg does not give enough credit to the influence of environmental policies on improvements in environmental indicators. He rarely gives unqualified support to any environmental protection measure.[10] Instead, he regularly applies a set of assumptions or propositions as reasons for withholding support for environmental laws and policies (Dernbach 2002, p. 466). He also rarely attributes environmental improvements to the impact of environmental regulation (Kysar 2003, p. 246–247).[11] He tries to avoid admitting any role of government action in achieving the favorable conditions that he describes (Kysar 2003, p. 248).
- Prioritization:
  Lomborg overlooks rational reasons for accepting some risks while simultaneously spending money to eliminate lesser dangers. For instance, whether people face a risk voluntarily or whether it is imposed upon them often plays a significant role in risk management policy decisions (Rohlf 2002, p. 312).
  He weighs the environment only against things like hospitals and sanitation, rather than against, for example, industry subsidies and defence spending (Schulz 2001, p. 2).
  When hypothetical alternate uses of funds are raised as persuasive grounds for defeating a regulatory initiative, no reliable mechanism exists to ensure that the proposed alternate use actually is undertaken (Kysar 2003, p. 257–258). Lomborg ignores or does not recognize this.

- The nature of problems: Lomborg reduces many environmental problems to poverty problems (de Groot and Hoekstra 2002, p. 77) and in this way tries to strengthen his argument that economic growth is the solution to all problems as it is also suggested to solve poverty problems.

3.1.3. Theoretical issues

- Treatment of environmental science:
  He misrepresents or does not understand basic environmental science concepts (Gleick 2001, p. 2): he does not seem to understand what "ecosystem services" are and what their value is (Harvey 2002, p. 2); he regularly comments on the quantity of resources, without addressing the issue of quality (Gleick 2001, p. 2). Kysar (2003, p. 238–239) notes that "He attempts, for instance, to discount the collapse of world fisheries by reporting a figure for global fish production that includes farm-raised fish. However, he never mentions the feed grain inputs, biological and chemical pollutants, genetic contaminants, and other environmental factors that make aquaculture an imperfect substitute for wild catch".
  He systematically underestimates environmentally-related risks (Dernbach 2002, p. 459). According to Dernbach (2002, p. 458–462), Lomborg's underestimation of environmentally-related risks is mainly caused by treating part of a problem as if it were the entire problem, by arguing that we should not worry about environmental issues for which scientific uncertainty exists and by conducting an issue-by-issue analysis.
  Although he himself acknowledges that he is not an expert regarding environmental problems, he interprets his environmental data with great confidence (Czech 2002, p. 1).[12]
- Treatment of welfare economics, environmental economics, development economics and public economics:
  Sometimes Lomborg recognizes market failures and sometimes he does not. He recognizes, for instance, that the prices of energy and other commodities, whose production and use affect the environment, often fail to reflect their true social costs. On the other hand, he believes that the price of oil is a good indicator of its scarcity (Lomborg 2001a, p. 122). This, however, ignores various imperfections in oil markets.
  Risk, risk aversion and scientific uncertainty have economic relevance, but Lomborg does not seem to recognize this. He claims the precautionary principle is about making worse decisions than we need to (Dubgaard 2002, p. 197–198). However, if there is a small probability of a scenario with very serious consequences, it can be rational to avoid this scenario and thus act upon an uncertain outcome. (Aage 2002, p. 20) notes: "After all, few people would consider their fire insurance premium to be wasted just because their houses did not burn down during the insurance period". Thus, properly used, the precautionary principle is not an alternative to, but part of a rational economic prioritization (Hansen 2002, p. 47).
  He gives the impression that economic growth is an essential precondition for environmental protection. This is not the case: a great deal of environmental protection can be accomplished now, with good governance, even in developing countries (Anderson and Kosnik 2002; Dernbach 2002).

Institutions like property rights and the rule of law are particularly important in this respect. See further the discussion on the environmental Kuznets curve (EKC) in Section 5.

He denies or is unaware of the growth debate. The disparities between renowned scientists in this debate are considerable and he completely ignores this. In addition, his own position in the debate, "technocrat" and "optimist" (van den Bergh and de Mooij 1999), is not very well substantiated. He believes that economic growth can continue indefinitely even though natural resources and the environmental capacity for storage and assimilation of waste are finite. This belief is based on his presumption that human ingenuity is limitless and that no individual feature of the environment absolutely is essential to human survival. However, he never tries to investigate the empirical foundation for this presumption (Kysar 2003, p. 246).

- He wants to base prioritization strictly on cost-benefit analysis. However:

  An (expected) cost-benefit analysis is only feasible to elucidate alternative strategies if we can calculate the probabilities of specific environmental effects as well as their impacts on people's economy and welfare (Hansen 2002, p. 45).

  Cost-benefit analysis relies on ethical and political assumptions that are far from indisputable (Dubgaard 2002, p. 197). It typically monetizes the value of life, discounts the interests of future generations, and excludes the distributional consequences (including issues like intra- and intergenerational equity and environmental justice). These assumptions can not be disputed on the basis of scientific evidence, but on the basis of their moral justification (Kysar 2003, p. 229 and 278).

3.1.4. Data problems

- Lomborg fails to discuss some data problems at a general level, such as inadequate data collection and dissemination, how to read and understand environmental data, and how to tell good data from bad data (Gleick 2001, p. 3).
- He makes many mistakes when discussing, presenting, or interpreting data, faults which are unexpected and disturbing in a statistician (Gleick 2001, p. 3):
  - Selective use of data (Cole 2003, p. 377):
    - In many cases he neglects inconvenient literature and overemphasizes work that supports his view (Schneider 2001, p. 1). Examples are the impact of pollution on allergies and asthma (Bodnar et al. 2004), the impact of acidic deposition on forest ecosystems (Kysar 2003), the EKC (Fog 2002b; Section 5), and climate change (Section 5).
    - He systematically selects statistics to support his claims that global welfare is generally improving and environmental policy is unnecessary (Fitzroy and Smith 2004).
    - He seems to change his categories from case to case according to what is favorable to him, notably in relation to biodiversity loss and deforestation (Fog 2002a, p. 99).
    - Where global trends support his arguments, he highlights them, whereas when these are less favorable, he often switches to regional trends, for

example, in relation to grain production, pollution trends, and tuberculosis (Harvey 2002, p. 2).

- Misuse of data (Gleick 2001, p. 5): He often combines data sets that are incongruent, for example, on drinking water and sanitation, and on starvation in Africa (Gleick 2001, p. 5); and he sometimes chooses the most convenient time-scales for examining trends (Bodnar et al. 2004, p. 59).
- Errors of fact: He makes many errors, both important and trivial. He should have taken more care in checking basic information (Gleick 2001, p. 6; Holdren 2002a).

3.1.5. Statistics

Statistical aspects are treated poorly in the book:

- Lomborg hardly mentions the concept of significance, and it is rarely evident in his book whether the trends described are significant (Fog 2002b, p. 211). This is partly because his analysis mostly depends on graphical illustrations, without performing rigorous statistical analysis.
- For many environmental issues, scientific uncertainty exists. Most scientists deal with this by using scenarios of possible or likely futures (Dernbach 2002, p. 456) and by describing environmental effects in terms of a range of outcomes or an average and a standard deviation. Lomborg, however, simply ignores this uncertainty. He presents his figures as if known with certainty, or he gives predictions and claims these are the true outcomes. His predictions are made by picking out a value at the low end of the environmental impact range (Dernbach 2002, p. 460). Gundermann (2002, p. 145) notes: "The skeptical environmentalist is positive that future emissions will be in the low range of the possible global scenarios assessed by the IPPC, despite the fact that the panel precisely states that they are spanning the entire, immense outcome space of the future state of Planet Earth, given the difficulty of forecasting a hundred years from now".
- He frequently uses absurd precision in his numbers, for example, on biodiversity loss (Fog 2002b, p. 211).
- He often uses words like "plausible" and "likely", but he never attaches any probability to these words (Schneider 2002). Often when he states that his hypothesis is "plausible", he does not discuss an alternative hypothesis that might be just as plausible.
- He mistakes correlation for causation (WRI and WWF 2001, p. 2).

