



## Methodological and Ideological Options

## New foundations for ecological economics

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## ABSTRACT

Ecological economics has been repeatedly described as transdisciplinary and open to including everything from positivism to relativism. I argue for a revision and rejection of this position in favour of realism and reasoned critique. Looking into the ontological presuppositions and considering an epistemology appropriate for ecological economics to meaningfully exist requires rejecting the form of methodological pluralism which has been advocated since the start of this journal. This means being clear about the differences in our worldview (or paradigm) from others and being aware of the substantive failures of orthodox economics in addressing reality. This paper argues for a fundamental review of the basis upon which ecological economics has been founded and in so doing seeks improved clarity as to the competing and complementary epistemologies and methodologies. In part this requires establishing serious interdisciplinary research to replace superficial transdisciplinary rhetoric. The argument places the future of ecological economics firmly amongst heterodox economic schools of thought and in ideological opposition to those supporting the existing institutional structures perpetuating a false reality of the world's social, environmental and economic systems and their operation.

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## 1. Introduction

Early on, in the modern history of ecological economics, both [Costanza \(1996\)](#) and [Daly \(1991\)](#) appealed directly to Schumpeter's preanalytic approach as something which should inform the new movement, and in so doing both quoted the same paragraph of his *History of Economic Analysis* ([Schumpeter, 1994 \[1954\]](#): 42, paragraph two). This shows early recognition of the need to clarify what is ontologically different about ecological economics and where its key concerns might lie. However, the project seems to have stalled at birth as no distinct set of coherent phenomena appeared, nor currently can be readily identified, as forming the basis of our analytical efforts. This seems to be due to the readiness to accept diversity at the cost of coherence, but more generally, to the lack of theoretical underpinning provided after the initial establishment of the society and journal.

In the first issue of this journal, ecological economics was defined by [Costanza \(1989: 1\)](#) as including neoclassical environmental economics and ecological impact studies, as well as encouraging new ways of thinking. The name was taken to signify an "interdisciplinary, and holistic view", although soon [Costanza \(1991, 1996\)](#) strongly advocated

transdisciplinarity. The journal was stated to be pursuing "a strategy of pluralism", which was left for definition, in that first issue, by [Norgaard \(1989\)](#) under the title of "methodological pluralism". That article remains one of the few attempts to explore the philosophy of science behind ecological economics. Norgaard discussed a specific form of positivist epistemology in economics and ecology and concluded this could neither be accepted as 'the' way ahead, due to its flaws, nor rejected, due to the practical consideration of its dominance in economics. I will question this argument and conclusion while clarifying the role and meaning of positivism. I will also argue against the all encompassing pluralism which has been advocated ever since, not least because of the resulting incoherence and brushing over of fundamental conflicts between different worldviews and the need to question the validity of those views in light of reality.

The first introductory book ([Costanza et al., 1998](#)), by leading American figures in the society, maintained an uneasy balance between requesting a new worldview, to address our social and environmental woes, and not ejecting the body of orthodox thinking. Daly, as a co-author of that book, appears to have later developed a seemingly more radical position. The introductory textbook by [Daly and Farley \(2004\)](#) invokes the concepts of both a new preanalytic vision for economics and a Kuhnian revolutionary change. At one point Daly and Farley propose rejection of a value basis in subjective preferences and deride pluralism. They state: "we must have a dogmatic belief in objective value, an objective hierarchy of ends ordered with reference to

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some concept of ultimate end” (Daly and Farley, 2004: 42).<sup>1</sup> However, this lacks explanation and, elsewhere, they call upon what they have attacked (e.g. marginal analysis, utilitarian explanations, mainstream models and concepts), and are happy to endorse tradable permit markets as consistent with ecological economic principles. Their main message is then that scale and distribution must be addressed prior to the pursuit of efficiency. The other main introductory text has no revolutionary claims to make but rather falls back on standard orthodox economic theory and methodology (Common and Stagl, 2005). This includes using the same philosophy of science (a form of logical empiricism) and ethical theory (utilitarianism) as associated with neoclassical economics. Such a position seems to ally ecological economics closely with mainstream environmental and resource economics. On the basis of such books, perhaps we should not then be surprised by Ehrlich (2008: 1) stating that he regards environmental and resource economics as identical to ecological economics, or that the *Journal of Economic Literature* classifies ecological economics under “Q5—Environmental Economics”.<sup>2</sup>

