

Does Environmental Economics Produce Aeroplanes Without Engines? On the Need for an Environmental Social Science

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Accepted: 1 October 2010 / Published online: 11 January 2011
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Abstract In this paper we first critically review conventional environmental economics. We conclude that the standard theory offers too narrow a perspective for many real world problems and that many theories are not empirically tested. Consequently, environmental economics is at risk of producing aeroplanes without engines. Next, we welcome and discuss some recent trends, particularly the rapid developments of behavioural and new institutional economics as well as the increased interest in empirical analysis. Yet, we conclude that more ‘logical duels’ between competing theories, more interaction between theory and empirics, and more integration between the social sciences are needed to achieve a better understanding of real world environmental problems and the development of adequate policy handles. Finally, we present an outline of steps towards the development of an environmental social science and briefly present the papers that make up this special issue as important building stones of such a discipline.

Keywords Economic methodology · Environmental economics · Experiments · Logical duels · Moral philosophy · Political science · Psychology · Sociology · Spatial sciences · Surveys

We are grateful for very helpful comments from Fredrik Carlsson, Partha Dasgupta, Eugenio Figueroa, Siegwart Lindenberg, Åsa Löfgren, Peter Martinsson and Thomas Sterner. The usual disclaimer applies.

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JEL Classification A12 · B41 · Q50

1 Introduction

Adam Smith is generally seen as the founding father of modern economics. Yet, the economics, or more precisely, political economy, of Adam Smith was in many respects a considerably broader field than modern economics. Indeed, Smith embedded his economic analyses in frameworks that we today would characterize as psychology (e.g. his analyses of the role of emotions in human behaviour in *The Theory of Moral Sentiments*), political science (e.g. his work on the proper role of government in *Lectures of Jurisprudence*), sociology (e.g. his discussions of social norms and social status), law (e.g. his treatments of legislation and its impacts on social development), religious studies (e.g. his analysis of the evolution of religions in *History of Astronomy*) and, of course, moral philosophy, which was the subject of his chair at the University of Glasgow.

Adam Smith is not an exception. Until the early 1900s, most economists were social scientists in the first place and analyzed economic problems from a social science, rather than from a narrowly defined economics, perspective. Well-known examples are Thomas Robert Malthus, Alfred Marshall, Karl Marx, John Stuart Mill, Vilfredo Pareto and David Ricardo. While most economists today have a much more narrow scope than the founding fathers, there are major exceptions. A recent example is Michio Morishima, who abandoned the narrow field of economics out of discontent with the practice that has flourished in the discipline, as pointed out by Sen in the first *Morishima Lecture*. Sen observes that Morishima's discontent was based on '*...the economic theorists' lack of knowledge about the empirical reality about which they theorize...and ...that this lack of knowledge about the empirical reality was clearly connected with a lack of interest in the world beyond the deliberately simplified reality studied in economic theory*' (Sen 2008, p. 619). In Morishima's own words, '*We have in our discipline been led up the wrong path by the invisible hand of the demon, and because it takes both time and money to make an engine, we are producing on a large scale "aeroplanes" which have no engine*' (Morishima 1984). After having worked as a pure theorist, Morishima later on turned very critical of pure theory and the narrow perspective of the field. He then proceeded to alter the boundaries of the discipline of economics by '*...taking economics into the territories that had been formerly allocated to sociology, anthropology and history*' (Sen 2008, p. 619–620).

However, economists who alter the boundaries of the discipline and treat economic problems as intrinsically embedded in their social settings constitute a small minority. The clear trend since the early 20th century has been specialization, not only by field (e.g. micro economics) but also within a field (e.g. producer theory) and even further (e.g. oligopoly theory), and to largely ignore the broader social context, which the fields and subfields are fundamental parts of or intrinsically related to. However, while specialization continues, a reversed trend seems to be emerging (Gintis 2009). This applies both to applications, where discipline boundaries have become more and more diluted, and to methodology, where different social sciences learn from each other. The present paper, as well as the special issue as a whole, discusses the need for, and potential of, this reversed trend for environmental economics.

There is not much explicit discussion of environmental issues in Smith's *The Theory of Moral Sentiment* (1759) or *The Wealth of Nations* (1776). However, he did discuss what we would nowadays denote externalities and public goods, the key concepts in environmental

economics. Moreover, environmental problems, and in particular natural resources,¹ were prominent themes in the works of the late 1800 and early 1900 ‘economists’ Malthus (*An Essay on the Principle of Population* from 1798) and Ricardo (*On the Principles of Political Economy and Taxation* from 1817).

Hence, environmental and natural resource problems were topics of interest in early modern economics, though in rudimentary form. Yet, just as social science was split up in many sub-disciplines, and as economics developed as a narrower and more formalized field in the beginning of the 20th century, environmental issues were removed from the core of economics (and the other social sciences as well).

Modern environmental economics (which from now on is understood to also include natural resource economics, unless stated otherwise) definitely entered the scene in the 1960s, although one of the most fundamental solutions to pollution and environmental degradation, i.e. a tax on polluting activities to internalize the social cost, had been presented some decades earlier by Arthur Pigou in *The Economics of Welfare* from 1920. Since the 1960s, however, environmental economics has developed from modest beginnings to a major sub-discipline of economics (Pearce 2002). The field is concerned with the interdependencies between the economy and the natural environment and focuses on the options and possibilities that the environment (including natural resources) offers for economic development and welfare, but also vice versa: the impacts of economic activity on the environment.

Concerning methodology, the development of environmental economics has largely resembled economics in general, with strong emphasis on the analysis of optimal behaviour derived from an axiomatically based core theory. Furthermore, in some areas, e.g. regulation, management of exhaustible and renewable resources, and international environmental problems and policy, there is some imbalance between theory and empirics in that theories and hypotheses are not always rigorously empirically tested.² In addition, when theory and empirics are connected, it is more common that theory is used to enlighten empirical analysis, typically to derive predictions and hypotheses of economic behaviour in a deductive fashion, than the other way around, i.e. to reject or refine theories or hypotheses on the basis of empirical evidence. Thus, in environmental economics there is a tendency for theory and empirics to live rather separate lives.

The tradition in economics with strong emphasis on the analysis of optimal behaviour based on an axiomatically derived core theory without rigorous empirical testing in some areas contrasts the methodological practice in the other social sciences, particularly sociology and psychology, where theoretical and empirical analysis tend to be on more equal footing. Particularly, hypotheses tend to be derived and provisionally accepted in closer interaction between theory and empirics. Below we argue that one reason for this is the larger variety of data collection methods, including qualitative methods, applied in the sister social sciences.

The objective of this paper is to address the following question: Does Morishima’s concern that economics produces aeroplanes without engines also apply to environmental economics? Particularly, are the theoretical framework and the relationship between theory and empirics in environmental economics adequate for a comprehensive and thorough understanding of the environmental world and the development of effective and efficient policy handles? And, in the case of an affirmative answer to the first question (and hence a negative to the second), what is the most effective and efficient way to produce aeroplanes that do have engines and

¹ One reason for the interest in natural resources was presumably that natural resource-based activities were the main sources of wealth and rent creation at the time.

² Note that there are other areas where there is profusion of empirical studies, such as environmental valuation and cost-benefit analysis.

can fly? To answer these questions, we critically, albeit of course briefly, review in Sect. 2 the methodological practice in environmental economics and the nature of its theoretical foundations. To address the third question, we describe in Sect. 3 some promising recent trends, i.e. the rise of behavioural and new institutional economics, respectively, which are closely related to the other social sciences, especially psychology, sociology and political science. In Sect. 3, we also discuss the increased interest in empirical research and associated methodological issues, particularly the increased use of experimental methods. In Sect. 4, we formulate some suggestions for building environmental aeroplanes equipped with engines, and that can fly. That is, we present an outline of a possible development into the direction of an environmental social science. In Sect. 5, we summarize the papers that make up this special issue in a bid to install some engines in the environmental aeroplanes. Section 6 concludes the paper.

2 Conventional Environmental Economics and Its Challenges

One reason for the rather separate lives of theory and empirics in environmental economics is presumably the widespread beliefs that it is possible to analyze and predict economic behaviour with sufficient accuracy and precision based on the meta model of constrained utility or profit maximization and that empirical testing is not always really necessary. Even more so, many highly simplified models and theories live on and are applied for explanatory or predictive purposes, in spite of the fact that they have not, or even cannot, be subjected to (rigorous) empirical testing. As an illustration, consider Kreps' (1990, p. 7) observation that '*...models untested rigorously may still lead to better understanding, through a process that combines casual empiricism and intuition.*

Although Kreps' view is disputable, as he himself observes (p. 8), we do share his opinion that empirically untested models may serve to develop a *first, tentative* understanding of a complex social phenomenon. Moreover, when immediate policy conclusions are needed, one may sometimes have to rely on empirically untested models as a first approximation to the problem at hand. However, under those circumstances, extra attention should be given to the criticisms, refinements and expansions of the model that one is using for predictions or advice. Theoretical environmental economics frequently fails in this respect in that it often uncritically proceeds on the basis of the standard neoclassical model and ignores alternative paradigms, notably behavioural and new institutional economics.³

Note that the foregoing does certainly not mean that we are arguing against the use of models, i.e. against simplifying representations of reality to develop preliminary insights, since such simplifications are essential to any understanding of complex phenomena. Indeed, we fully agree with Krugman (1994), who observes: '*The problem is that there is no alternative to models. We all think in simplified models, all the time. The sophisticated thing to do is not to pretend to stop, but to be self-conscious—to be aware that your models are maps rather than reality.*' What is objectionable, though, is to ignore Krugman (1988) warning that '*...the fact that an economist offers a theoretical analysis does not and should not automatically command respect. What is needed is some assurance that the analysis is actually relevant.*' Hence, rather than criticizing economic theory and economic models for being simplifications of reality, we emphasize that we should critically evaluate them in terms of relevance for the problem at hand, as well as their explanatory and predictive power. This

³ There exist many different definitions of the neoclassical model. See the next subsection for the definition used in this paper.

includes of course identifying their weaknesses and shortcomings, but also consideration of alternative theories and models. In the following subsection, we shall very briefly do this for neoclassical theory, i.e. the standard baseline model in economics including environmental economics.