3.1.6. Form and style

- Lomborg tries to give the impression that his book is very scientific. He does this in several ways: for example, by using a very large number of notes and references. However, his book is not as scientific as it appears to be. The bibliography contains many secondary sources relative to the number of primary sources (Fog 2002b, p. 210). In addition, he often cites articles that have not undergone scientific peer review, and that do not reflect current scientific consensus (WRI and WWF 2001, p. 6).

- In the end, his book is just a polemic. He exaggerates for effect, substitutes forceful assertion for weight of argument, sometimes makes sweeping generalizations from particular instances, is inconsistent in his use of logic, presents false choices and is selective in his use of data and quotations – the familiar features of polemics. These features are illegitimate in scholarship (Burke 2001, p. 15).
- He tries to present himself as a left-wing environmentalist by emphasising that he once was a member of Greenpeace (Preface in Lomborg 2001a). However, Greenpeace does not seem to have any record of Lomborg's membership (Bjorn Lomborg 2006). Lomborg's suggestion that he converted from pessimism to optimism could have the effect that his current opinions are regarded as reliable and persuasive.
- His conclusion has no premises, no conditional if-then statements about ethics, science, technology, education, politics, policy, and management (Norgaard 2002, p. 288). It is common in environmental and social sciences to conditionally forecast, for example, using a range of scenarios with external, exogenous, or policy conditions.
- He employs a rhetorical style. For example, he constantly claims that ''things are getting better''. What he often seems to mean by ''better'', though, is ''not as bad as some think'', ''getting worse at a slower pace'', or ''better in developed countries'' (Dernbach 2002, p. 458).

3.1.7. Use of references

- Lomborg often writes things that are not in accordance with the original sources. This is caused by, inter alia, selective quotations (Wilson 2001, p. 1) and misquotations (Schneider 2001, p. 4). See for examples: air pollution (Kysar 2003, p. 247), extinction of species (Fog 2002b, p. 204), number of people without access to water and sanitation (Gleick 2001, p. 7), deforestation (Matthews 2001, p. 1), and sun spot effect on climate (Gundermann 2002, p. 147–148). Several of these people indicate that Lomborg misrepresents their own research in his book.
- He does not make a sharp distinction between what is said by scientists, environmental organizations, and the media (Rohlf 2002, p. 301).

Some criticisms have been mentioned in more than one article. In combination with the argumentation and examples, this provides valuable information about the seriousness of, and widespread concern, about certain flaws of Lomborg's book. Table 1 summarizes the criticisms that have been most frequently mentioned in the reviews of Lomborg's book. A criticism is included if it was judged as valid (i.e. part of the above summary) and mentioned in at least five different reviews. The criticism ''selective use of data'' was mentioned most often, namely 36 times. At a second place (21 mentions) comes the criticism ''Lomborg often writes things that are not in accordance with the original sources''.[13]

3.2. Positive judgments

Next, the main statements reflecting a positive judgement of Lomborg's book are documented and commented upon.[14] Statements that were evaluated as valid are:

- The book forces one to think (de Groot and Hoekstra 2002, p. 771).
- The book has a high level of detail (Gleick 2001, p. 1).
- The book correctly points out that some environmentalists exaggerate the scope and severity of environmental problems to generate headlines and revenues (Burke and Lomborg 2001, p. 1).
- The idea of prioritizing resources by comparing alternatives (taking into account opportunity costs), judging risks, and trading-off costs and benefits certainly has validity. It makes sense to include some consideration of relative risk when making decisions about allocating resources to reduce threats to humans and the environment (Rohlf 2002, p. 300 and 311).[15]
- Insofar as he asks "whether we could do more good spending our resources on helping especially the third world by investing less in global warming abatement and more on, e.g. clean drinking water, sanitation, and all the other but important needs", he raises an important question (Poirier 2002, p. 410).
- It is generally true, as Lomborg says, that many social and economic measures of human well-being have improved, including life expectancy, human health, and education. (Dernbach 2003, p. 454).[16]
- He recognizes the enormous and often overlooked public health problem of developing countries "residential indoor air pollution", one of the largest single mortality risk factors in the world (Bodnar et al. 2004, p. 61).

The number of statements reflecting positive judgements of Lomborg's book is very small compared with the number of criticisms as documented in Section 3.1. This may disappoint the reader and give the impression that our study is selective or biased. To convince the reader that this is not the case, additional positive statements – from reviews – that were evaluated as unconvincing (as opposed to the ones above) are briefly mentioned below. Arguments in support of our negative evaluation of these judgements are given as well (in Italics).

- The book is remarkably free of factual errors (Schoenbrod 2002, p. 54).
  However, as was argued in Section 3.1 (notably under "4. Data problems"), Lomborg actually makes many factual errors.
- The statistical detail is impressive (Grubb 2001, p. 1285).
  However, as discussed in Section 3.1 (notably under "5. Statistics"), statistical aspects are treated poorly in the book.
- The book is exhaustively referenced to allow checking of his analysis, with many of these references available on the Internet (Stone 2002, p. 50).
  However, as was stated in Section 3.1 (notably under "7. References"), some of his references are very difficult to trace. Thus, it is not always possible to check Lomborg's analysis or conclusions.
- He clearly understands that increasing prosperity is the key to improving human and environmental health (Bailey 2002a, p. 5).
  However, as noted in Section 3.1 ("3. Theoretical issues") there is no unambiguous empirical evidence for this (see also Section 5).
- Lomborg pre-emptively defuses any accusations of selectivity in his choice of statistics by using only mainstream sources, and wherever possible, exactly the same sources as those whose claims he is analyzing (Stone 2002, p. 49).

However, using official data sources in itself does not guarantee that there is no selectivity in Lomborg's choice of data and indicators. As Section 3.1 (notably under "4. Data problems") makes clear, Lomborg does indeed selectively use data. Moreover, Lomborg does not only use mainstream data sources.

- As the work of an apostate, one converted from pessimism to optimism, it is even more persuasive and therefore the most powerful (Yandle 2002, p. 285).
  However, in Section 3.1 under point (6) ("Form and style") it was explained that there is no clear proof of Lomborg's conversion from pessimism to optimism; for one thing, Greenpeace does not have any record of Lomborg's membership. More importantly, this argument is irrelevant from a scientific perspective.
- The book is interesting for a broad audience, ranging from interested laymen to students and insiders in environmental problems (de Groot en Hoekstra 2002, p. 771).
  On the contrary, the book is unsuitable for interested laymen and undergraduates, since they will lack the knowledge and experience to detect and judge the various flaws, biases and subjectivity present in the book.
- Unlike most social scientists, Lomborg really is willing to reject a hypothesis (Anderson and Kosnik 2002, p. 439).
  However, as was stated under point (1) in Section 3.1 ("Methodological issues"): "The overall methodological principle applied by Lomborg is a form of simple falsification to dismiss competing theories and simple verification to accept his own hypothesis. This approach yields predetermined results". Thus, Lomborg is not open to rejecting his own hypothesis.
- Lomborg has done his work with remarkable care (Huffman 2002, p. 392).
  However, in view of the seven main points of critique in Section 3.1 this clearly is an incorrect statement.

4. Lomborg replies

A balanced evaluation of Lomborg's book needs to take account of Lomborg's responses to his critics. The author focuses on the responses that Lomborg earlier made available through his website (recently, he removed these). These are based on the following reviews:

- the WRI and the WWF in *Nine things Journalists should know about The Skeptical Environmentalist* (2001),
- J.A. Harvey and S.L Pimm in *Nature* (2001),
- M. Grubb in *Science* (2001), and
- T. Burke in *Prospect Magazine* (2001).
- S. Schneider, J.P. Holdren, J. Bongaarts and T. Lovejoy in the 11-page editorial in *Scientific American* (2002),
- the Danish Ecological Council in *Sceptical Questions, Sustainable Answers* (Ege and Christiansen 2002),

In addition, counter responses from J.P. Holdren and J. Rennie to Lomborg's rebuttal of the editorial in *Scientific American* have been examined.