Such misclassifications are possible because ecological economists have not themselves made a sufficient stand as to where the differences lie. A keyword search of this journal covering 3402 articles gives one result for ontology (Baumgartner and Quaas, 2010), and four for epistemology (Baumgartner et al., 2001; Bromley, 2008; Mayumi, 1997; O'Connor, 2000). Lack of attention to the theoretical foundations of ecological economics has left it in a precarious and epistemologically confused position. Faber (2008: 4), in bemoaning the fragility of ecological economics, states: “a generally accepted theoretical framework or methodology has yet to be defined”. Similarly, Röpke (2005) has argued that the knowledge base is not well structured nor systematically organised, and that the identity of the field is weak. The conflict between a proposed new outlook and reliance on existing economic theory and methods leaves authors visibly struggling in their attempts to reconcile the differences.

The contention of this paper is that ecological economics requires solid foundations in the philosophy of science to clarify how natural and social sciences can cooperate and the extent to which they can combine in a way which meaningfully advances knowledge. Ecological economics must clarify its position on such issues as the use of mathematical formalism, the role of empiricism and the meaning of pluralism. A distinct and radical synthesis is called for in order to establish new foundations. This can be seen as relating to various calls for developing a preanalytic vision (Costanza, 1996; Costanza et al., 1998; Daly, 1991; Daly and Farley, 2004; Munda, 1997; Özkaynak et al., 2002). In doing so, we should not be afraid to articulate our ideological positions (Söderbaum, 1999). Indeed, as Schumpeter (1994 [1954]) explained, this is to be expected in the formation of a new or innovative development in economic thought.

In conducting this discussion I hope to be more precise than the seminal paper by Norgaard (1989) because he confuses, fails to address or fails to clarify the differences between ontology, epistemology and methodology, between methodological and value pluralism, and between diversity in methods as opposed to methodologies. Epistemology (from the Greek *episteme*, meaning knowledge) concerns the theoretical basis on which we create understanding of the world. This involves theories about the origin and limits of knowledge. It describes how we can form knowledge about the world and what is the meaning of truly knowing something. What comes prior to how we can know is the metaphysical (ontological) question of what exists, and so what are

the primary entities of concern in any given field, and what are their most general features and relationships. What comes after is methodology. The tools of scientific investigation form the methods and the term method should not be confused with or used as shorthand for methodology (as is too often done). Methodology concerns the principles that determine how such tools are deployed and interpreted. Methodology is used in two senses referring to (i) the principles and practices that underlie research in a discipline or subject area, and (ii) the appropriateness of the methods. This requires general principles about the formation of knowledge in practice and so becomes interrelated with the theory of knowledge (i.e., epistemology); in economics, methodology is often used as synonymous with epistemology. Overall we can simplify the philosophy of science as a progression from ontology to epistemology to methodology to methods.

This paper does not pretend to be definitive but rather aims to provide some theoretical reflections about the type of ontology, epistemology and methodology which appear most suited to such an interdisciplinary enterprise as ecological economics. Next, in Section 2, the background to epistemological confusion in ecological economics is explained as deriving from a misinterpretation of logical empiricism and its role in economics. This has led to arguments simultaneously attacking positivism in general while arguing for its inclusion alongside conflicting epistemologies under a supposed pluralism. Understanding this confusion requires placing positivism and logical empiricism in context and explaining the development of the latter and its role in economics. This also provides some introduction to key aspects of an empirical epistemology which should inform ecological economics. Section 3 follows this discussion with the case against the existing form of methodological pluralism in ecological economics. Section 4 moves on to explore the concept and meaning of a preanalytic vision and pursues this in the context of refining an ontology and epistemology for ecological economics. Section 5 brings the discussion together via a set of tentative propositions on ontology, epistemology, methodology and ideology. The overall aim is to initiate a debate within ecological economics as to its meaning and future direction.