2.1 The Basic Environmental Economics Model

Theoretical environmental economics typically assumes sovereign consumers who have stable preferences that are represented by a utility function. The consumers are assumed rational; i.e. they possess perfect information (or search optimally), behave consistently according to their stable preferences, and maximize utility subject to a budget constraint. The actions taken by the consumers depend on the opportunities that they observe in the market place. Similar assumptions apply to producers. They are also assumed rational and to maximize profit subject to restrictions imposed by their technological production possibilities sets, and their actions also depend on opportunities perceived in the market place. Supply and demand interact in the marketplace, resulting in prices of final consumption goods that reflect marginal production costs for producers and marginal willingness to pay for consumers. It is often assumed that consumers and producers are unable to control prices and that demand and supply are adjusted via prices, resulting in equilibrium. Equilibrium analysis (including equilibrium dynamics) is used to explain and predict consumer and producer behaviour (i.e. the actions that will be taken to maximize utility and profit, respectively) and their consequences.⁴

The conventional neoclassical model, routinely applied in environmental economics, has been criticized for more than half a century. For example, [Simon \(1957\)](#) noted that individuals only have limited information, since not everything can be known. Furthermore, they face uncertainty and have limited capacity for processing the limited information. Individuals will therefore, not make optimal decisions in the sense of maximizing a utility function. Instead they tend to make choices that are considered ‘good enough’, although they are generally not the best ones. In Simon’s terminology, consumers are satisficing rather than optimizing individuals. In his *bounded-rationality-satisficing-behaviour* framework, they make choices from a limited number of alternatives that are considered satisfactory, applying simple stopping rules ([Gilovitch et al. 2002](#)).

There is also much empirical, including experimental, evidence that the decision-making process as postulated in standard neoclassical environmental economics fundamentally deviates from reality. For example, there is a large psychological literature on dual (and sometimes higher dimensional) decision making that consists of an intuitive and a rational process, or an emotional and a cognitive process; see e.g. [Kahneman \(2003\)](#). A related issue concerns limited willpower, i.e. even when individuals know what is in their own interest they do not always choose the optimal alternative due to lack of self-control. Consequently, time inconsistent preferences arise; see e.g. [Akerlof \(1991\)](#) and [Laibson \(1997\)](#) for seminal contributions.

⁴ The conditions for equilibrium analysis are extreme, as noted already by [Hayek \(1937\)](#): ‘It is necessary to remember here that the perfect market which is required to satisfy the assumptions of equilibrium analysis must not be confined to the markets of all individual commodities; the whole economic system must be assumed to be one perfect market in which everybody knows everything. The assumption of a perfect market then means nothing less than that all the members of the community, even if they are not supposed to be strictly omniscient, are at least supposed to know automatically all that is relevant for their decisions.’ Nevertheless, equilibrium analysis is routinely applied in theoretical and empirical environmental economics apparently without much consideration of Hayek’s warning.

Not only do consumers have limited cognitive capacity and rationality, the same applies to firms, which are guided by managers with the same psychological dispositions as consumers; see [Cyert and March \(1963\)](#) for a seminal contribution and [Armstrong and Huck \(2010\)](#) for a recent state-of-the-art review. Moreover, the modern producer is not the individual decision maker as assumed in standard neoclassical economics. Rather, decision-making is a complex process in which many individuals at different positions with conflicting interests, both within the firm and in its environment, play a role. In addition, for the modern firm, profit maximization in the narrow sense is only one element in a complex set of objectives. Particularly, the set of objectives usually also includes different kinds of social (including environmental) responsibilities (e.g. [Forest et al. 2008](#)).

Virtually all other axioms of standard neoclassical economics have been questioned. Particularly, much empirical (including experimental) evidence demonstrates that the axiom of the selfish individual (in a narrow material sense) does not hold—not even as a crude approximation. For example, [Brennan and Buchanan \(1985\)](#) observe that individuals face choices in social settings in which the existence and behaviour of other individuals, along with institutions, constrain their behaviour. In addition, [Bechetti et al. \(2008\)](#) extend the notion of utility to include subjective well-being that depends on social preferences and interpersonal relationships.⁵

2.2 Relevance and Explanatory Power of the Neoclassical Environmental Economics Model

As observed above, simplifying assumptions are necessary to gain insight into the fundamentals of a phenomenon. Therefore, the conventional neoclassical model cannot be rejected merely based on simplifying assumptions. However, the simplifications cannot be arbitrarily simple, since they are restricted by the requirements that a theory should meet. Particularly, (economic) theory serves the following purposes:

- (i) It presents a framework for interpreting and integrating new theoretical and empirical findings;
- (ii) It is instrumental in developing empirically testable hypotheses by providing theoretically and empirically validated concepts, and specifying relationships among them, in terms of which the phenomenon of interest can be captured and analyzed;
- (iii) It allows predictions of endogenous developments or of impacts of exogenous inputs (e.g. policy interventions) under conditions that bear similarity to conditions that have been analyzed, tested and accepted.⁶

By its very nature, standard neoclassical environmental economics can only accommodate new theoretical results that are based on the same underlying assumptions (see [Lindenberg 1996](#)) and not theoretical or empirical findings that are based on other fundamental assumptions or findings, such as Simon's *bounded rationality-limited information-satisficing behaviour* framework. Furthermore, it can only generate narrowly defined neoclassical hypotheses for empirical testing⁷ and not testable hypotheses based on a broader framework that includes

⁵ See e.g. [Fischbacher and Gächter \(2010\)](#) and [Messer et al. \(2010\)](#) for some recent experimental contributions to the literature on social preferences and [Fehr and Schmidt \(2006\)](#) for a corresponding survey, [Fehr and Fischbacher \(2003\)](#) for evolutionary arguments behind social preferences, and [Sen \(1987\)](#) for a more general treatment of ethics and economics.

⁶ As pointed out by [Popper \(1974\)](#), theories are always provisionally accepted. This methodological principle applies of course also to the social sciences including economics.

⁷ Einstein is reputed to have said that '*Theory determines what we observe*'; see [Bolles \(2004, p. 257\)](#).

insights from e.g. new institutional or behavioural economics. Yet, hypotheses derived from standard neoclassical theory can still contribute to the development of the field in that they can serve as highly tractable benchmarks against which more complex, non-selfish or less rational behaviour can be tested.⁸

Of special importance are the consequences of relying solely on narrowly defined neoclassical theory for specifying econometric models. As shown by inter alia [Greene \(2003\)](#), ignoring systematic explanatory variables (in the present case systematic variables other than those based on conventional neoclassical theory) is likely to lead to misspecification and hence specification error, i.e. biased estimators of the coefficients of the systematic variables that are included in the model, and to biased tests (because of biased error variance estimators), except when the omitted and included variables are uncorrelated, which is rarely the case in economics. Note that the present misspecification problem can be reduced by adopting the LSE or *from-general-to-specific-approach* (see e.g. [Hendry and Ericsson 1991](#); [Gilbert 1986](#)), i.e. to start from a general hypothesis that includes all the systematic variables identified as explanatory factors for the problem under investigation rather than from a limited set specified by the neoclassical model, possibly supplemented with variables based on intuition or ad hoc reasoning.

It is our perception that environmental economists often make the standard neoclassical assumptions without much reflection on the fact that they are indeed extreme simplifications of reality, and without carefully considering whether alternative assumptions that are less restrictive and more in line with reality are worth the costs in terms of more complexity. Of course, even the most persistent neoclassical environmental economist will, when pushed, pay lip service to Simon and the many others who have questioned the standard neoclassical model. Yet many of them, it seems to us, still continue with business as usual without reflecting much on alternative assumptions.

Why is it that environmental economists appear to be so addicted to the standard neoclassical framework? A possible answer is mathematical tractability. After all, utility or profit maximization under a budget, technological or market constraint can be straightforwardly formulated and solved as a constrained maximization problem, something that cannot be said for e.g. Simon's *bounded rationality framework*. However, mathematical tractability should not stand in the way of truth, as observed by [Krugman \(2009\)](#) when reflecting on the role of economists in the context of the recent financial crisis: '*As I see it, the economics profession went astray because economists, as a group, mistook beauty, clad in impressive-looking mathematics, for truth.*'

3 Changing Times: The Rise of Behavioural and New institutional Economics and the Increased Interest in Empirical Research

The endurance of standard neoclassical economics and the failure to modify its fundamental axioms in response to its criticisms have led to the development of two main alternative schools of thought in environmental microeconomics: behavioural economics and new institutional economics.⁹ In this section we will briefly discuss both schools as well as the

⁸ Put in the vocabulary of statistics, neoclassical theory is the set of null hypotheses on economic behaviour.

⁹ Contributions to each of these approaches have recently been awarded the Nobel Memorial Prize in Economic Sciences. Psychologist Daniel Kahneman and economist Vernon Smith received the Prize in 2002 for their contributions to behavioural and experimental economics, and political scientist Ellinor Ostrom and economist Oliver Williamson in 2009 for their work in institutional economics. In addition, the 1978 Prize

increased interest in empirical analysis and associated methodological developments, and particularly experimental methods.