4.1. Stressing own reliability and questioning integrity of critical reviewers

In responding to some of his critics, Lomborg tries to give the impression that his book is very reliable and scientific. He does this by stressing that he openly states the facts and the sources; that everybody is free to point out where these are faulty or incorrect; and that such errors then of course will be posted on his website (Lomborg 2002d, p. 1). As mentioned in note 13, he ultimately mentioned 11 minor errors on his website. Furthermore, he repeatedly notes that he uses the best available statistics from official sources like the UN, OECD, World Bank, IMF, EU, and US (Lomborg 2001c, p. 2; 2002d, p. 4; and 2002f, p. 1). In his rebuttal of the review of the WRI and the WWF he says: ''On the main points in the book, I don't ask my audience to trust me, but to trust my sources''. (Lomborg 2001c, p. 3). However, the use of these sources is neither a necessary nor a sufficient condition for Lomborg's book being reliable or scientific, or for the arguments in it having validity.

In addition, Lomborg tries to make his opponents seem unreliable, not objective and unscientific. Their objectivity is questioned, for example, in his response to *Scientific American*. There he claims that the four experts who criticize his treatment of their fields of expertise have not been chosen randomly as he criticized them in his book. Subsequently, he mentions wrong predictions that two of the experts had made suggesting that this discredits them (Lomborg 2002d, p. 3). However, Schneider, Holdren, Bongaarts and Lovejoy are strong representatives of their field of expertise, thus representing logical reviewers of parts of Lomborg's book. Rennie (2002, p. 2) states: ''Scientists do sometimes make mistakes; they also revise their conclusions as new evidence accumulates. Unlike Lomborg, I see no reason for this to permanently discredit them''. Indeed, progress in science is realized by continuously improving earlier findings, not by denying errors and resisting fair criticism.

Lomborg (2002d, p. 3) further tries to question the objectivity of his critics in the following way: ''The obvious lack of any concern for presenting a balanced review of my work calls into question the real purpose of this *Scientific American* feature''. This ''real purpose'' is then clarified by him as follows (Lomborg 2002d, p. 3):

> ''Schneider considers the 'ethical double bind' that might occur to the scientist who is also concerned to contribute to a better world. As a scientist he focuses on truth. As a concerned citizen he must take an interest in political efficiency. Quite obviously, Schneider finds that this presents a delicate dilemma and he expresses the hope that one might be both honest and effective. However, as Schneider agonizes over this dilemma he does offer the following bit of unambiguous advice 'So we have to offer up scary scenarios, make simplified, dramatic statements, and make little mention of any doubts we might have'. Could John Rennie have taken this as editorial advice? I don't know, but I feel that it would account for the tone and the lack of balance of the Feature considered as a whole. Unfortunately, this tone and lack of balance also seem to represent a disappointing and painful abandonment of the long proud tradition of enlightenment and rationality for which Scientific American has been respected in the past''.

Lomborg is suggesting here that one should question the integrity of both Schneider and Rennie (the latter without any argumentation). But the statement by Schneider (from 1989) does not offer the ''unambiguous advice'' as stated by Lomborg. Instead it presents the ''scary scenarios, ...'' to be an extreme choice which is not the ''right balance''.

More examples in which Lomborg discredits his opponents can be mentioned. In his reaction to Schneider he writes: ''If I am so wrong, one would expect that my critic should have had an easy time showing it, not having to rely on nitpicking, quoting out of context, and misrepresenting'' (Lomborg 2002d, p. 9), and in his reaction to Holdren he writes: ''However, I do find the tone of the entire critique surprisingly rough, indicating that Holdren found it necessary to substitute good analysis with plain negative words''. (Lomborg 2002d, p. 19). He is here suggesting a lack of good analysis without providing any evidence.

4.2. Misrepresentation of, and selective responses to, criticisms

Lomborg often reacts to a criticism by responding to a misinterpretation of it or without going to the core of it. This happens in different ways, as will be shown with a few examples.

In some cases, Lomborg does not respond to the full contents of a criticism but only to selected elements of it. An example is his response to Jespersen's (2002, p. 9) criticism of his use of global figures. Lomborg only quotes a part of Jespersen's criticism: ''Global averages are misleading indicators of the 'real state' ... What is the sense of a statement such as, 'We have seen a global reduction of people living in poverty', when it covers a dramatic deterioration in Africa, a growing number of street orphans in Brazil, more unemployed people in Indonesia, and heavily reduced old age pensions in Russia, outweighed by fewer hungry people in China?'' In response Lomborg says he has pointed out time and again in his book that things are getting better, but are still not necessarily good (Lomborg 2002e, p. 3). However, Lomborg does not mention and respond to Jespersen's main argument here, which is that only genuinely global phenomena, such as the atmospheric content of greenhouse gases and ozone-depleting substances, can be meaningfully analyzed using a global average, while averaged developmental trends – even for a region – are informative only if the region is sufficiently homogenous.

Another example is his response to a criticism by Holdren in *Scientific American*. Holdren (2002a) is critical of Lomborg's statement that the switch by developed economies to low-sulfur coal, scrubbers and other air-pollution control devices has today removed the vast part of sulphur dioxide and nitrogen dioxide emissions. According to Holdren (2002a, p. 70–71), ''U.S. emissions of nitrogen oxides from coal-burning electric power plants were 6.1 million short tons in 1980 and 5.4 million short tons in 1998. Emissions of sulfur dioxide from U.S. coal-burning power plants were 16.1 million short tons in 1980 and 12.4 million short tons in 1998. These are moderate reductions, welcome but hardly the 'vast part' of the emissions''. In his rebuttal, Lomborg (2002a, p. 17–18) claims that he was referring to emissions per ton of coal burned and not to total emissions, and that he picked 1970 as a starting point rather than 1980. He continues by starting that, if this is taken into account, the sulphur dioxide pollution per quantity of coal has dropped by 75%, underscoring that the statement of vastly diminished pollution is correct. This, however, does not recognize that total emissions are more relevant than emissions per ton. Moreover, he does not mention anything about nitrogen dioxide emissions.

An example of selective citing by Lomborg from his own book is as follows. Jespersen (2002, p. 9) criticizes Lomborg for using average caloric intake as an indicator of the real state of the world, because there are many instances of starvation and undernourishment in countries that seemingly (based on observing

the national average) could feed their entire population. Lomborg responds to this by noting that Jespersen's critique seems to suggest that just stating the average caloric intake neglects all the people who are starving. Then he says he also discusses this and gives a quote from his book: ''The caloric figure is nonetheless, an average. It is not unthinkable that the figure conceals the fact that some people live better lives while increasing numbers of others just manage or even starve''. (Lomborg 2002e, p. 4–5). He thus gives the impression that Jespersen's did not read him well. However, the previous citation is immediately followed by the sentence: ''But here, as elsewhere, things are improving''. (Lomborg 2001, p. 61). With ''here'' Lomborg is referring to the increasing trend of average caloric intake. In other words, on the basis of the average caloric intake he draws the unconditional conclusion that things are improving.

The following is an example of Lomborg answering a misrepresentation of a criticism. Holdren criticizes Lomborg in *Scientific American* for spending most of his energy chapter attacking a view that is very rare among environmentalists. Holdren (2002a, p. 69) claims: ''What environmentalists mainly say on this topic is not that we are running out of energy but that we are running out of environment – that is, running out of the capacity of air, water, soil and biota to absorb, without intolerable consequences for human well-being, the impacts of energy extraction, transport, transformation, and use. They also argue that we are running out of the ability to manage other risks of energy supply, such as the political and economic dangers of over-dependence on Middle East oil and the risk that nuclear energy systems will leak weapons materials and expertise into the hands of proliferation-prone nations or terrorists''. Lomborg's (2002d, p. 61) response to this is: ''This is exactly the kind of exposition which I try to counter in my book – without any references Holdren manages to describe everything as going ever worse and even include into the environmental agenda concepts that are far removed from its core, such as nuclear proliferation, terrorism and economic recession from oil price hikes''. Of course, it is clear that Holdren does not say ''everything is going ever worse''. He merely gives an interpretation of the various concerns of environmentalists in relation to energy use. However, Lomborg simply waves these concerns away as being non-environmental in nature. Thus he is able to avoid answering the real criticism, namely that he is knocking down a straw man. Moreover, despite what Lomborg says Holdren actually mentions four references in the subsequent paragraph to substantiate his criticism.