## 2. Epistemology in Science and Economics: Positivism and Logical Empiricism

In economics, standard undergraduate texts start by distinguishing positive (value free) economics from the normative (value laden); the is/ought dichotomy going back to Hume. The former is generally regarded as the ‘scientific’ branch, and the division is one which claims facts are separable from values. Furthermore, the implication is that positive economics can establish causal relationships as true in an objective sense, i.e. which nobody could logically deny.

Norgaard (1989: 51) has argued that ecological economics should include the dominant methodology in economics, which he believes is logical positivism. He claims that adopting an alternative would exclude “nearly all of economics”. Simultaneously, he is highly critical of the approach and advocates a conflicting historical descriptive methodology, with reference to the German historical school.<sup>3</sup> More recently, Söderbaum (2011: 1019) has stated that “there will certainly be a role for positivism also in the future”, although he then proposes social constructivism and hermeneutics, as better able to aid our understanding of sustainability policy. These types of ‘pluralist’ proposals leave unanswered how such divergent and conflicting approaches are to be made compatible. The implication is that ecological economics needs positivism, even if supplemented, but what exactly is being recommended?

<sup>1</sup> This position is left rather unexplained with merely a reference to a book by C. S. Lewis, the Christian apologist. God is mentioned as a possible ultimate end and so source of objective value. There then almost seems to be an implicit appeal to Natural Law behind this.

<sup>2</sup> The more specific entry is “Q57—Ecological Economics: Ecosystem Services; Biodiversity Conservation; Bioeconomics; Industrial Ecology”.

<sup>3</sup> For a brief overview of the historical school see Sandelin et al. (2008: 64–78).

## 2.1. Positivism and Logical Empiricism

Positivism was a product of the Enlightenment, founded as a system of thought by Auguste Comte (1798–1857) after having been secretary to Henri de Saint-Simon (1760–1825) and a student at the École Polytechnique (from 1814 to 1816) at the time of teachers such as Pierre-Simon Laplace (1749–1827). Comte's positivism did not separate philosophy of science from political philosophy (Bourdeau, 2011). However, during the 19th Century positivism developed away from its originator's ideas and became associated with an objective non-political foundation for science on the basis of using observation. Observation as a personal experience also connects positivism with the earlier philosophy of David Hume (1711–1776) and his empiricism (i.e. use of the senses). Scientific positivism combined with mechanism can be seen as having informed some basic positions in mainstream economics. Norgaard (1987, 1994b) has been highly critical of such 19th Century thought and its attributes—universalism, atomism, monism—and like Georgescu-Roegen (2009 [1979]) has rejected a mechanistic epistemology in economics on what amount to realist and ontological grounds.

In the 20th Century logical empiricism arose in response to new developments in physics. This distinct development was a modernist movement combining a logical analytical approach for framing propositions about the world with the requirement for empirical testing of those propositions. Logical empiricism was strongly developed in Austria and Germany, during the 1920s and 1930s, and most notably advanced by the scholars of the Vienna Circle (see Appendix A), before spreading more widely and dominating philosophy of science over several decades. Some, especially economists, refer to this as logical positivism, although this terminology was little used by the Circle and tends to represent a specific narrow characterisation (Uebel, 2011). The term logical empiricism is more general and inclusive (Creath, 2011). Unfortunately Norgaard's (1989) coverage skips past 20th Century debates and developments in logical empiricism and is inaccurate in several respects.<sup>4</sup> He follows the modern tendency to deride logical empiricism as imposing a narrow dogmatism as to proper scientific conduct.

Characterisation of logical empiricism as a united, anti-pluralist school of thought is certainly misleading. There were important divisions within the movement and substantive changes in positions over time.<sup>5</sup> Various forms of pluralism were also present in the ideas of key members.<sup>6</sup> Clearly ecological economics is in part an empirically based body of knowledge and cannot ignore the form and meaning of observational investigation which it accepts as valid or the role it attributes to scientific investigation. So learning from logical empiricism seems important. Key common aspects of the approach were a rejection of metaphysics, unifying science, and establishing a criterion of validity and a scientific methodology. Each is addressed in turn.