3.1 Behavioural and New Institutional Economics

Behavioural economics starts from neoclassical economics, but supplements it with insights from other social sciences, especially psychology. Particularly, it incorporates several of the criticisms on the neoclassical behavioural assumptions (although typically not all of them simultaneously); see e.g. [Camerer and Loewenstein \(2004\)](#); [Fehr and Schmidt \(2006\)](#) and [Loewenstein \(2007\)](#) for overviews. It acknowledges that emotions, perceptions, expectations and habits, rather than (merely) objective ‘facts’, usually also steer economic behaviour. It also recognizes that agents have cognitive limitations and that they at least partly for this reason may make irrational decisions. Moreover, and related to this, behavioural economics acknowledges that actors often have limited self-control, in the sense that they are not always doing what they believe is in their own (long-run) interest.

A great deal of work in behavioural economics builds on the observation that people’s behaviour is not solely motivated by their own material pay-offs, and that perceived fairness, solidarity, altruism and social norms often influence human decisions to a large extent. It also acknowledges that individuals act in social settings and that social approval and status are central motivators of human behaviour. Note that essentially all these issues were discussed already by Adam Smith (see [Evensky 2005](#); [Ashraf et al. 2005](#)), in particular in *The Theory of Moral Sentiments* but also in *The Wealth of Nations*.

Environmental economics initially incorporated insights from behavioural economics relatively slowly, but the scene has changed such that behavioural environmental economics is currently gaining ground. Recent contributions include [Bateman et al. \(2008\)](#), who consider alternative models of preference formation in contingent valuation surveys; [Bouma et al. \(2008\)](#), who analyze how trust and social capital affect community resource management; and [Hepburn et al. \(2010\)](#), who examine the implications of hyperbolic discounting for environmental policy. See also [Brekke and Johansson-Stenman \(2008\)](#); [Shogren and Taylor \(2008\)](#); [Carlsson \(2010\)](#) and [Johansson-Stenman and Konow \(2010\)](#) for overviews.

New institutional economics also departs from neoclassical economics, yet considers a more general institutional framework as its base ([Williamson 1975](#)). In addition to the market and the price mechanism, which are the main institutions in conventional neoclassical economics, new institutional economics also considers laws and property rights as well as informal institutions (values and social, ethical and religious norms) as constraints on (economic) behaviour ([North 1990](#)). It furthermore acknowledges that institutions are not only constraints on economic behaviour, but also social capital and thus a production factor. Particularly, institutions indicate what kind of behaviour is respected in society and thus facilitate coordination. In addition, conformation to institutions increases self-regard (intrinsic motivation) and respect from others (extrinsic motivation) ([North 1990](#); [Bowles 1998](#)).

In environmental economics, the increasing role of new institutional economics is inter alia reflected in the development of alternative policy instruments. Particularly, instruments like liability rules, damage compensation, voluntary approaches, zoning and land use

Footnote 9 continued

awarded to Herbert Simon and the 1988 Prize to Maurice Allais were also largely for contributions to what is now denoted behavioural economics. Similarly, the 1991 Prize to Ronald Coase and the 1993 Prize to Robert Fogel and Douglass North were largely for contributions to new institutional economics. (Note that the 1993 Prize can also be seen as a reward for the development of *new economic history* or cliometrics, which focuses on the use of quantitative methods in history).

planning (see e.g. Barde 2000 for an overview) bear the marks of new institutional economics in that they are related to formal or informal institutions. New institutional economics has been especially relevant for the development of policy handles in developing countries. For instance, Ghate et al. (2008); Dietz et al. (2003), Ostrom (1990, 2009) and Ostrom et al. (1992) have proposed policy instruments based on local institutions to effectively handle social dilemma-type situations.

The differences between neoclassical environmental economics and new institutional and behavioural environmental economics are, of course, reflected in their explanatory frameworks, e.g. with respect to the analysis of compliance with environmental regulations. Particularly, there are differences in the definitions of concepts (e.g. ‘objective’ facts in standard neoclassical economics versus perceptions and expectations in behavioural economics) and in the sets of explanatory variables (e.g. the much wider set of constraints considered by new institutional and behavioural economics compared to neoclassical economics). For instance, whereas standard neoclassical economics explains and predicts compliance in terms of a rational trade-off between the marginal pecuniary benefits of violation and the expected penalties, behavioural and new institutional economics consider a wider range of possible explanations including intrinsic motivation, prestige and social norms (see below for further details).

3.2 The Coexistence of Neoclassical, Behavioural and New Institutional Economics

The numerous criticisms of the standard neoclassical model and the rise and development of behavioural and new institutional environmental economics have not led to its ousting. One reason for its persistence is that behavioural and new institutional economics use many building blocks derived from neoclassical economics. Another is that neoclassical theory may be used to develop preliminary understanding of a complex problem and serve as a benchmark for further analysis in a wider behavioural or institutional setting. A third is that it is useful as a framework for normative analysis, as e.g. in the case of optimal exploitation of natural resources or to get insight into efficiency aspects of human behaviour.

The pervasive, uncritical use of the conventional neoclassical environmental economic model appears to be at odds with the *process of error elimination* (Popper 1994). In Popper’s view, competing hypotheses need to be systematically subjected to rigorous attempts of refutation, and the refuted hypotheses need to be replaced with alternatives that are more plausible.¹⁰ Only in this way is progress of scientific knowledge possible in that theories that thus evolve are superior to the refuted in terms of explanatory and predictive power. Put differently, competing theories need to enter into ‘logical duels’ (Tarde 1898) for a discipline to evolve. The outcome of the logical duels is: (i) the theory of one school is rejected, (ii) the theory of the other is rejected, (iii) both theories merge into a synthesis,¹¹ or (iv) the duels induce the search for a new theory, which in turn may lead to the rejection of both theories. From the moment that the duel would be decided, the defeated theory could only receive, at most, a small place in the history books. This is clearly far from what we observe in (environmental) economics and the other social sciences. Why is this so? One reason

¹⁰ Note that the process of error elimination need not lead to an immediate, binary all-or-nothing outcome in the sense that either one or the other is chosen as the preferred alternative. Rather, there may be a continuum of support for each of the competing theories (as expressed by the p -value for the null hypothesis in a statistical test). In addition, rejection of the refuted theory need not imply rejection of all its aspects. Elements that have not been refuted could be part of the surviving theory.

¹¹ Observe that behavioural and new institutional economics are compatible and that there are no obstacles to their integration.

is that it is generally much more difficult to measure causal relationships in social science compared to natural sciences, where controlled experiments often are easier to conduct.¹² Hence, it may take time for a duel to be decided and it may also be difficult to judge its outcome. Another reason is preoccupation with once adopted models and prejudice against alternatives. Yet another is lack of interaction between theory and empirics. After all, as long as a theory is not empirically rejected, there are reasons to retain it. Nevertheless, although there are good reasons for a *live and let live* attitude between conflicting theories, progress of the field requires confrontation, logical duels and error elimination.

3.3 Pick and Mix Policymaking

The fact that there are co-existing but conflicting theories in environmental economics has led to a smorgasbord of different solutions to various, highly similar, policy problems, which allows for *pick and mix* policymaking. Specifically, politicians and policymakers can choose the results that are most in line with their needs and then present them with a halo of being ‘scientifically proven’. A well-known example from macroeconomic policy relates to the policy handles proposed to deal with the 2008–2010 financial-economic crisis. Macroeconomists of the Chicago school, such as Robert Lucas, are sceptical of large-scale government interventions and instead emphasize a balanced budget as policy handle for economic recovery, also in the short run. New Keynesian economists (who share some similarities with new institutional economists) on the other hand give opposite advice and strongly recommend large-scale government intervention, e.g. in the form of extra expenditures and tax cuts (e.g. [Krugman 2009](#)). For example, [Krugman \(2010\)](#) claims that ‘...*premature fiscal austerity will lead to a renewed economic slump*’. Since both Lucas and Krugman have received the Nobel Memorial Prize in Economic Sciences, it is obviously difficult, especially for non-specialists, to develop clear policy handles on this issue from the discipline of economics. Moreover, this encourages a self-serving selection of seemingly scientific opinions.

Similar differences can be found in the context of environmental policy making. For instance, based on conventional neoclassical theory, it is often argued that market-based instruments, such as environmental taxes, are superior to command-and-control instruments from an efficiency point of view. Yet, [Frey and Oberholzer-Gee \(1997\)](#), based on insights from social psychology, show that incentive-based instruments like subsidies reduce intrinsic motivation to behave pro-socially. They provided empirical support for this crowding out effect using a survey relating to the location of a nuclear waste repository facility, as they found that individuals were less willing to accept the facility to locate in their community if they were offered monetary compensation.¹³

When effects like crowding out are at work, it is less clear whether price instruments are superior to command-and-control instruments, also from an efficiency point of view. Hence, policymakers who are sceptical of human rationality, well-functioning markets and institutions can find many arguments for their views in behavioural and new institutional economics, whereas their opponents can find support for application of standard market-based instruments in conventional neoclassical theory.

The co-existence of conflicting schools of thought and inconsistent answers to similar policy questions tend to reduce the credibility and usefulness of a discipline ([Krugman 2009](#);

¹² Yet, astronomy and ecology illustrate that this is not always the case.

¹³ See also [Weck-Hahneemann and Frey \(1995\)](#); [Frey \(1997\)](#); [Gneezy and Rustichini \(2000a,b\)](#) and [Lindenberg and Steg \(2007\)](#) for discussions on and evidence of crowding out mechanisms.

Folmer 2009). The way out is of course logical duels, implying more and improved empirical testing and associated elimination of error (Popper 1963, 1974, 1994).

Yet, the fact that more realistic theories, e.g. theories developed in behavioural economics such as crowding-out theory, may generate less clear-cut policy recommendations than conventional economic theory is not a valid argument against their use. The relevant question for crowding-out is not solely whether it occurs, but how large the effect actually is. If it is sufficiently small, then conventional market-based instruments can be straightforwardly applied. If not, alternatives need to be considered. Obviously, empirical analysis is needed to decide upon the policy issue.