Another example of Lomborg's misinterpretation of a criticism can be found in his correspondence with Burke in *Prospect Magazine*. In it, Burke calls the Litany a caricature of Lomborg's own creation, and he criticizes Lomborg for not recognizing that the public is much more influenced by real events that have happened than by a few environmentalists who play on people's fears. He writes: ''There is indeed an environmental Litany. It is a litany of tragedy. It reads: DDT, Bhopal, Torrey Canyon, Sveso, Exxon Valdez, Flixborough, CFCs, Chernobyl, BSE ... These are not words that people have written, but events that have happened. These events, and many more, were brought to the public's attention by the carelessness or ignorance of businesses and governments, not by environmentalists. In my 30 years as an environmentalist, nothing I or my colleagues have ever said or written has had as much influence on the public as these events''. (Burke in Burke and Lomborg 2001, p. 1). Lomborg reacts to this by saying: ''Curiously, you then go on to confirm my claim of a Litany – you say that there is a litany of

environmental tragedy and list examples such as DDT, oil spills from Torrey Canyon and Exxon Valdez, and CFCs damaging the ozone layer. Because these are actual events, they somehow show that the environmental decline is real and not just the creation of environmentalists. But singular events cannot reliably be used to describe general trends''. (Lomborg in Burke and Lomborg 2001, p. 3). This is a very surprising, peculiar reasoning, which makes clear that Lomborg avoids replying to Burke's point by misinterpreting him.

4.3. Counter-criticising reviewers

The following examples illustrate Lomborg's use of a strategy to criticize an opponent and thus avoid having to respond to the contents of the criticism.

Bongaarts mentions in *Scientific American* that past population growth has led to high population densities in many countries. He criticizes Lomborg for dismissing concerns about this issue based on a simplistic and misleading calculation of density as the ratio of people to all land. According to him, a more useful and accurate indicator of density would be based on the land that remains after excluding areas unsuited for human habitation or agriculture. To clarify this, Bongaarts (January 2002, p. 72) calculates the density of Egypt in both ways. This country has a population density of 68 persons per square kilometre according to Lomborg's simple calculation but an astonishing 2000 persons per square kilometre if the unirrigated Egyptian deserts are excluded. He concludes that, measured properly, population densities have reached extremely high levels, particularly in large countries in Asia and the Middle East. Lomborg reacts as follows: ''It is curious that Bongaarts, trying to show how wrong I am, is forced to use a hypothetical argument (of Egypt) and does not even find it necessary to point out that I never make this argument. The real challenge is in the text shown above, where I point out that some of the most densely populated areas of the world are in Europe. Is Bongaarts obvious point at all relevant to my examples of, for example, the Netherlands being far more densely populated than India? We are never told''. (Lomborg 2002d, p. 22). However, Bongaarts never gave the impression that Lomborg presents an argument about Egypt. He clearly points out that he gives an example to clarify that his measure of density is more useful than that of Lomborg. Secondly, Bongaarts point is very relevant to Lomborg's examples; for instance, the population density in the Netherlands in terms of the number of people per square kilometre of potentially arable land (385) is actually lower than that of India (437) (Rennie 2002, p. 7). By counter-criticizing Bongaarts, Lomborg is able to avoid having to respond to the criticism, and in particular to say what the best measure of density is and why.

Another example can be found in Lomborg's response to Holdren's review in *Scientific American*. Holdren (2002a) criticizes Lomborg for not giving a clear explanation in his energy chapter of the distinction between ''proved reserves'' and ''remaining ultimately recoverable resources''. Lomborg (2002d, p. 16) reacts by counter-criticizing Holdren: ''Holdren spends half this paragraph complaining that I do not explain all distinctions, while above arguing that I make an obvious point (so that I presumably should not spend vast amounts of space explaining everything). Even on a kind reading, this critique seems excessively compulsive''. The ''obvious'' point Lomborg is talking about refers to the former paragraph in Holdren's rebuttal in which Holdren (2002b) says: ''Lomborg gets right the basic

point that the dominance of oil in the world energy market will end not because no oil is left in the ground, but because other energy sources have become more attractive relative to oil''. However, immediately after saying this, Holdren criticizes Lomborg for not recognizing that the transition from oil to other sources will not necessarily be smooth or occur at prices as low as those enjoyed by oil consumers today. Furthermore, Holdren argues that Lomborg does not show a good understanding of the complete problem. Again, Lomborg avoids responding to the main criticism of the reviewer.

4.4. The use of an authoritative source as an excuse to not respond to a criticism

At several occasions Lomborg counters criticism by suggesting that his use of an authoritative source means he is not responsible for his own statement. This then serves as an excuse to not respond to the criticism. This is illustrated by the following examples.

Lomborg claims in his book that there is no case of forest decline in which acidic deposition is known to be a predominant cause. Lovejoy (2002, p. 74–75) criticizes him for this statement in *Scientific American* and says this is simply untrue. According to him two clear-cut examples are red spruce in the Adirondacks and sugar maple in Pennsylvania. Lomborg (2002d, p. 28) reacts to this by saying: ''Lovejoy neglects to mention that the quote is not mine but the conclusion of NAPAP, the official American acid rain project, which is the world's biggest, longest and most expensive study of acid rain; it spanned most of a decade, involved about 700 scientists, and cost half a million dollars. It would seem that a little more than ''simply untrue'' would be needed for Lovejoy to counter this conclusion''. The NAPAP paper which Lomborg cites dates back from 1990. It was even considered controversial at the time of its release and its conclusions were hotly debated. The NAPAP's Biennial Report to Congress from 1998, updating the earlier work, arrives at quite another conclusion: ''Sulfur and nitrogen deposition have caused adverse impacts on certain highly sensitive forest ecosystems in the United States''. Rennie (2002, p. 10). Clearly, Lomborg used an outdated source.

Another example can be found in his response to the review in *Nature* written by Harvey and Pimm (2001). In trying to prove that the projection of extinction rates can not be based on the species-area curve, Lomborg (2001, p. 254) discusses deforestation rates and the extinction of forest birds in North America in his book. He states that the eastern forests were reduced over two centuries to fragments equal to just 1–2% of their original area, but that only one forest bird became extinct. Harvey and Pimm claim in their review in *Nature* that this is incorrect. According to them, the correct percentage is close to 50%, and the number of extinctions four, plus two species seriously wounded. They state that these statistics confirm the predictions made from the species-area curve models (Harvey and Pimm 2001, p. 150). Lomborg reacts by saying that the statistics on forest and bird loss come from the biologist Daniel Simberloff, who advised the World Conservation Union (IUCN). He consequently states: ''If he is wrong, Pimm and Harvey should criticize him''. (Lomborg 2001b, p. 5). Again, Lomborg peculiarly suggests that he is not responsible for his own statement.

In both cases, an honest response would have been to admit the mistakes and try to learn from the additional information offered by the reviewers.

4.5. Content of responses to criticisms

In many cases where Lomborg offers a substantial response to a commentary by a reviewer, the substance of his answer can be criticized.

Tom Burke in *Prospect Magazine* criticizes Lomborg for misrepresenting Lester Brown's views about the food problem. Lomborg claims that Brown keeps on telling us that food production is going down the tubes (Burke in Burke and Lomborg 2001, p. 1–2). Burke, however, says the only thing Brown wrote (in a passage from 1965, quoted by Lomborg) is that the food problem emerging in the less developing regions may be one of the most nearly insoluble problems facing man over the next few decades. Lomborg (in Burke and Lomborg 2001, p. 3) responds by stating that "insoluble" is a vague term, and that, since Brown said this, more than two billion extra people have been fed properly, the proportion of hungry people has declined from more than 35–17%, and even the absolute number of hungry people has declined from about 1 billion to 760 million. He also notes that the UN expects the proportion of hungry people to decline even further to 6% in 2030, down to some 400 million. He concludes that Brown's previous claims of pessimism have been entirely wrong. However, Lomborg merely provides information which allows one to conclude that the food problem is currently unsolved and is likely to be unsolved in 2030, 65 years after Brown's statement.