Logical empiricism is associated with an approach which rejected metaphysics (e.g. ontology) as unscientific. Logically metaphysics was deemed meaningless for creating scientific knowledge because it did not conform to experimental verification. For the left wing of the Circle rejection of metaphysics was also politically driven, because the totalitarianism of the time made use of pseudo-scientific claims which they

felt scientific truth seeking could expose and avoid (Creath, 2011). Unscientific metaphysical ways of thinking were regarded as entrapping people in anti-Semitism, racial hatred, sexism, homophobia and so on. Articulating and defending a scientific worldview was then both an academic position and a political act aimed at social reform and emancipation.

From the logical analytical perspective a stress on observability led to a unity of science position. Some took this to mean that all knowledge about nature could be expressed in a single language. However, for those on the Circle's left wing, this also had a political pluralist and social reformist character because empiricism would reveal grounds for reasonable disagreement and absence of dominant solutions; unity of science could then be linked to improved communication and public participation (O'Neill, 2003). It also related to internationalism as an aim of Marxism. In this way the logical and analytical advances being made were complementary to a socialist political agenda. At the same time theoretical advances in analytical philosophy could be made independently of this political agenda.

On the Circle's analytical agenda were the grounds for validating a proposition as true. Some logical empiricists, following Ernst Mach, argued for complete verification by observational evidence as the criterion of validity.<sup>7</sup> Verifiability proved problematic because it rules out as meaningless certain statements of universal form, which are often used in the specification of general scientific laws, as not being conclusively verifiable. One exception could falsify them, and no number of confirming instances can guarantee that such an exception will never be found (e.g. all Swans are white until you observe a black one). Such criticism is often associated with Karl Popper, although self-criticism was prevalent within the Circle. Popper regarded the idea of consciously and constantly trying to falsify a hypothesis as the essence of the scientific methodology for establishing provisionally true laws. However, as Popper later realised, falsification also proves problematic for a number of reasons (see Caldwell, 1991).

One alternative to both verifiability and falsifiability is 'confirmability'. Confidence that a test accurately confirms, or disconfirms, a hypothesis requires that initial test conditions and auxiliary hypotheses should be finite in number, empirically specifiable, technologically realisable and met. These conditions are virtually impossible to fulfil, especially in the social sciences. As Caldwell (1980: 65) notes: "Thus, paradoxically, a number of auxiliary hypotheses may be implicit in any test situation, but their presence can go undetected until they fail to hold". The role and importance of auxiliary concepts were recognised early on in the Circle by Otto Neurath and Philipp Frank (O'Neill and Uebel, 2004: 91). Their presence implies that choice between competing hypothesis cannot be made on purely logical or empirical grounds. Neurath in particular wrote on the conditional nature of all science and the sociological dimensions of the acceptance of knowledge claims (Uebel, 1996: 92).

Another contested area was the allowance of non-observable phenomena, and so metaphysics. Rejection of metaphysical concepts means being unable to address statements which make reference to non-observable theoretical entities (e.g. at the time atoms). Yet science posits the existence of such things. One solution is then to only test systems of thought, while allowing non-observables as part of such systems. More formally, the structure of a theory (a hypothetico-deductive system) contains axioms (primitives) which may refer to non-observable entities and theorems (derivatives). All terms gain meaningfulness to the extent that the theory as a whole is confirmed, usually by checking the derivative theorems (or predictions) against evidence.

The overall development of logical empiricism has elements which space precludes covering (e.g. the role of probability), and it contained diverse opinions. However, some significant aspects of a

<sup>4</sup> For example, the claim that logical positivism has been dominant in science for several centuries conflates it with earlier forms of positivism. The statement that it employs falsification as a criterion of validity is incorrect, as discussed below. Also the approach is not, as he claims, an active research area today, nor even a dominant epistemology in philosophy of science.

<sup>5</sup> Caldwell (1980; 1994) has provided influential, detailed accounts but ones that are misleading in representing the Circle as a unified and stable movement. This neglects the divisions between the left and right wings of the Circle. Recognising this division is potentially important for ecological economics (O'Neill, 2004). Note, Caldwell has strong sympathies with Hayek, a free market liberal and Austrian economist. Hayek opposed and attacked Neurath in the debate over the need for non-monetary measures in economic choice—the socialist calculation debate.

<sup>6</sup> Carnap is noted to have defended logical and methodological pluralism (Creath, 2011), and Neurath in addition political and social pluralism (O'Neill, 2003).