3.4 Experimental Methods and Surveys

Kim et al. (2006) and Angrist and Pischke (2010) observe that the interest in empirical research in economics has increased in recent years. This applies in particular to experimental methods, i.e. lab experiments, field experiments and natural experiments. Because of their growing role in environmental economics (see e.g. List 2006), we briefly discuss the pros and cons of different kinds of experiments and how they compare to (non-experimental) surveys.

Before going into detail, we observe that in economics, the main empirical strategy has traditionally been to estimate and test models using non-experimental data, in particular data collected by way of surveys. As shown by inter alia Oppenheim (1992), Saris and Stronkhorst (1984) and Saris and Gallhofer (2007), the empirical model analyzed on the basis of survey data, particularly causal structures, depends on the designs of the survey and the questionnaire, which in turn depend on the state of the underlying theory and its translation into the questionnaire. Yet it is often difficult to know how well each of these crucial requirements for adequate measurement has been executed and thus how well causal relationships between incentives and responses have been measured. In recent years, a fundamental scepticism regarding the possibility to measure causal relationships by non-experimental methods has developed; see e.g. Angrist and Pischke (2010) and Imbens (2010). These authors basically question all empirical analysis where causal effects have not been identified by design, i.e. by some kind of experiment that unambiguously relates stimulus and response under controlled conditions.

As noted by e.g. Davis and Holt (1993) and Cummings and Taylor (2001), the major strengths of experiments are replicability (which allows independent verification of findings), control (which makes it possible to keep all irrelevant variables constant and hence to identify causal relationships) and simplicity (which allows distillation of complex situations into their basic elements). Yet, while these features are indeed strengths, experiments of course also have major drawbacks, which, however, differ by type.

One major limitation of *lab experiments* is related to the fact that university students are usually chosen as experimental subjects. While this may work for preliminary identification and testing of hypotheses, generalization of the results to other domains is problematic due to the specific properties of the sample used. Although many studies (e.g. Smith et al. 1988) do not find significant differences between experiments with students and actual decision-makers, the results are not universal (see e.g. Davis and Holt 1993). Second, the experimental design may not adequately parallel an actual decision-making environment (Cummings and Taylor 2001). For instance, lab experiment payments usually bear little resemblance to factual payments and the complex hierarchical decision-making structure is for the most part difficult to mimic in experiments. Third, while chemical molecules in an experimental setting do not react differently than in the real world, this does usually not hold for subjects in economic lab experiments. For example, for experiments related to social preferences, there is evidence that subjects tend to act differently in the lab than in a similar choice situation

outside the lab (Levitt and List 2007). One reason for this is self-signalling, i.e. individuals deviate from their true preferences and adopt actions in the lab that are in line with social behaviour in order to improve their self esteem (e.g. Benabou and Tirole 2002).¹⁴ Yet, see Falk and Heckman (2009) for a defence of lab experiments. They argue that despite obvious limitations, lab experiments are a major source of knowledge in the social sciences.

Partly as a reaction to some of the above-mentioned drawbacks, *field experiments*, i.e. experiments conducted with a non-student sample, often in a natural environment, have recently gained increasing attention; see e.g. Levitt and List (2009) for an overview. However, there are many different kinds of field experiments, some of which are more or less similar to lab experiments and hence suffer from the drawbacks described above. To see this, consider the following classification of field experiments (Harrison and List 2004): First, *artefactual field experiments* are conventional lab experiments but with non-student subjects; second, *framed field experiments* are artefactual field experiments but with field context in the commodity, task, or information set; and finally, *natural field experiments* are framed field experiments where the subjects perform their tasks in a fully natural environment. Specifically, the subjects do not know that they are part of an experiment.¹⁵ In our opinion, natural field experiments are in many ways the most promising, particularly because subjects do not know that they are part of an experiment. Yet, compared to lab experiments the advantages come at a cost, of course. In particular, field experiments are typically more expensive and more difficult to control. Therefore, the number of treatments and repetitions, which are needed for generalization, tend to be limited.

Natural experiments (sometimes denoted quasi-experiments) are experiments where the assignment of treatments has been made 'by nature' instead of by the experimenter. Natural experiments are similar to (natural) field experiments, but they are not based on artificial or unrealistic treatments. However, their main limitation is that for many important phenomena of interest, nature does not provide treatments. Another drawback is that many natural experiments may not be as 'pure' as initially thought. For example, the treatment, which in a natural experiment is a natural exogenous shock, may sometimes have been anticipated by some agents. Nevertheless, the interest in natural experiments has rapidly increased in economics in recent years, and is also increasing in environmental economics; see e.g. Chay and Greenstone (2003, 2005); Greenstone and Gallagher (2008) and Greenstone and Gayer (2009).

Note that in spite of the strengths of experimental methods to analyze causal relationships, notably the possibilities of control and simplicity, the outcomes may be inconclusive, even in cases that seem to be well-suited for experimentation. An example is the analysis of endowment effects. As is well-known, standard neoclassical economics predicts that at the margin and in the absence of income effects, the purchase price of a given commodity equals the sales price. Behavioural economics research, by means of experiments, has shown that both prices usually strongly differ—the *endowment effect*—even in the case of such trivial goods as simple lottery tickets (Borges and Knetsch 1998). In environmental economics, this basic result has been used to explain why the willingness to pay for an improvement in environmental quality is systematically smaller than the willingness to accept an equivalent loss of environmental quality (e.g. Vatn and Bromley 1994; Knetsch 2000).¹⁶ Yet, despite the large number of experiments that have found sizable endowment effects, there is all but consensus.

¹⁴ Self-signalling may also occur in surveys.

¹⁵ Peter Bohm (1972, 1979) conducted some of the earliest field experiments in economics. In the above terminology, most of his field experiments are artefactual or framed field experiments. Bohm was also one of the pioneers of experiments in environmental economics; see e.g. Bohm (2003) and Bohm and Carlén (1999, 2002).

¹⁶ See also Bateman et al. (2009) on the problem of loss aversion when valuing environmental change.

For example, List (2003) found that market experience significantly reduces the endowment effect, whereas Plott and Zeiler (2005) found that the price discrepancy vanishes for standard consumption goods when an incentive-compatible design without misconceptions is used. Hence, the limitations of experimental methods, as well as other empirical methods, need to be fully acknowledged when reporting results, in particular when making generalizations.

In the debate in (environmental) economics between structuralists (who often rely on survey data) and experimentalists, Smith (2007) observes: *'As in most important debates about methodology, the truth is that neither position is completely right. The devil is in the details, but details alone do not bring on the angels.'* Smith's observation is especially, but not only, relevant for the ongoing debate about the use of hypothetical markets to extract valuations of environmental quality. As is well known, economists, unlike many other social scientists, are rather sceptical of stated preference methods, particularly because they are not consequential in a monetary or material sense; see e.g. Bertrand and Mullainathan (2001). A possible way out is to extract valuation by means of experiments. However, even though there are sometimes good reasons for the tradition in economics to trust *what people do* better than *what they say*,¹⁷ there are serious limitations of relying on observed behaviour via experiments as well. As mentioned above, for many important problems in environmental economics, nature does not cooperate such that field or natural experiments can be applied. In addition, the use of lab experiments is hampered by the general problem of limited external validity discussed above. Therefore, conventional non-experimental empirical methods will be needed as well; see Deaton (2010); Leamer (2010) and Nevo and Whinston (2010) for details on these and related issues.

Experiments and surveys can also be used as complements. Particularly, Presser et al. (2004) and the references therein point out that experiments can be applied to preliminary test survey hypotheses as well as for questionnaire design, particularly framing of valuation questions. In a similar vein, experiments can be applied to test survey outcomes, e.g. to reduce uncertainty with respect to the stated preferences. Surveys on the other hand are needed to generalize experimental results to populations when large-scale repetition, as in e.g. the testing of medicines, is not feasible. For studies that combine surveys and experimental methods in environmental economics, see e.g. Shogren et al. (1999); Lusk et al. (2006) and Chang et al. (2009).

In our opinions there are good reasons for economists to also consider application of other data collection methods than surveys and experiments, particularly, content analysis (Krippendorf 2004), observation, and interviews with key informants (Patton 2005).¹⁸

¹⁷ Observe, however, Sen's (1973, p. 258) relativization: *'...we have been too prone, on the one hand, to overstate the difficulties of introspection and communication and, on the other, to underestimate the problems of studying preferences revealed by observed behaviour.'* This observation does, of course, not invalidate the warnings by psychologists and others (e.g. Kahneman and Knetsch 1992; Kahneman et al. 1999) regarding the interpretation of valuation results obtained by stated preference methods; see also Ariely et al. (2003) and Carlsson (2010).

¹⁸ Neuendorf (2002, p. 10) defines content analysis as follows: *'Content analysis is a summarising, quantitative analysis of messages that relies on the scientific method (including attention to objectivity, intersubjectivity, a priori design, reliability, validity, generalisability, replicability, and hypothesis testing) and is not limited as to the types of variables that may be measured or the context in which the messages are created or presented.'*

Although these methods usually cannot generate data that fully substitute survey or experimental data, they can nevertheless produce important insights when experiments or surveys cannot be used. For instance, collection of data on environmental behaviour of nations via surveys or experiments is usually inhibited by various factors including availability of test subjects, costs, confidentiality or cooperation. However, content analysis, observation and interviews with key informants may be applied to collect information on e.g. climate policy negotiations and decision making and thus to gain insight into the empirical validity of theories and hypotheses on these issues; see e.g. [Stokman et al. \(2000\)](#) for details on the analysis of complex decision making.