Holdren in *Scientific American* criticizes Lomborg for not recognizing that the transition from oil to other sources will not necessarily be smooth or occur at prices as low as those enjoyed by oil consumers today. Lomborg (2002d, p. 16) simply answers that it is true that this could happen, but that it is very unlikely because we have had this kind of fear of running out of oil many times and each time it has proven incorrect. Moreover, he claims we have good reasons to believe that the many different energy sources can give us sufficient energy also for future use at competitive prices. Lomborg's argument in not well substantiated for two reasons. First, the fact that our fears of running out of oil have proven incorrect in the past can not be projected unconditionally into the future. Secondly, "we have good reasons to believe" is not a substantive argument, as the reasons are not spelled out.

In another instance, Lovejoy criticizes Lomborg for selective quoting. Lomborg writes in his book (2001a, p. 254): "Colinvaux admits in *Scientific American*[17] that the (extinction) rate is "incalculable". However, what Colinvaux really says, is: "As human beings lay waste to massive tracts of vegetation, an incalculable and unprecedented number of species are rapidly becoming extinct". Lovejoy (2002, p. 75). Lovejoy rightly notes that it is evident that Colinvaux simply means that the number is "vast". Yet, Lomborg is unwilling to even admit such an evident mistake: "Of course Lovejoy would like me to quote that Colinvaux really does believe that the number is large, but this is a personal and unsubstantiated point. If someone says "Nixon resigned in 1974 and that was a great loss to the nation", Lovejoy's requirement that I can only quote the scientific statement when also quoting the personal conviction is equivalent to requiring me not only to quote that Nixon resigned in 1974 but also that it was a great loss to the US". The word "incalculable", however, is not a personal conviction but clearly has a unique meaning in this context, which is "large".

As a final example, Lovejoy criticizes Lomborg for superficial research and selective use of numbers in his forest chapter. He claims the data of the FAO suffers

from so many different definitions and methods that any statistician should know they can not be used to create a valid time series (Lovejoy 2002, p. 75). Lomborg (2002d, p. 29) reacts to this by stating that Lovejoy neglects to say that it is the only long-run data series, and that he actually points out that these data are very uncertain in his book on page 111. However, in his book Lomborg (2001a, p. 111) only talks about the uncertainty of the somewhat shorter data series of the FAO and the need to focus on the longest possible time periods because of these short-term uncertainties. This gives the impression that the long-run data series is certain or more certain. In note 770 of his book, Lomborg briefly mentions that the measurement of global forest area is notoriously inaccurate, but on page 111 of his book and in the rest of his forest chapter nothing is said about the long-run data series being uncertain, and the impression is given that the long-run data can be used to create a valid time series. At the end of the chapter, Lomborg (2001a, p. 117) also feels able to draw the general conclusion that since World War II the forested area has not changed much, without making any reservations in view of unreliability of the data.

4.6. Closing remarks

Although Lomborg never admits any important criticism of his reviewers, it is unlikely that he is unaware of the many mistakes in his book. This can be concluded from the way he replies to his critics as illustrated in sections 4.2–4.5. In the few cases where he selectively responds to a criticism, he often avoids going to the core of it, or in many cases the quality (substantial content) of his responses is very low. This not only suggests Lomborg's awareness of some mistakes, but also it explains why Lomborg's responses have not led to much understanding between him and his critics about the validity of certain points. Furthermore, it simply cannot be true, as Lomborg tries to suggest, that so many recognized experts have been structurally mistaken in expressing (many similar) criticisms on Lomborg's book.

Before Lomborg wrote his rebuttal to *Scientific American*, he sent out a broadcast email to ask people for help, with the text (Rennie 2002, p. 7):

> "Naturally, I plan to write a rebuttal to be put on my web-site. However, I would also love your input to the issues – maybe you can contest some of the arguments in the SA pieces, alone or together with other academics. Perhaps you have good ideas to counter a specific argument. Perhaps you know of someone else that might be ideal to talk or get to write a counter-piece".

This can be regarded as reflecting Lomborg's main interest in – at any cost – winning a debate rather than advancing knowledge and honestly searching for the truth. Moreover, one can see it also as showing a lack of confidence by Lomborg in the correctness of what he wrote in his book. If Lomborg was sure that his (important) statements and conclusions were valid and well-checked, he should not have had to ask other people for help in countering arguments.

To conclude this section, one can best cite the editor-in-chief of *Scientific American* (Rennie 2002, p. 1): "... many of his counter-arguments ... display the same patterns of misdirection, bias and selective citation that our authors found in his book".

5. Consistency with environmental economics

In the longer version of this article (see the acknowledgements), a number of themes discussed in Lomborg's book are compared with relevant approaches and insights in the literature on environmental economics. It shows that Lomborg's measurement of the state of the world and his policy recommendations are not based on an adequate treatment of economic theories, empirical studies, and related insights. This is briefly illustrated by discussing two topics that play a prominent role in Lomborg's overall argumentation and conclusions, namely optimal climate policy and the EKC.

To start with, on the basis of the results of a single, particular cost-benefit analysis (Boyer and Nordhaus 2000), Lomborg discourages society from radically cutting CO_2 emissions. In the first place, Lomborg does not give sufficient credit here to alternative, competing economic analyses of climate policy (for an overview, see Kelly and Kolstad 1999). Moreover, a CBA of climate change or climate policy faces several problems, as recently illustrated by the reopening of many old debates with the publication of the Stern Report (Stern 2007). These debates centre on intergenerational discounting, valuation of mortality, uncertainty and extreme events (e.g. Lind 1982; Azar 1998; Demeritt and Rothman 1999; Gjerde et al. 1999; Woodward and Bishop 2000; DeCanio 2003; van den Bergh 2004, 2009b). However, these various debates are simply ignored in Lomborg's book. In particular, climate change may involve physical and socioeconomic effects that are catastrophic and irreversible (over time scales relevant to humans and their societies). Combining this with the uncertainty associated with (but possibility of) such effects means that an (expected) CBA is not an evident or rational approach, so that the idea of an optimal climate policy turns out to be mere wishful thinking. This does not mean that rationality should be rejected in determining a specific reduction-level of GHGs. Instead, a precautionary or minimax regret approach can be defended as rational (Gollier et al. 2000). This means that one should recognize the problem as a risk management problem: the choice for a specific climate policy requires balancing the largely economic risks associated with a rapid abatement of greenhouse gases now against the environmental and resulting economic risks of no or little abatement (van den Bergh 2004). In the minimax regret approach (Loulou and Kanudia 1999), this translates into a comparison of the costs the world will suffer under a stringent climate policy (a transition to a sustainable energy system) with the costs the world will suffer under a business-as-usual approach (climate damage and adaptation costs). Under an extreme scenario of climate change, natural instability could produce undesirable feedbacks to the economic system of a magnitude that might not be absorbed without extreme monetary and psychic cost. This will imply a more stringent climate policy than proposed by Lomborg. All together, Lomborg's interpretation of economic analyses of climate policy must be judged as selective, methodologically weak and not well embedded in the literature. The most important shortcoming is that he does not take the possibility of irreversible and catastrophic climate change seriously. As a result, his policy proposal simply comes down to gambling, clearly a non-rational (even irrational) approach to policy.

The second example of Lomborg's inconsistency with environmental economics relates to the EKC. This describes an inverted U-shaped relation between income per capita and particular indicators of environmental pressure. Lomborg seems to

accept the EKC as a general, indisputable pattern or law. He derives an extreme policy recommendation from it; namely, that countries should stimulate economic growth to solve environmental problems. According to Lomborg (2001a) economic growth is the solution for air pollution (p. 176), deforestation (p. 114), extinction of species (p. 256) and pollution in rivers (p. 205), because "only when we get sufficiently rich can we afford the relative luxury of caring about the environment" (p. 33). This conclusion is, however, not supported by the literature on the EKC. First of all, Lomborg refers to a few selected, early studies (notably Shafik 1994; Grossman and Krueger 1995) rather than to the full set of relevant EKC studies or surveys (e.g. Stern et al. 1996; de Bruyn and Heintz 1999). Therefore, Lomborg does not recognize that empirical research has only shown EKCs for specific pollutants and not for environmental problems in general. Furthermore, he does not acknowledge, or simply is not aware, that the policy relevance of empirically assessed EKCs is very limited. There are a number of reasons for this (Stern et al. 1996; Rothman 1998; de Bruyn and Heintz 1999; Stern 2004). First of all, many empirical EKCs were estimated for a cross-section panel of countries, which does not automatically imply that over time individual countries will follow the estimated EKC pattern. Secondly, national EKC analyses do not take into account industrial relocation and trade shifting patterns. Thirdly, it is questionable whether the observed decreases in environmental degradation in the second phase of EKCs are of a permanent nature. One can not exclude that in the long run, when we have run out of easy technological solutions, a relinking of economic and pollution growth will occur (which has been referred to as an *N*-curve). Fourthly, EKCs have been mainly found for local problems associated with evident and extreme health risks (drinking water quality, smog in cities), but not for problems associated with long term sustainability (solid waste, global warming). Fifthly, an EKC found for a specific pollutant reflects a partial insight: environmental degradation may have shifted from one pollutant to another. Lomborg's general optimism about EKC patterns is thus unfounded. Given that growth automatically solves environmental problems in his world view, it is logical that environmental policy receives little weight in his solutions for the future, as was already discussed (and criticised) in Section 3.1.