<sup>7</sup> Interestingly Common and Stagl (2005) support a verificationist account of knowledge acquisition with a fact based (value free) objective economic science seeking to determine what is true from what is false.

main synthesis of its mature formulation might be summarised as follows. First, individual statements contained in a theory were not to be tested separately; rather, an entire theory was to be tested to see if its observable deduced consequences corresponded to reality. Second, confirmability became the criterion of cognitive significance. Third, there was no need to worry about whether theoretical terms made reference to real entities (the realist-instrumentalist controversy); what counted was whether the hypotheses which contained them could be confirmed. Yet, even this formulation of logical empiricism faces serious problems. There exists no sharp distinction between what is observable and what is not. Thus, any observation requires both selection and interpretation by the observer and theory may become intertwined with fact (Caldwell, 1980). The objectivity of science can then be challenged, and this line of reasoning supports a postmodern critique leading to the belief that all reality is relative to the observer (relativism).

However, Neurath for one was aware of such failings and came to reject all three standard accounts of scientific methodology—falsification, induction and confirmation. He recognised that choice enters at various levels in framing any test for compatibility between a hypothesis-system and the data/facts. Systematically different choices lead to different systems of understanding. Neurath therefore came to believe that no datum could falsify a system of hypotheses, they could only shake one's confidence in it. He accepted that additional social and political criteria were necessary to judge between competing hypotheses (Cartwright and Cat, 1996: 84–85).<sup>8</sup>

In summary, logical empiricism evolved as a distinct approach to scientific understanding which strongly diverged from 19th Century positivism. There were competing forms of logical empiricism and distinct groupings within the Vienna Circle. Common derogatory characterisation is a misrepresentation of diversity and self-criticism within the Circle.<sup>9</sup> This brief overview should make clear that logical empiricism cannot be easily dismissed and certainly not on the basis of simplified caricatures. It was responsible for many advances in epistemology. At the same time the empiricism of ecological economics must be aware of the pitfalls logical empiricism exposed and cannot simply follow mainstream economics. In actual fact, what form of epistemology—19th Century positivism, a form of logical empiricism or something else—is extant in economics today is far from clear, as will be explained next.

## 2.2. Epistemology in Economics

Hutchinson (1938) has been attributed with first introducing a form of logical empiricism into economics (Caldwell, 1980). The desire for economics to be a science, in the mode of physics, meant that the rhetoric of logical empiricism spread even if its actual practice did not. Elements of this persist today. The promise of empirical testing explains why experimental approaches have been on the rise. The belief in observation, as a key to finding the truth, supports the popularity of behavioural theories (e.g. if things such as emotions cannot be observed they are inappropriate subjects for scientific investigation). Yet logical empiricism is far from having dominated economics in practice.

Indeed, there has been much variety in economics concerning both empirical practice and the appropriate epistemological approach. There is Friedman's (1953) widely cited, but muddled and confused (Pheby, 1988: 88), essay in which he advocates the primacy of prediction in testing theories and denigrates the role of explanation. There is

<sup>8</sup> Neurath's work directly informed the development of the sociology of science. For example, Howard (2000: footnote 29) references the acknowledgment of Neurath by Quine.

<sup>9</sup> Similarly, Caldwell (1980) has added to this caricature by relying on the analytical philosophical ideas of the exiles in America (e.g. Carnap) to the exclusion of competing ideas. In this respect, account must be taken of the influence McCarthyism had on science-policy in the USA and in restricting the political engagement of the exiles work (see Appendix A).

the early 1960s discussion of this, in the *American Economic Review*, where Samuelson attacked Friedman and others. Caldwell (1980: 70) describes Samuelson's contribution as "advocacy of the nineteenth-century view of explanation" with regards to positivism, and notes that this "obfuscated all intelligible discussion" in economic methodology for decades.

This neglect of epistemology undoubtedly led to further mixed practices and was not reversed until the 1980s. At this time Blaug (1980) attacked the prevalence of verification as opposed to falsification in economics, although what he described as "measurement without theory" hardly conformed to a verifiability principle. He noted the state of affairs as follows:

"The journals abound with papers that apply regression analysis to every conceivable economic problem, but it is no secret that success in such endeavours frequently relies on "cookbook econometrics": express a hypothesis in terms of an equation, estimate a variety of forms for that equation, select the best fit, discard the rest, and then adjust the theoretical arguments to rationalise the hypothesis that is being tested" (Blaug, 1980: 256–257).