4 Aeroplanes with Engines: Environmental Social Science

As described above, environmental economics today is still largely based on the heavily criticized standard neoclassical model, with increasing intrusion of still poorly integrated behavioural and new institutional economics. Is it possible to change this state of affairs of conflicting and fragmented schools of thought? Is there room for logical duels in a bid to definitively leave behind repudiated theories and to fully integrate compatible theories? Even more so, is it possible to go a step further and follow in Smith's, Marshall's, Mill's, Pareto's, Ricardo's, Marx's and Morishama's footsteps and to move into the direction of an environmental social science? We believe the answers to these questions, in principle, are in the affirmative. In this section, we shall first sketch some possible outlines of an environmental social science. Next, we shall briefly summarize the papers that make up this special issue, and, which in our opinion, are important building blocks of an environmental social science.

4.1 Outline of an Environmental Social Science

How should an environmental social science be developed? The first step that comes to mind is to cross borders, both between schools of thought within a discipline (e.g. neoclassical, behavioural and new institutional economics) and between disciplines, notably between economics, sociology, psychology and political science. Not only theoretical borders but also methodological borders should be crossed. What is crucial here is to ignore disciplinary boundaries. For example, there is no reason whatsoever for a political scientist or sociologist to stay away from a problem because it 'belongs' to the domain of, say, economics or psychology, and vice versa. The second step is logical duels in a bid to select between competing theories, to replace rejected theories, and to merge compatible theories in a synthesis. A third step is more interaction between theoretical and empirical research.

It is uncertain whether an environmental social science developed along the above lines will be more, or less, fragmented than the present state. The short run will probably show more fragmentation. After all, the dominant theory in environmental economics, i.e. standard neoclassical theory, is, compared to theories in other social sciences, rather homogenous. Moreover, it is a model that is frequently applied as a first (and often also final) analytical framework to any problem, which turns it into a universal or grand theory. Hence, inputs from alternative theories are likely to make the field less universal, more fragmented and less

homogenous.¹⁹ On the other hand, more logical duels and rigorous testing will presumably lead to fewer surviving theories.²⁰

Quantitative empirical research, as recommended above, requires well-defined and validated concepts and a theoretical model that allows generation of hypotheses in testable form. Below we briefly summarize [Lindenberg \(2001a,b\)](#) social rationality model, which integrates sociological and psychological hypothesis generating frameworks. Combined with a methodology of induction, hypothesis generation, deduction, testing, hypothesis revision, deduction, testing and so on (cf. [de Groot 1969](#)), this model has, according to [Folmer \(2009\)](#), the potential to reduce the risk of misspecified empirical models.

As far as the empirical methodology is concerned, according to [Lindenberg \(2001a,b\)](#) and [Folmer \(2009\)](#), sociology and psychology tend to start with the formulation and demarcation of a research problem. As a first step the research problem is embedded in a conceptual model, i.e. a theoretical framework that consists of theoretical concepts and hypothetical relationships among them, as tentative answers to the research questions. The next step is theoretical concept validation, the purpose of which is to define the concepts (in the case of new concepts) or refine them (in the case of existing concepts) in the light of theoretical or empirical evidence or intuitive or ad hoc insights and to identify their dimensions. Particular attention is paid to the identification and removal of logical contradictions between the dimensions. The third step is empirical concept validation,²¹ which consists of relating observable indicators to the unobservable theoretical concepts or latent variables.²² It concerns both converging (aimed at evaluating the similarity between measurements of the same concept) and discriminating (identifying differences between concepts) validation and requires interaction between theory and empirics. Note that the conceptual model serves as an instrument for selecting and specifying the aspects that are relevant to the research problem at hand and provides a basis for selecting the most appropriate research methods. In addition, it serves as a framework for interpreting the empirical findings.

¹⁹ This is in line with what is happening in new institutional economics as expressed by Oliver [Williamson \(2000, p. 595\)](#): *'I open my discussion of the new institutional economics with a confession, an assertion, and a recommendation. The confession is that we are still very ignorant about institutions. The assertion is that the past quarter century has witnessed enormous progress in the study of institutions. The recommendation is that, awaiting a unified theory, we should be accepting of pluralism. [...] Speaking of myself I [...] work predominantly on partial mechanisms rather than general theories at this stage.'*

²⁰ Note that we are not arguing to search for a grand theory or model. Rather than attempting to develop a theory that relates to all aspects (horizontal integration), we believe that at this stage, it is more productive to combine the partial models across disciplines by theme.

²¹ Special attention needs to be paid to the evaluation of the quality of concept validation. In this respect, the analysis of the systematic and random measurement errors plays a crucial role. In economics, inter alia [Haavelmo \(1950\)](#), Frisch (see [Bjerkholt and Dupont 1995](#)), and [Aigner and Goldberger \(1977\)](#) have made seminal contributions to this topic. Currently it is mainly the domain of sociology and psychology.

²² Latent and observed variables can be handled simultaneously by means of structural equation models that are made up of a measurement model that relates the latent variables to their observed indicators, and a structural model that presents the relationships among the latent variables ([Joreskog and Sorbom 1996](#)). According to [Folmer and Oud \(2008\)](#), the use of structural equation models may lead to a closer correspondence between theory and empirics, and may reduce multicollinearity and attenuation bias. Note that in empirical economic research, latent variables (e.g. socioeconomic status) are usually simply replaced with observed indicators (e.g. income, education, profession), which is likely to increase multicollinearity. More importantly, the substitution of observed variables for latent variables ignores the fact that the former only partly measure attitudes, propensities and characteristics, as observed already in 1911 by the statistician and philosopher of science [Pearson \(2007\)](#). For instance, observed variables like age or sex only partly measure what they are intended to measure in e.g. environmental valuation, i.e. attitudes and propensities. Whereas Pearson's insights are basic principles in sociology and psychology, they hardly play a role in current economics.

The conceptual model itself contains explicit microfoundations. But instead of a utility or profit maximizing agent actor, Lindenberg's (2001a,b) social rationality model assumes a cognitively plausible, social actor, i.e. an actor with bounded rationality who is subject to social influences, even with regard to what preferences and goals are salient at a given moment. Instead of the catch all notion of utility, it takes physical and social well-being as universal goals, which, in turn, are realized by hierarchically ordered means-end chains ("social production functions" (Lindenberg and Frey 1993)). Not absolute but relative improvements with regard to situationally salient goals are paramount, so that reference points take on special importance.²³ Realisation of the goals takes place within a set of physical and social restrictions, including budget constraints and formal and informal institutions, in a problem solving process in which the actors have limited information only, apply heuristic stopping rules, are resourceful in their goal pursuit (i.e. do not only choose between given alternatives but can think of new ways to achieve a goal), constantly form expectations about future events based on situational social influence, are able to learn from experience, and can use their self-regulatory capacities to create and maintain meaningful structures; see Lindenberg and Steg (2007) for an application of the social rationality model to analyze environmental behavior and Lindenberg (1992) for an application to institutional analysis.

The social rationality model is substantially broader than the standard neoclassical model of constrained maximization. Particularly, Folmer (2009) shows that it captures the basic elements of the standard neoclassical, behavioural and new institutional economics models.²⁴ In addition, Lindenberg (2001c) shows that the standard neoclassical model is a special case of the social rationality model. Observe that as such, it allows generation of hypotheses that are less at risk of specification error than the standard neoclassical model.²⁵ Furthermore, it presents a framework for interpreting and integrating new theoretical and empirical findings from the entire social science field.²⁶

²³ Improvement may also mean prevention of deterioration of the present situation or reduction of a loss. See Aronsson and Johansson-Stenman (2008) and Wendner and Goulder (2008) for recent analysis of optimal public good provision in a second-best world where people care about relative consumption.

²⁴ A potential objection to the specification of models based on a broad theoretical framework like Lindenberg's social rationality model is that it might lead to large numbers of variables, and hence to some spurious relationships. However, according to Haavelmo (1944), this risk is limited: '*Do we actually need to consider an enormous number of factors to explain decisions to produce, to consume, etc.? I think our experience is rather to the contrary. Whenever we try, a priori, to specify what we should think to be important factors, our imagination is usually exhausted rather quickly; and when we attempt to apply our theory to actual data (e.g. by using certain regression models), we often find even a great many of the factors in our priori list turn out to have practically no factual influence.*' Hence, the main problem seems not to be associated with too large a number of variables, but rather with missing out on systematic explanatory variables that are not captured by a given theory.

²⁵ In contrast to the dominant practice in environmental economics to proceed from *specific-to-general*, i.e. from the standard neoclassical model to a behavioural or a new institutional model, the sociological methodology combined with the social rationality model is basically from *general-to-specific*.

²⁶ A possible objection to the social rationality model is that it does not allow mathematical analysis. Yet, while mathematically expressed models have advantages in that results can often be obtained analytically, mathematical analysis in economics is of course not a goal, but only a means. Observe that while analytical precision may sometimes be harder to achieve without than with mathematics, it definitely is not a prerequisite to obtain well-defined and precise results, as shown by e.g. Hicks (1951).

5 Installing Some Engines: The Papers in this Special Issue

In this section, we present the papers that make up this special issue as buildings blocks of an environmental social science.

The first paper, *The Ethics of Intertemporal Distribution in a Warming Planet* by John Roemer, who is professor of both economics and political science, presents an economic analysis of the global warming problem of intergenerational resource allocation based on a normative perspective derived from moral philosophy. The normative perspective is logical since environmental policy is ethical in nature in that it deals with prescriptive or normative issues, i.e. questions as what *should* be done, and not only what *is* actually being done. Roemer explains that to derive normative conclusions, one has to explicate the ethical values one departs from. This is particularly important in the global warming area due to the major intergenerational distributional issues. It seems to Roemer that many analysts in the global warming debate have problems separating ethical views from facts about the world.

A central theme in Roemer's paper is discounting. Starting from a utilitarian social welfare function, he criticizes the often (typically implicitly) made assumption that the decision problem for a society with many generations is equivalent to the decision problem of an infinitely-lived consumer. He argues that among the reasons commonly proposed for discounting, the only ethically defensible one, based on utilitarianism, is the uncertainty of the existence of future generations. Consequently, he argues that the discount rate that most analysts have adopted is too large.