Concluding, Lomborg covers a lot of environmental economics' ground without showing awareness of relevant standard insights of that field. The latter have nevertheless been documented in a large number of textbooks (for an overview up to 2002, see http://www.ucl.ac.uk/~uctpa15/envecontexts.pdf).

6. Conclusions

Five distinct conclusions can be drawn on the basis of an examination of the negative and positive reviews of the book. First of all, Lomborg has not convincingly measured the "state of the world": his research is contaminated by a lack of objectivity; he uses certain approaches that are unable to give a good indication of the real state of the world (e.g. he neglects regional trends in favor of highly aggregated or global trends; and he selectively chooses data, illustrations and sources to support his optimistic view); he does not portray conceptual issues well (ecosystem services, irreversible changes, evaluation of uncertain extreme climate events, GDP growth as a solution); and his research is not without flaws (e.g. he often writes things that are not in accordance with the original sources). Secondly, it is

questionable whether Lomborg's predictions of the future will become reality. They are not based on facts or knowledge, but on optimism. Instead of making conditional if-then statements about, for instance, education, policy, politics or technology when he draws his optimistic conclusions, Lomborg just seems to "know" for sure that things will get better. In addition, Lomborg does not give enough credit to environmental policies – in part inspired by environmentalists – as a cause of environmental improvement. Thirdly, most correct comments made in positive reviews are rather superficial, while the more substantive ones turn out to be incorrect in virtually all cases. Fourthly, the way Lomborg reacts to his critics suggests his awareness of certain flaws in the book. In some cases he selectively responds to a criticism; he often reacts to a criticism without going to the core of it; and the quality (substantial content) of his responses is often very low. His rebuttal style would be considered as unacceptable in peer review procedures as commonly employed by scientific journals. It is also good to realize that among Lomborg's critics are several of the most eminent experts in particular fields covered by Lomborg's book.[18] Moreover, indicative of his lack of confidence in the correctness of many of his own statements is that he sent out a broadcast email to ask other people for help in countering the arguments in the *Scientific American* reviews. Fifthly, Lomborg's discussion of the need for prioritization of resources by comparing alternatives, judging risks, and trading-off costs and benefits has some relevance, but this is old news as it is the approach of mainstream environmental economics since the 1970s. Furthermore, he does not pay much attention to the implications of uncertainty and potentially irreversible and catastrophic events. The treatment of two major topics in the book, namely economic analysis of climate policy and the EKC, reflect a very incomplete knowledge of modern (environmental) economics. Such knowledge is nevertheless essential to address some of the broad questions Lomborg wants to resolve. Lomborg should have been better informed about the literature and relevant debates, so that he could have included the necessary conditional statements and provisions. At this point he clearly has failed to be balanced, careful and up to date.

All three lines of scrutiny – i.e. reviewing the reviews, assessing Lomborg's responses, and examining the environmental economics content of the book – support the same insight, namely that *The Skeptical Environmentalist* is not a reliable source of information and certainly not a work of science. Too often Lomborg does not seem to be looking for truth and validation but just wants to find support for a particular conviction. In his interactions with reviewers he frequently shows a mere interest to win a debate at any cost rather than to advance – his own and public – knowledge. Of course, given a lack of relevant education and research experience (and peer-reviewed publications) in natural, environmental and social sciences, Lomborg could not be expected to accomplish the formidable task of covering the wide range of themes addressed in his book.

The question remains why a book that contains so many flaws by someone without any scientific credentials has received so much public attention. Part of the answer seems to be that the book was marketed well, notably by a prestigious publisher (CUP), as a work of science from a (ex-)left-wing environmentalist. This gave the book a flavour of objectivity. However, objectivity is exactly what the book lacks. In fact, it is just a polemic. Yet, if the book had been presented as such, Bjørn Lomborg would have been much less renowned than he is today. Nisbet (2003, p. 1) says about this:

> "The vast criticism of the book from credentialed scientists contrasts sharply with the early advance hype from the mainstream media. Just how so much glowing enthusiasm and credibility could be thrust upon a single book from an unknown author before experts could even begin to weigh its claims offers an excellent case study in the manufacture of news".

CUP surely carries an immense responsibility for the misinformation and public confusion that Lomborg's book generated. Just referring to a standard referee procedure, as CUP's employee Harrison (2004) does, is inadequate. Referee procedures once in a while may fail in adequately judging the scientific quality of a manuscript. It is likely that the reviewers of CUP were impressed by the broad perspective, smooth writing style and amount of detail and never bothered to systematically check the latter. The overwhelming collection of unusually critical reviews by experts (as mentioned in this paper) could have been regarded by CUP as an improved, ex post review procedure, and in response the publication decision might have been rectified. Nevertheless, the book is anyway sure to go down in history as an unreliable source of information and argumentation, being one of the most severely criticized texts issued ever by a prestigious academic publisher. Not particularly something to be proud of, neither by Lomborg or CUP. To close, the following brief statement perhaps best summarizes the Lomborg case:

> "The greatest regret I have about it all is the time wasted by scientists correcting the misinformation you created" (E.O. Wilson in a letter addressed to Lomborg (Harvey 2002)).

Acknowledgments

Excellent research support was provided by Renske Jongsma, who was tireless in collecting and summarizing the relevant literature. The author is indebted to Henri de Groot, Giorgos Kallis and Piet Rietveld and two anonymous reviewers for useful comments. The usual disclaimer applies. A longer report with summaries of all reviews and a large number of detailed motivations, notes and references is available upon request.

Notes

1. This section draws on Fog (2006, p. 2–3).
2. Twelve of the original 18 authors who contributed to *Fremtidens Pris* participated in *Sceptical Questions, Sustainable Answers*. Their expertise ranges from economics, social sciences and development studies to biology and environmental science.
3. See http://info-pollution.com/lomborg.htm for a quite complete overview of responses.
4. Schoenbrod and Wilson (2003) and members of "Heidelberg Appeal the Netherlands" (http://www.stichting-han.nl/lomborg.htm).
5. This institute was an idea of Lomborg himself. Its purpose was to evaluate environmental issues by use of statistical methods. It was established by A.F. Rasmussen who had promised Lomborg that he would establish such an institute if he would come to power. This happened when Rasmussen became Prime Minister of Denmark in November 2001. Lomborg left his position at this institute on 22 September 2004.
6. This paragraph is largely based on Fog (2006, p. 7).
7. On 21 February 2002 the DCSD received a complaint from K. Fog, on 7 March one from M. Hertz and H. Stiesdal, and on 22 March 2002 also one from S. Pimm and J. Harvey (Fog, 2006, p. 8).
8. The DCSD comprises three committees: a committee for the natural sciences, agricultural and veterinary science and technical science; a committee for health and medical science; and a committee for the social sciences and the humanities.
9. The following list is not meant to imply that criticisms mentioned under different bullets have equal weight.