This shows employment of auxiliary hypotheses at its worst. A situation which appears unchanged.

This pseudo-logical empiricist approach is today backed-up by claims of rigour in theorising based on the ever increasing reliance on mathematical formalism. This monist method also makes for monist methodology by discouraging variety (Dow, 2007). Yet, McCloskey (1983: 484) has described the 'official' methodological approach as combining "an amalgam of logical positivism, behaviorism, operationalism, and the hypothetico-deductive model of science". While the 'official' discourse conforms to formalism, in terms of a particular range of mathematical techniques for formulating theory and assessing evidence, every day practice relies on a much wider range of approaches to argumentation. She has therefore put forward the case for economics being nothing more than rhetoric, and proposed that it adopts serious study of this form of reasoning and persuasion as its methodological approach.

In contrast, Blaug (1980) has argued for the adoption of a falsification approach he attributes to Popper. His formulation introduces a highly prescriptive epistemological principle which instructs how science should be conducted, and provides rules for the demarcation of what counts as science (or in this case economics). Thus, proposing axioms which are claimed to be true but cannot be falsified is deemed unscientific. Note that this criticism of making infallible claims would apply to Daly and Farley (2004) who recognise that they are being dogmatic in their assertion of objective hierarchical values and an unknowable ultimate end. Of course this is also how prescriptive criteria are used to dismiss alternative modes of thought.

Falsification is actually hard to achieve in a social science such as economics and suffers various problems, which Popper himself recognised as relevant even for the natural sciences. Bromley (2008: 8), writing in *Ecological Economics*, has incorrectly criticised Popper in this regard. The American Pragmatist approach advocated by Bromley (2008: 9) argues for criticism, which he refers to as "a gauntlet of hostile challenges".<sup>10</sup> Popper himself advocated 'critical rationalism' as

<sup>10</sup> I follow the convention used by Norton (2011) and Callicott et al. (2011) of using a capital 'P' for this philosophical school and a lower case 'p' if referring to pragmatism in common usage (i.e., dealing with things in a way that is based upon practical rather than theoretical considerations). Being, lower case, pragmatic is then regarded as being practical about how best to proceed or what to hold as true. Philosophical, capitalised, Pragmatism is an approach that assesses the truth of beliefs in terms of their practical and instrumental applicability. There is much variety and dispute within Pragmatism. While Bromley is a self proclaimed American Pragmatist, the likes of Norgaard and Costanza can be regarded as being pragmatic in common terminology. Elsewhere I have used the later form in the term "new environmental pragmatism" to characterise the pragmatic turn in environmentalism and ecological economics (Spash, 2009c).

underpinning his use of falsification as a principle, and in later life developed his ontology to recognise the prevalence of complex open systems and differences between physical and social reality (Lawson, 2008). Critical rationalism argues for sometimes evaluating a theory on strict empirical falsification grounds, but allows at other times, especially for the social sciences, for criticising a theory by applying logic or other methods. This opens the door for metaphysical theories as long as they can be rationally criticised, although the form and role of criticism then become contentious (Caldwell, 1991).

In this regard, an interesting development is the introduction of critical realism to economics (Archer et al., 1998; Fleetwood, 1999; Lawson, 1997). This posits the existence of an objective reality that is knowable and can be described, whilst accepting that all knowledge claims are fallible. Critical realists have pointed out that economics hides and avoids discussing its ontology and, in fact, assumes one implicitly in its epistemology (the epistemic fallacy).<sup>11</sup> In addition, they note that failing to address the nature of existence and assuming event regularities, which rarely occur in the social realm, means that economic forecasters (econometricians) cannot forecast accurately, and economic theorists using deduction are unable to illuminate us. Critical realists in economics conclude that social explanation is possible but only if we move away from the deductivist methodology. As Lawson (1997: 36), a major advocate, states: “Specifically, social explanation, appropriately conceived, is not the attempted deduction of events from sets of individual conditions and constant-conjunction ‘laws’, but identification and illumination of structures and/or mechanisms responsible for producing, or facilitating, social phenomena of interest.”