Roemer then goes on to question utilitarianism *per se* claiming that '*intergenerational maximin*, or sustainability of welfare, is arguably a more attractive ethic than utilitarianism.' While our conjecture is that many economists, and, more generally, social scientists, do not fully share this moral intuition, it is nevertheless important to carefully explore implications of different ethical assumptions including intergenerational maximin. It turns out that the policy implications of the latter are quite different compared to the utilitarian case.

Roemer also criticizes what he denotes consumptionist fallacy, which takes human welfare as a function of commodity consumption only, and shows that it seriously limits the possibilities for maintaining or increasing welfare. On the basis of a parameterized model in which the consumptionist fallacy is avoided and that acknowledges that educated leisure, the quality of the biosphere, and knowledge are direct inputs into human welfare, he shows that to achieve welfare sustainability at the highest possible levels, we should be investing at a considerably higher rate in capital and knowledge than we currently are. Furthermore, if conjectures about high productivity improvements are correct, this policy recommendation holds, even if we are uncertain about the existence of future generations.

The second paper, *Potential Contributions of Political Science to Environmental Economics*, by political scientists Jon Hovi, Arild Underdal and Hugh Ward focuses on theoretical frameworks and three core concepts as contributions of political science to environmental economics. The authors note that rational choice theory is the core framework in environmental economics, while political science is a much more diverse discipline in this respect. Nevertheless, the authors argue that the rational choice framework in environmental economics can sometimes be fruitfully supplemented, combined or even replaced by approaches that are frequently used in political science. Yet, the authors also observe that political science has benefited largely from incorporating ideas and approaches routinely applied in economics, such as game theory and other rational choice based approaches.

The three core concepts discussed are ideas, power and institutions. The authors define ideas as combinations of beliefs and values held by many individuals and argue that they

are influenced by social conformity. Moreover, ideas tend to fluctuate, even in the medium term. The alternation between ideologies, such as liberalism, conservatism and socialism, has important implications for the development of ideas. For instance, in the context of environmental policy it is instrumental in explaining why a certain issue can suddenly receive or lose attention, even when the underlying rational choice arguments remain rather constant over time.

The second core concept and theoretical building block is power. The authors explain that power is a function of interest (i.e. preference over outcomes) and control (over activities that determine these outcomes). They discuss power through organizations, power as a social construction and the actual impact of power. The authors furthermore distinguish between formal and informal power relationships and show that the latter do not require the former. This is illustrated by the case of Al Gore, who has substantial power in the global warming debate in spite of the fact that he has no formal power anymore.

The third core component is institutions. The authors argue that parallel to the development of new institutional economics, in political science three more or less independent approaches to institutions have been developed: rational choice institutionalism, which uses models based on instrumental rationality, strategic interaction, exogenous preferences, information, and equilibrium to explain behaviour; historical institutionalism, which uses the comparative historical approach to identify causal mechanisms underlying observed empirical patterns; and sociological institutionalism, which focuses on cultural determinants of institutions. The authors point out that institutions are a central theme in the international environmental agreements literature, in particular enforcement.

The third paper, *Social psychology and environmental economics: a new look at ex ante corrections of biased preference evaluation* by Nicolas Jacquemet, Alexander James, Stéphan Luchini and Jason Shogren, deals with the important topic of preference elicitation in environmental social science. It focuses in particular on the well-known issue of hypothetical bias, i.e. the tendency for stated willingness to pay for an environmental improvement to be systematically (rather than randomly) higher than the real willingness to pay, as a consequence of the hypothetical nature of the valuation scenario.

Concerning causes of hypothetical bias, the authors focus on the impacts of the social context on valuation, i.e. that some people are particularly influenced by others' opinions about them. They hypothesize that these people are relatively sensitive to framing effects and that their preferences are more context dependent than generally. The social psychological notion of social representation suggests that the accuracy of valuation can be increased if one can take respondents' degree of socialization, i.e. how 'social' they are, into account. The authors discuss ways of categorizing people in this respect.

Another cause of hypothetical bias follows from social isolation of respondents. In particular, while in-person interviews are often considered to be the preferred method of preference elicitation, inter alia because of the possibility to ask questions to (and get direct responses from) the interviewer, several studies have suggested that in-person surveys may increase the social pressure for responding in a pro-social or pro-environmental way, which would tend to bias responses.

The authors discuss various ways to reduce hypothetical bias, in particular the use of cheap talk scripts, which explain to the interviewee that respondents tend to exaggerate their willingness to pay. On the basis of a literature review and own recent experiments, they show that standard cheap talk scripts, which come down to simply informing interviewees about pro-social or pro-environmental behaviour and asking them not to exaggerate their responses, may not be sufficient to reduce hypothetical bias.

Next the authors describe stronger versions of cheap talk scripts. Drawing on the social psychological literature on commitment theory, they argue that a person is less likely to tell untruths, or behave inconsistently with previous statements, after a strong pledge. The authors discuss the use of a solemn *oath* as a truth-telling commitment device, which comes down to asking respondents to swear on their honour to give honest answers. They conclude that this type of commitment device appears promising.

The topic of the fourth paper, *Overreaction to Fearsome Risks*, by law professor Cass Sunstein and Richard Zeckhauser, is highly relevant to environmental social science since virtually all environmentally related decisions are risk related. The authors draw on availability heuristic theory, associated with psychologists Amos Tversky and Daniel Kahneman. This theory states that people tend to relate the likelihood that some event is going to occur to previous experience, particularly examples that they can bring to mind. Whether they will under- or overestimate the probability, and hence whether they will under- or over-react to the risk, will then clearly vary from case to case. Yet, the authors argue that for fearsome risks, i.e. risks that have low probability but lead to strong emotional responses because of fear of the possibility of extremely bad outcomes, people tend to overestimate the likelihood of the bad outcome and hence to exaggerate the benefits of preventive, risk-reducing, or ameliorative measures.

Next, the authors discuss probability neglect, i.e. the tendency to completely disregard probability when making a decision under uncertainty. They present a simple example of probability neglect relating to arsenic in water where the stated willingness to pay to eliminate the cancer risk did not vary, even for a 10-fold variation in risk. In another experiment they found that the willingness-to-accept price for a painful but non-dangerous electric shock did not change for probabilities varying between 1 and 100%. They explain probability neglect based on the evolution and functioning of the brain.

The authors argue that public policy and law tend to put too large a weight on catastrophic outcome/low probability events. They illustrate their claim with several environmental examples. The tendency is partly a consequence of vote-maximizing behaviour of politicians in response to biased voters' fears, and partly an effect of the policy makers' own availability bias. The authors conclude that society should sometimes invest in the reduction of fear itself, which would have both direct benefits, since fear itself is costly (in a well-being sense), and indirect benefits, since both private and public responses to fearsome risks would then be less irrational.

The fifth paper, *Social norms and behaviour in the local commons through the lens of field experiments* by Juan Camilo Cardenas, considers the role of social norms for cooperative behaviour in common property resource management. While the notion of social norms is a core concept in sociology, and to some extent also in psychology, economists have only recently begun to analyze various kinds of norms and their impacts. The author argues that thanks to the working of social norms, Hardin (1968) prediction in *Tragedy of the Commons* did not materialize in the case of thousands of areas around the globe that according to the World Database on Protected Areas deserve to be conserved. Without social norms, they would not have existed any longer.

To support his arguments, the author applies both lab and field experiments to study how institutions, social norms and behaviour interact to produce either tragedies or successes with respect to common pool resources. Based on a large sample of experimental sessions, he finds that individuals are prepared to forego material payoffs in order to comply with norms. This result can be used by external regulators or the own group to protect common-pool resources. The evidence in the paper also suggests that formal regulations may not solely act as direct deterrence mechanisms, through increased expected costs of violation, but also as normative

guidance that triggers existing social norms.²⁷ Hence, regulators and policy makers should more carefully pay attention to the interaction between formal regulations and social norms as elements of environmental policy.

The remaining two papers support the plea for improved empirical research. Moreover, they deal with space, which is an essential element of an environmental social science. The sixth paper, *Accounting for Spatial Effects in Economic Models of Land Use: Recent Developments and Challenges Ahead* by Michael Brady and Elena Irwin, discusses the increasing availability of spatial data and the opportunities that this kind of data offer for land use modelling. The authors argue that spatial research is basically multidisciplinary, with major contributions from inter alia regional science, geography and urban economics. They furthermore review the econometric challenges associated with spatial data analysis as well as spatial models and methods to analyze land markets and land use change. They point out several important areas of application including firm and household location choice modelling.

The seventh and final paper, *Local Transportation Policy and the Environment* by Armin Schmutzler, surveys environmental and welfare effects from urban transport regulation. It focuses in particular on public transportation subsidies, road pricing and driving restrictions. The author shows that subsidies for public transport can be effective at reducing automobile transportation and, to a somewhat lesser extent, pollution. The signs of the welfare effects are generally hard to determine, however.

Two types of driving restrictions are analyzed more thoroughly, i.e. 'days without cars' typically used in Latin America, and 'Low Emission Zones', which are frequently used in Europe. Both approaches share the potential for undesired side effects, which tend to be particularly large in the former case. Road pricing, on the other hand, has a large potential for cost-effective environmental improvement if properly designed. The problem of spatial diversion, i.e. that some road transport is simply moved to other, non-priced roads with unintended and often negative consequences, is found to exist, yet appears to be larger for long-distance freight transport than for local transport. However, actual experience with road pricing is still very limited. The author concludes that the most important problem with road pricing may be its limited public support.