10. The main concrete environmental policy recommendations that Lomborg gives are a strong regulatory system to manage the risks of GM technology (Lomborg, 2001, p. 348) and the taxing of energy "such that its actual price would adequately reflect the social costs in production and emissions" (Lomborg, 2001, p. 132). However, in the latter case he quickly adds that we should not support renewable energy with subsidies and tax exemptions since "the market will invest the optimal amount of renewable energy if taxes reflect social costs". This is, however, inconsistent with received insights on instruments aimed at stimulating innovation, niche markets and escape of lock-in.
11. The only time Lomborg attributes environmental improvement to an environmental policy seems to be when he discusses the ozone hole (Lomborg, 2001, p. 275). However, in numerous other cases of environmental improvement, he states that it would also have occurred without environmental policy, or he does not mention the impact of environmental policy. For example: "It seems likely that in the absence of the Clean Air Act of 1956 substantial improvements in air quality would have occurred anyway". Lomborg (2001, p. 170).
12. Lomborg has had no professional training and has done no professional research in any field related to ecology, biology or environmental science.
13. The site http://www.lomborg-errors.dk/ discusses a long list of errors (over 300) found in the book. Lomborg himself (http://www.lomborg.com/publications/the_skeptical_enviromentalist/errors/) mentions only 11 errors (with corrections).
14. Several of these appeared in a special issue of *Case Western Reserve Law Review* (vol.53(2)), a magazine edited by students of law (http://law.case.edu/student_life/journals/law_review).
15. However, this idea is not original at all; it is central to the discipline of environmental economics, which exists already since the late 1960s (see Section 5). Moreover, Lomborg presents a number of fake choices (e.g. stringent climate policy or drinking water improvement), as he ignores that choices in an intertemporal context cannot be reduced to static cost minimization. Instead, they are really about implementing policies that give incentives for socially and environmentally more desirable directions of innovation, industrial structure, and development.
16. But Lomborg generally ignores measures of human well-being that are worsening, and he often neglects the fact that measures which are globally improving are at the same time getting worse in some countries. Moreover, he does not pay attention to studies which suggest an unstable and very weak relation between GDP growth and happiness improvements in rich countries (van den Bergh 2009a).
17. Lomborg refers here to an article in *Scientific American* of 1989.
18. Reputation in science is established through repeatedly shown quality of work and expertise, confirmed by anonymous evaluation by peers in competition for funding as well as publication in journals. This should count for something. Moreover, multiple experts and eminent reviewers agree in their criticism on Lomborg. Among Lomborg's most critical reviewers are E.O. Wilson (em. Professor at Harvard, one of the most influential and honored biologist alive); S. Schneider (professor of Environmental Biology and Global Change at Stanford University, and editor-in-chief of the journal *Climatic Change*); J. Holdren (Professor of Environmental Policy and Director of the Program on Science, Technology and Public Policy at the John F. Kennedy School, and Professor of Environmental Science and Public Policy in the Department of Earth and Planetary Sciences of Harvard University); Thomas Lovejoy (conservation biologist, who was, among others, chair of the Yale Institute for Biospheric Studies, president of the American Institute of Biological Sciences, chairman of the United States Man and Biosphere Program, and president of the Society for Conservation Biology); J.A. Harvey (Senior Scientist at the Netherlands Institute of Ecology, and a former editor of *Nature*); and S. Pimm (Professor of Conservation Ecology, Duke University, Durham).

References

Aage H. 2002. The world's future according to Dr. Pangloss. In: Ege C, Christiansen JL, editors. Sceptical questions and sustainable answers. Denmark: The Danish Ecological Council. p. 16–27. Available from: http://www.ecocouncil.dk/download/sceptical.pdf

Anderson TL, Kosnik L. 2002. Sustainable skepticism and sustainable development. Case Western Reserve Law Rev. 53:439–448.
"Bjorn Lomborg". Wikipedia. Available from: http://en.wikipedia.org/wiki/Lomborg.
Azar C. 1998. Are optimal CO_2 emissions really optimal? Four critical issues for economists in the greenhouse. Environ Resour Econ. 11:301–315.
Bailey R. 2002. Green with ideology. Available from: http://www.reason.com/0205/fe.rb.green.shtml.
Bodnar AR, Castorina M, Desai P, Duramad S, Fischer N, Klepeis S, Liang S, Mehta K, Naumoff EM, Noth M, et al. 2004. Lessons learned from "The Skeptical Environmentalist": an environmental health perspective. Int J Hygiene Environ Health. 207:57–67.
Bongaarts J. 2002. Population: ignoring its impact. Sci Am. 286(1):67–69.
Boyer J, Nordhaus W. 2000. The structure and derivation of RICE. Chapter 2. In: Nordhaus W, Boyer J, editors. Warming the world: economic models of global warming. Cambridge (MA): MIT Press.
Brown L. 2001. Bjørn again. Grist Magazine December 2001, Available from: http://www.grist.org/advice/books/2001/12/12/bjorn/index.html
de Bruyn SM, Heintz RJ. 1999. The environmental Kuznets curve hypothesis. In: van den Bergh JCJM, editor. Handbook of environmental and resource economics. Cheltenham: Edward Elgar, p. 656–677.
Burke T. 2001. Ten pinches of salt: a reply to Bjørn Lomborg. Available from: http://www.green-alliance.org.uk/grea_p2.aspx?id=392
Burke T, Lomborg B. 2001. Discussion between Tom Burke & Bjørn Lomborg in October 2001 in UK's Prospect Magazine. Available from: http://www.prospect-magazine.co.uk/article_details.php?id=3731.
Cole MA. 2003. Environmental optimists, environmental pessimists and the real state of the world – an article examining *The Sceptical Environmentalist: measuring the real state of the world* by Bjorn Lomborg. Econ J. 113:362–380.
Czech BM. 2002. Lomborg's theoretical shortcomings. Available from: http://legalminds.lp.findlaw.com/list/ecol-econ/msg03559.html
Davis D. 2001. Unhealthy skepticism. Grist Magazine December 2001. Available from: http://www.grist.org/advice/books/2001/12/12/unhealthy/index.html.
DeCanio SJ. 2003. Economic models of climate change: a critique. Houndmills, UK: Palgrave-Macmillan
DCSD (Danish Committees on Scientific Dishonesty). 2003. *The Skeptical Environmentalist* Author found guilty of scientific dishonesty: decision regarding complaints against Bjørn Lomborg. January 2003, Available from: http://www.mindfully.org/GE/2003/Bjorn-Lomborg-Dishonesty7jan02.htm.
DCSD (Danish Committees on Scientific Dishonesty). 2004. Annual Report 2003. Denmark. Available from: http://fist.dk/site/english/news/news-2004/annual-report-2003-danish-committees-scientific-dishonesty.
de Groot HLF, Hoekstra J. 2002. De toestand in de wereld door Lomborg. Economisch-Statistische Berichten. 87(October):770–771.
Demeritt D, Rothman D. 1999. Figuring the costs of climate change: an assessment and critique. Environ Plan A. 31:389–408.
Dernbach JC. 2002. Sustainable versus unsustainable propositions. Case Western Reserve Law Rev. 53(2):449–475.
Dubgaard A. 2002. Sustainability, discounting, and the precautionary principle. In: Ege C, Christiansen JL, editors. Sceptical questions and sustainable answers. Copenhagen, Denmark: The Danish Ecological Council, p. 196–202.
Ege C, Christiansen JL, editors. 2002. Sceptical questions and sustainable answers. Denmark: The Danish Ecological Council. Available from: http://www.ecocouncil.dk/download/sceptical.pdf
Fitzroy F, Smith I. 2004. Welfare, growth and environment: a sceptical review of The Skeptical Environmentalist. Scot J Polit Econ. 51(5):707–717.
Fog K. 2002a. How many species go extinct? In: Ege C, Christiansen JL, editors. Sceptical questions and sustainable answers. Copenhagen, Denmark: The Danish Ecological Council, p. 81–103.