This last paper illustrates our scepticism outlined above of the methodological ideal that empirical analysis should always be based on deductively derived hypotheses. Although this ideal tends to generate well defined and relatively simple models, their relevance for empirical research are limited when the subject of analysis is highly complex, as illustrated by the present case of identifying and measuring the consequences of different transport regulation systems in a far from ideal economic environment. A possible consequence of the empirical complexity is that the available literature on the effects of different kinds of transport regulation, in spite of its obvious relevance to actual transport management, is quite limited and fragmented. Hence, real-world problems rather than theoretical considerations should drive empirical analysis to a larger extent than presently is the case.

6 Conclusion

The founding fathers of economics, with Adam Smith in the lead, were broad social scientists who viewed the economy as a social subsystem embedded in society as a whole and intrinsically interrelated with the other social subsystems. Many of them also explicitly

²⁷ Observe that this is an example of a crowding-in mechanism that works in the opposite direction of the crowding-out mechanism discussed in Sect. 3.

acknowledged that economic behaviour is not merely driven by selfishness and narrowly defined material interests based on rationality and full information, but also by e.g. social concerns, reputation, and subject to limited cognitive capacity and rationality.

By early 1900, however, social science of that time split up in specializations and sub-specializations that have been growing further and further apart. Although the specializations within the social sciences and the specializations within each sub-discipline have led to the development of many important insights in each of the sub-disciplines, it has also led to fragmentation of theory, methodology and empirical research such that incomplete and occasionally distorted knowledge of social reality has been obtained. Recent developments, particularly the upswing of behavioural and institutional economics, which include many insights from psychology and sociology, and the increased interest in empirical analysis, indicate a reverse trend in the direction of convergence of the social sciences.

Environmental economics is a relatively new sub-discipline of economics that really took off in the 1960s. As such, it adopted the main models and methodology of mainstream economics at the time, i.e. the standard neoclassical model as the main school of thought and a practice to live with empirically untested theories and hypotheses in several important areas. Similar to the trends in general economics, there is growing interest in behavioural and institutional environmental economics as well as in application of experiments. Nevertheless, standard neoclassical economics is still the main school of thought, integration of behavioural and new institutional environmental economics proceeds relatively slowly, and there are still many relevant theoretical frameworks and methodologies in the sister social sciences that have not been explored or exploited.

The main conclusion of this paper is that more logical duels between competing theories and models, regardless of origin of discipline, and frequent interaction between theory and empirics in the environmental arena are needed to improve the explanatory power of environmental social science and its relevance for policymaking. For this purpose a variety of theories and empirical research methods, including large-scale surveys, experiments, interviews with key informants, observation and content analysis as well as their combinations are available. Proceeding along these roads may turn environmental economics from a follower in economics into a frontrunner in environmental social science. The papers included in this special issue constitute important steps in this direction.

References

- Aigner DJ, Goldberger AS (eds) (1977) *Latent variables in socio-economic models*. North Holland, Amsterdam
- Angrist JD, Pischke JS (2010) The credibility revolution in empirical economics: how better research design is taking the con out of econometrics. *J Econ Perspect* 24(2):3–30
- Ariely D, Loewenstein G, Prelec D (2003) Coherent arbitrariness: stable demand curves without stable preferences. *Quart J Econ* 118:73–105
- Armstrong M, Huck S (2010) Behavioral economics as applied to firms: a primer. CESIFO Working paper no. 2937
- Aronsson T, Johansson-Stenman O (2008) When the Joneses' consumption hurts: optimal public good provision and nonlinear income taxation. *J Public Econ* 92:986–997
- Ashraf N, Camerer CF, Loewenstein G (2005) Adam Smith, behavioral economist. *J Econ Perspect* 19:131–145
- Barde JP (2000) Environmental policy and policy instruments. In: Folmer H and Gabel HL (Eds) *Principles of environmental and resource economics*, Edwards Elgar, Cheltenham, pp 157–201
- Bateman I, Burgess D, Hutchinson G, Matthews D (2008) Learning design contingent valuation (LDCV): NOAA guidelines, preference learning and coherent arbitrariness. *J Environ Econ Manage* 55:127–141

- Bateman JJ, Day BH, Jones AP, Jude S (2009) Reducing gain-loss asymmetry: a virtual reality choice experiment valuing land use change. *J Environ Econ Manage* 58:106–118
- Bechetti L, Pelloni A, Rosetti F (2008) Relational goods, sociability and happiness. *Kyklos* 61(3):343–363
- Benabou R, Tirole J (2002) Self-confidence and personal motivation. *Quart J Econ* 117:871–915
- Bertrand M, Mullainathan S (2001) Do people mean what they say? Implications for subjective survey data. *Amer Econ Rev (Papers and Proceedings)* 91:67–72
- Bjerkholt O, Dupont A (eds) (1995) Foundations of modern econometrics, selected essays of Ragnar Frisch. Edward Elgar, Aldershot
- Bouma J, Bulte EH, van Soest DP (2008) Trust, trustworthiness and cooperation: social capital and community resource management. *J Environ Econ Manage* 56:155–166
- Bohm P (1972) Estimating demands for public goods: an experiment. *Europ Econ Rev* 3:111–130
- Bohm P (1979) Estimating willingness to pay: why and how? *Scand J Econ* 81:142–153
- Bohm P (2003) Experimental evaluations of policy instruments. In: Mäler KG, Vincent JR (eds) *Handbook of environmental economics*, vol 1. Elsevier, Amsterdam, pp 438–460
- Bohm P, Carlén B (1999) Emission quota trade among the few: laboratory evidence of joint implementation among committed countries. *Resour Energy Econ* 21:43–66
- Bohm P, Carlén B (2002) Cost-Effective approaches to attracting low-income countries to international emissions trading: theory and experiments. *Environ Resour Econ* 23(2):187–211
- Bolles EB (2004) Einstein defiant: genius versus genius in the quantum revolution. Joseph Henry Press, Washington, DC
- Borges BFJ, Knetsch JL (1998) Tests of market outcomes with asymmetric valuations of gains and losses: smaller gains, fewer trades and less value. *J Econ Behav Organ* 33:185–193
- Bowles S (1998) Endogenous preferences: the cultural consequences of markets and other economic institutions. *J Econ Lit* 36:75–111
- Brekke KA, Johansson-Stenman O (2008) The behavioral economics of climate change. *Oxf Rev Econ Pol* 24(2):280–297
- Brennan G, Buchanan JM (1985) The reason of rules. Constitutional political economy. Cambridge University Press, Cambridge
- Camerer C, Loewenstein G (2004) Behavioral economics: past, present, future. In: Camerer C, Loewenstein G, Rabin M (eds) *Advances in behavioral economics*. Princeton University Press, Princeton, pp 3–52
- Carlsson F (2010) Design of stated preference surveys: is there more to learn from behavioral economics. *Environ Resour Econ* 46:167–177
- Chang JB, Lusk J, Norwood FB (2009) How closely do hypothetical surveys and laboratory experiments predict field behavior?. *Amer J Agr Econ* 91(2):518–534
- Chay KY, Greenstone M (2003) The impact of air pollution on infant mortality: evidence from geographic variation in pollution shocks induced by a recession. *Quart J Econ* 118(3):1121–1167
- Chay KY, Greenstone M (2005) Does air quality matter? Evidence from the housing market. *J Polit Econ* 113(2):376–424
- Cummings RG, Taylor LO (2001) Experimental economics in natural resource and environmental management. In: Folmer H, Tietenberg T (eds) *The international yearbook of environ resource econ 2001/2002*. Edward Elgar, Cheltenham
- Cyert RM, March JG (1963) A behavioral theory of the firm. Prentice Hall, Endlewood Cliffs
- Davis DD, Holt CA (1993) *Experimental economics*. Princeton University Press, Princeton
- Deaton A (2010) Instruments, randomization, and learning about development. *J Econ Lit* 48(2):424–455
- de Groot, AD (1969) *Methodology: foundations of inference and research in the behavioral sciences* (translated from Dutch by Spiekerman JAA), Mouton, The Hague
- Dietz T, Ostrom E, Stern PC (2003) The struggle to govern the commons. *Science* 302:1907–1912
- Evensky J (2005) Adam Smith's theory of moral sentiments: on morals and why they matter to a liberal society of free people and free markets. *J Econ Perspect* 19:109–130
- Falk A, Heckman J (2009) Lab experiments are a major source of knowledge in the social sciences. *Science* 326(5952):535–538
- Fehr E, Fischbacher U (2006) The nature of human altruism. *Nature*, pp 785–791
- Fehr E, Schmidt K (2006) The economics of fairness, reciprocity and altruism—experimental evidence and new theories. In: Kolm SC, Ythier JM (eds) *Handbook of the economics of giving, reciprocity and altruism*, vol 1. Elsevier, North-Holland, Amsterdam, pp 615–691
- Fischbacher U, Gächter S (2010) Social preferences, beliefs, and the dynamics of free riding in public goods experiments. *Am Econ Rev* 100:541–556
- Folmer H (2009) Why sociology is better conditioned to explain economic behaviour than economics. *Kyklos* 62:258–274

- Folmer H, Oud J (2008) How to get rid of W: a linear structural equation approach to models with spatial dependence. *Environ Plan A* 40:2526–2538
- Forest LR, Stavins RN, Vietor RHK (2008) Corporate social responsibility through an economic lens. *Rev Environ Econ Policy* 2(2):219–239
- Frey BS (1997) Not just for the money. An economic theory of personal motivation. Edward Elgar, Brookfield
- Frey BS, Oberholzer-Gee F (1997) The costs of price incentives: an empirical analysis of motivation crowding out. *Am Econ Rev*, pp 746–755
- Ghate R, Jodha NS, Mukhopadhyay P (eds) (2008) Promise, trust, and evolution: managing the commons in South Asia. Oxford University Press, Oxford
- Gilbert CL (1986) Professor Hendry's econometric methodology. *Oxf Bull Econ Stat* 48:283–307
- Gilovitch T, Griffin D, Kahneman D (eds) (2002) Heuristics and biases: the psychology of intuitive judgement. Cambridge University Press, New York
- Gneezy U, Rustichini A (2000) Pay enough or don't pay at all. *Quart J Econ* 115(2):791–810
- Gneezy U, Rustichini A (2000) A fine is a price. *J Legal Stud* 29(1):1–17
- Gintis H (2009) The bounds of reason: game theory and the unification of the behavioral sciences. Princeton University Press, Princeton
- Greenstone M, Gallagher J (2008) Does hazardous waste matter? Evidence from the housing market and the superfund program. *Quart J Econ* 123:951–1003
- Greenstone M, Gayer T (2009) Quasi-experimental and experimental approaches to environmental economics. *J Environ Econ Manage* 57(1):21–44
- Greene WH (2003) *Econometric analysis*. Prentice Hall, Upper Saddle River
- Haavelmo T (1944) The probability approach in econometrics. *Econometrica* 12: 1-118
- Haavelmo T (1950) Remarks on Frisch's confluence analysis and its uses in econometrics. In: Koopman TC (ed) *Statistical inference in dynamic economic models*. Cowles commission monograph, 10. Wiley, New York
- Hardin G (1968) The tragedy of the commons. *Science* 162:1243–1248
- Harrison GW, List JA (2004) Field experiments. *J Econ Lit* 42:1009–1055
- Hayek FA (1937) Economics and knowledge. *Economica* 4:33–54
- Hendry DF, Ericsson NR (1991). Modeling the demand for narrow money in the United Kingdom and the United States. *European Economic Review* 35:833–886
- Hepburn C, Duncan S, Papachristodoulou A (2010) Behavioural economics, hyperbolic discounting and environmental policy. *Environ Resour Econ* 46(2):189–206
- Hicks JR (1951) *A contribution to the theory of trade cycle*. The Clarendon Press, Oxford
- Imbens GW (2010) Better LATE than nothing: some comments on Deaton (2009) and Heckman and Urzua (2009). *J Econ Lit* 48(2):399–423
- Joreskog KG, Sorbom D (1996) LISREL 8: user's reference guide. Scientific Software International, Chicago
- Johansson-Stenman O, Konow J (2010) Fair air: distributional justice and environmental economics. *Environ Resour Econ* 46:147–166
- Kahneman D (2003) Maps of bounded rationality. *Psychology for behavioral economics*. *Amer Econ Rev*, pp 1449–1475
- Kahneman D, Knetsch JL (1992) Valuing public goods: the purchase of moral satisfaction. *J Environ Econ Manage* 22(1):57–70
- Kahneman D, Ritov I, Schkade D (1999) Economic preferences or attitude expressions? An analysis of dollar responses to public issues. *J Risk Uncertain* 19:203–235
- Kim EH, Morse A, Zingales L (2006) What has mattered to economics since 1970. *J Econ Perspect* 20:189–202
- Knetsch JL (2000) Environmental valuation and standard theory. In: Tietenberg T, Folmer H (eds) *The international yearbook of environmental and resource economics 2000/2001*. Edward Elgar, Cheltenham
- Kreps DM (1990) *A course in microeconomic theory*. Princeton University Press, Princeton
- Krippendorff K (2004) *Content analysis, an introduction to its methodology*. Sage Publications, London
- Krugman P (1988) *Strategic trade policy and the new international economics*. MIT Press, Cambridge
- Krugman P (1994) The fall and rise of development economics. In: Rodwin L, Schön DA (eds) *Rethinking the development experience: essays provoked by the work of Albert O. Hirschman*. Brookings Institution, Washington, DC, pp 39–58
- Krugman P (2009) How did economists get it so wrong? *New York Times*, 20 Sept
- Krugman P (2010) British fashion victims. *International Herald Tribune*, 23–24 Oct
- Laibson D (1997) Golden eggs and hyperbolic discounting. *Q J Econ* 62(2):443–478
- Leamer EE (2010) Tantalus on the Road to Asymptopia. *J Econ Perspect* 24(2):31–46
- Levitt SD, List JA (2007) What do laboratory experiments measuring social preferences tell us about the real world?. *J Econ Perspect* 21(2):153–174

- Levitt SD, List JA (2009) Field experiments in economics: the past, the present, and the future. *Eur Econ Rev* 53(1):1–18
- Lindenberg S (1992) An extended theory of institutions and contractual discipline. *J Inst Theor Econ* 148(2):125–154
- Lindenberg S (1996) Choice-centred versus subject-centred theories in the social sciences: the influence of simplification on explananda. *Eur Sociol Rev* 12:147–157
- Lindenberg SM (2001a) Social rationality as a unified model of man (including bounded rationality). *J Manage Gov*, pp 239–251
- Lindenberg SM (2001b) Intrinsic motivation in a new light. *Kyklos* 54:317–342
- Lindenberg SM (2001c) Social rationality versus rational egoism. In: Turner JH (ed) *Handbook of sociological theory*. Kluwer, New York
- Lindenberg S, Frey B (1993) Alternatives, frames, and relative prices: a broader view of rational choice. *Acta Sociol* 36:191–205
- Lindenberg SM, Steg L (2007) Normative, gain and hedonic goal frames guiding environmental behavior. *J Soc Issues* 63(1):117–137
- List JA (2003) Does market experience eliminate market anomalies?. *Quart J Econ* 118(1):41–71
- List JA (ed) (2006) *Using Experimental methods in environ resource econ*. Edward Elgar, Cheltenham
- Loewenstein G (2007) *Exotic preferences: behavioural economics and human motivation*. Oxford University Press, Oxford
- Lusk J, Pruitt JR, Norwood B (2006) External validity of a framed field experiment. *Econ Lett* 93(2):285–290
- Messer KD, Poe GL, Rondeau D et al (2010) Exploring voting anomalies using a demand revealing random price voting mechanism. *J Public Econ* 94:308–317
- Morishima M (1984) The good and bad uses of mathematics. In: Wiles PJD, Routh G (eds) *Economics in disarray*. Basil Blackwell, Oxford
- Neuendorf KA (2002) *The content analysis guidebook*. Sage Publications, Thousand Oaks
- Nevo A, Whinston MD (2010) Taking the dogma out of econometrics: structural modeling and credible inference. *J Econ Perspect* 24(2):69–82
- North DC (1990) *Institutions, institutional change and economic performance*. Cambridge University Press, Cambridge
- Oppenheim AN (1992) *Questionnaire design, interviewing and attitude measurement*. Continuum, New York
- Ostrom E, Walker J, Gardner R (1992) Covenants with and without a sword: self governance is possible. *Amer Polit Sci Rev* 86:404–417
- Ostrom E (1990) *Governing the commons: the evolution of institutions for collective action*. Cambridge University Press, New York
- Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. *Science* 325:419–422
- Patton MQ (2005) *Qualitative research*. Wiley, New York
- Pearce D (2002) An intellectual history of environmental economics. *Annual Review of Energy Environ* 27:57–81
- Pearson K (2007) *The grammar of science*. Cosimo, New York
- Pigou A (1920) *The economics of welfare*. Macmillan, London
- Plott CR, Zeiler K (2005) The willingness to pay–willingness to accept gap, the ‘endowment effect’, subject misconceptions, and experimental procedures for eliciting valuations. *Amer Econ Rev* 95:530–545
- Popper KR (1963) *Conjectures and refutations: the growth of scientific knowledge*. Routledge, London
- Popper KR (1974) *The logic of scientific discovery*. Routledge, London
- Popper KR (1994) *All life is problem solving*. Routledge, London
- Presser S, Cuoper MP, Lessler JT et al (2004) Methods for testing and evaluation survey questions. *Pub Opin Quart* 68(1):109–130
- Sen AK (1973) Behavior and the Concept of Preference. *Economica* 40:241–259
- Sen AK (1987) *On Ethics and economics*. Basil Blackwell, Oxford
- Sen AK (2008) The discipline of economics. *Economica* 75:617–628
- Saris WE, Gallhofer IN (2007) *Design, evaluation, and analysis of questionnaires for survey research*. Wiley, New York
- Saris W, Stronkhorst H (1984) *Causal modelling in nonexperiential research: An introduction to the LISREL approach*. Sociometric Research Foundation, Amsterdam.
- Shogren JF, Taylor L (2008) On behavioral environmental economics. *Rev Environ Econ Policy* 2:26–44
- Shogren JF, Fox JA, Hayes DJ et al (1999) Observed for food safety in retail, survey, and auction markets. *Amer J Agr Econ* 81(5):1192–1199
- Simon H (1957) *Models of man, Social and rational*. Wiley, New York
- Smith VK (2007) Reflections on the literature. *Rev Environ Econ Policy* 1:300–318

- Smith V, Suchanek GL, Williams AW (1988) Bubbles, crashes, and endogenous expectations in experimental spot asset markets. *Econometrica* 56:1110–1151
- Stokman FN, Van Assen MALM, Van der Knoop J, Van Oosten RCH (2000) Strategic decision making. *Adv Group Process* 17:131–153
- Tarde G (1898) *Les Loies Sociales*. Pempecheurs de Penser en Rond/Institut Synthélabo, Paris
- Vatn A, Bromley DW (1994) Choices without prices without apologies. *J Environ Econ Manage*, pp 126–148
- Weck-Hahnemann H, Frey BS (1995) Are incentive instruments as good as economists believe? Some new considerations. In: Bovenberg AL, Cnossen S (eds) *Public finance and the environment in an imperfect world*. Kluwer, Dordrecht
- Wendner R, Goulder LH (2008) Status Effects, public goods provision, and the excess burden. *J Public Econ* 92:1968–1985
- Williamson OE (1975) *Markets and hierarchies, analysis and antitrust implications*. Free Press, New York
- Williamson OE (2000) The new institutional economics: taking stock, looking ahead. *J Econ Lit* 38:595–613