Fog K. 2002b. Lomborg and the opinion formation. In: Ege C, Christiansen JL, editors. Sceptical questions and sustainable answers. Copenhagen, Denmark: The Danish Ecological Council. p. 203–223.
Fog K. 2006. The Lomborg story: an account of the Lomborg Case. . Available from: http://www.lomborg-errors.dk/lomborgstory.doc
Gjerde J, Grepperud S, Kverndokk S. 1999. Optimal climate policy under the possibility of a catastrophe. Resour Energ Econ. 21:289–317.
Gleick PH. 2001. Where's Waldo? a review of the skeptical environmentalist (Bjørn Lomborg). Union of Concerned Scientists, November. Available from: http://www.ucsusa.org/global_environment/archive/page.cfm?pageID=533
Gollier C, Jullien B, Treich N. 2000. Scientific progress and irreversibility: an economic interpretation of the precautionary principle. J Publ Econ. 75:229–253.
Grossman GM, Krueger AB. 1995. Economic growth and the environment. Quart J Econ. 111(2):353–357.
Grubb M. 2001. Relying on manna from heaven? Science. 294:1285–1287.
Gundermann J. 2002. Discourse in the greenhouse. In: Ege C, Christiansen JL, editors. Sceptical questions and sustainable answers. The Danish Ecological Council, p. 139–164.
Hammond A. 2001. Counter argument. Grist Magazine, December 2001, Available from: http://www.grist.org/advice/books/2001/12/12/hammond-argument/index.html.
Hansen AC. 2002. Is protecting climate stability worthwhile? In: Ege C, Christiansen JL, editors. Sceptical questions and sustainable answers. Copenhagen, Denmark: The Danish Ecological Council, p. 41–52.
Harrison C. 2004. Peer review, politics and pluralism. Environ Sci Pol. 7:357–368.
Harvey JA. 2002. Lomborg. Available from: http://legalminds.lp.findlaw.com/list/ecol-econ/msg03263.html
Harvey JA, Pimm S. 2001. No need to worry about the future. Nature. 414:149–150.
Harvey JA, Lovejoy TE, Myers N, Pimm SL, Wilson EO. 2001. Biodiversity distortions in Lomborg's *The Skeptical Environmentalist*. Union of Concerned Scientists, Available from: http://www.ucsusa.org/global_environment/archive/page.cfm?pageID=533
Holdren JP. 2002a. Energy: asking the wrong question. Sci Am. 286(1):65–67.
Holdren JP. 2002b. A response to Bjorn Lomborg's response to my critique of his energy chapter. Available from: http://www.sciam.com/print_version.cfm?articleID=000DC658-9373-1CDA-B4A8809EC588EEDF
Huffman JL. 2002. Either you're with us or against us: no room for the Skeptical environmentalist. Case Western Reserve Law Rev. 53(2):391–408.
Jespersen J. 2002. Lomborg's 'journalistic' method. In: Ege C, Christiansen JL, editors. Sceptical questions and sustainable answers. The Danish Ecological Council, p. 6–15.
Kelly DL, Kolstad CD. 1999. Integrated assessment models for climate change control. In: Folmer H, Tietenberg T, editors. The International Yearbook of Environmental and Resource Economics 1999/2000. Cheltenham: Edward Elgar.
Kysar DA. 2003. Some realism about environmental skepticism: the implications of Bjørn Lomborg's *The Skeptical Environmentalist* for Environmental Law and Policy. Ecol Law Quart. 30:223–278.
Lind RC, editor. 1982. Discounting for time and risk in energy policy. Resources for the future. Washington (DC): RFF Press.
Lomborg B. 2001a. The skeptical environmentalist: measuring the real state of the world. Cambridge: Cambridge University Press.
Lomborg B. 2001b. Bjørn Lomborg's comments on Nature review by Harvey and Pimm (2001). Available from: http://homepage.mac.com/motlowski/documents/ReplytoNature.pdf
Lomborg B. 2001c. Bjørn Lomborg's comments on the critique by World Resources Institute (WRI) and World Wildlife Fund (WWF). December 2001, Available from: http://www.lomborg.com/files/Response%20to%20WRI-WWF3.pdf
Lomborg B. 2002d. Bjørn Lomborg's comments to the 11-page critique in Scientific American (SA). January 2002, Available from: http://www.greenspirit.com/lomborg/ScientificAmericanBjornLomborgAnswer.pdf
Lomborg B. 2002e. Short reply to skeptical questions, sustainable answers. June 2002, Available from: http://www.lomborg.com/Reply%20to%20Skeptical%20Questions.pdf

Lomborg B. 2002f. The Skeptical Environmentalist replies. Sci Am. May:1.
Loulou R, Kanudia A. 1999. Minimax regret strategies for greenhouse gas abatement: methodology and application. Operat Res Lett. 25:219–230.
Lovejoy T. 2002. Biodiversity: dismissing scientific process. Sci Am. 286(1):69–71.
Matthews E. 2001. Not seeing the forest for the trees. Grist Magazine December 2001, Available from: http://www.grist.org/advice/books/2001/12/12/for/index.html.
Nisbet M. 2003. The Skeptical environmentalist: a case study in the manufacture of news. January 23, 2003. Available from: http://www.csicop.org/scienceandmedia/environmentalist
Norgaard RB. 2002. Optimists, pessimists and science. BioScience. 52(3):287–292.
Percival RV. 2002. Skeptical environmentalist or statistical spin-doctor? Bjørn Lomborg and the relationship between environmental law and environmental progress. Case Western Reserve Law Rev. 53(2):263–283.
Pielke RA. 2004. When scientists politicize science: making sense of controversy over ''The Skeptical Environmentalist''. Environ Sci Pol. 7:405–417.
Poirier MR. 2002. It was the best of times, it was the worst of times ... : science, rhetoric and distribution in a risky world. Case Western Reserve Law Rev. 53(2):409–437.
Rennie J. 2002. A response to Lomborg's Rebuttal. April 2002, Available from: http://www.sciam.com/print_version.cfm?articleID=00040A72-A95C-1CDA-B4A8809EC588EEDF
Rohlf DJ. 2002. Revenge of the once-ler: the Skeptical Environmentalist. Case Western Reserve Law Rev. 53(2):297–313.
Rothman DS. 1998. Environmental Kuznets curves – real progress or passing the buck? A case for consumption-based approaches. Ecol Econ. 25:177–194.
Schneider SH. 2001. Hostile climate. Grist Magazine December 2001. Available from: http://www.grist.org/advice/books/2001/12/12/hostile/index.html
Schneider SH. 2002. Global warming: neglecting the complexities. Sci Am. 286(1):62–65.
Schoenbrod DS. 2002. The Mau-Mauing of Bjorn Lomborg. Commentary. 114(2):51–55.
Schoenbrod DS, Wilson C. 2003. What happened to the skeptical environmentalist? March 2003, Available from: http://www.nyls.edu/pdfs/v46n3-4p581-614.pdf.
Schulz K. 2001. Let us not praise infamous men. Grist Magazine December 2001, Available from: http://www.grist.org/advice/books/2001/12/12/infamous/index.html.
Shafik N. 1994. Economic development and environmental quality: an econometric analysis. Oxford Econ Papers. 46:757–773.
Stern D. 2004. The rise and fall of the environmental Kuznets curve. World Develop. 32(8):1419–1439.
Stern N. 2007. The economics of climate change: the stern review. Cambridge, UK: Cambridge University Press.
Stern D, Common M, Barbier E. 1996. Economic growth and environmental degradation: the environmental Kuznets curve and sustainable development. World Develop. 24(7):1151–1160.
Stone R. 2002. When facts become an endangered species. Policy. 17(4):49–55.
van den Bergh JCJM. 2004. Optimal climate policy is a utopia: from quantitative to qualitative cost-benefit analysis. Ecol Econ. 48:385–393.
van den Bergh JCJM. 2009a. The GDP paradox. J Econ Psychol. 30(2):117–135.
van den Bergh JCJM. 2009b. Safe climate policy is affordable – 12 reasons. Climatic Change, doi: 10.1007/s10584-009-9719-7.
van den Bergh JCJM, de Mooij R. 1999. An assessment of the growth debate. In: van den Bergh JCJM, editor. Handbook of environmental and resource economics. Cheltenham: Edward Elgar.
Wilson EO. 2001. Vanishing point. Grist Magazine December 2001, Available from: http://www.grist.org/advice/books/2001/12/12/point/index.html
Woodward RT, Bishop RC. 2000. Efficiency, sustainability and global warming. Ecol Econ. 14:101–111.
WRI and WWF (World Resources Institute and World Wildlife Fund). 2001. Nine things journalists should know about *The Skeptical Environmentalist*. Available from: http://www.lomborg.com/files/Response%20to%20WRI-WWF3.pdf
Yandle B. 2002. Mr. Lomborg and the common law. Case Western Reserve Law Rev. 53(2):285–296.