So within economics there is actually methodological diversity and some recognition of the necessity for reasoned critique. This is hard to discern because the mainstream appears highly prescriptive and restrictive in its ever increasing reliance on mathematical formalism as a monist methodology. In practice there is mixed application of and attention to the strictures of empiricism, and substantive variety in methodology across schools of economic thought. Post Keynesians, neo-Marxists, critical institutionalists and feminists each have a somewhat different approach. Within each school there may be reliance on a range of different methods on the grounds that no one method is sufficient, something Dow (2007) refers to as pluralist methodology (not to be confused with methodological pluralism). She notes that these methods must be incommensurate, otherwise they would collapse into one method. Explicit adoption of this type of methodology typifies heterodox economics. The question for ecological economics is then on what grounds it should remain open to various methodologies, including those advocated by mainstream economists.

### 3. The Case Against Methodological Pluralism

Transdisciplinarity and methodological pluralism have been taken as core ideas by many in ecological economics, but with the apparent result that serious attention to theoretical contradiction has been lacking. At the core of Norgaard’s argument for methodological pluralism is his belief that “a diversity of methodologies is appropriate and pressures to eliminate methodologies for the sake of conformity should be avoided” (1989: 37). However, this is an argument against prescriptive epistemology not the elimination of some methodologies per se. Intellectual progress requires understanding built-on deciding what contributes to knowledge or, as Norgaard (1989: 38) admits, “the intellectual environment we create to sort the good from the bad”. He is highly critical of specific epistemological features—unity

of science, universal laws, independence of reality from observer and culture—and he clearly favours their rejection from any epistemology for ecological economics (see also Norgaard, 1994a). Furthermore, Norgaard (1989: 38) explicitly criticises both ecologists and economists for their adherence to such a prescriptive methodology as “logical positivism”, and states he is in “opposition to this long-standing belief in a right way of knowing and precise prediction”. Of course in doing so he is unwittingly offering another “right way of knowing”. In any case, his point does not seem to be that all methodologies can be regarded as equally valid or acceptable.

Yet, Norgaard (1989: 44) then claims that: “In fact, few scientists study methodology or make their beliefs explicit. Individual scientists, and eventually whole disciplines, succeed by being pragmatic”. Later he concludes that “logical positivism is inappropriate but necessary”, and it is necessary “because modern people perceive science in terms of objective, universal truths” (Norgaard, 1989: 51).<sup>12</sup> So ecological economists must apparently accept arguing on the same grounds! This amounts to recommending methodology on the basis of presumed popularity and fails to address the critical epistemological concerns and realist arguments he himself has raised.

Despite this poor foundation, the idea of an uncritical pluralism has spread within ecological economics and been promoted at the highest levels. Ecological economists Costanza, Perrings and Cleveland represent between them two former editors of the journal and two former international society presidents. In their combined opinion: “Ecological economics is necessarily eclectic and pluralistic. It is therefore difficult to pin down and summarize” (Costanza et al., 1997: xiii). Acceptance of this as the natural order of things seems to condemn ecological economics to ultimate irrelevance. As Dow (2007: 448) states “unstructured pluralism or eclecticism, understood as an absence of selection criteria, or “anything goes”, is antithetical to the building up of knowledge”. In addition, a belief in some objective reality (as opposed to a strong social constructivist position) adds further restrictions. As Dow (2007: 455) goes on to remark: “There is a limit to how far there can be plurality of understandings of the nature of reality, approaches to knowledge, and meaning, when knowledge needs to be developed within groups of researchers and communicated to others. Plurality in practice cannot be infinite.”

The need to save ecological economics from an “arbitrary openness to just everything” is recognised by Baumgartner et al. (2008). Although their discussion still claims an epistemological plurality to support plurality in the use of methods. Besides being unnecessary, there is a problem in proposing multiple epistemologies without any synthesis. This is the simple impossibility of simultaneously holding two (or more?) contradictory ways of understand the meaning of knowledge. Indeed, under epistemology, they actually end-up arguing for a social constructivist position, although without making clear if this is strong or weak.<sup>13</sup> They also state the need for a unified methodological basis which needs to be consistent with and systematically directed towards the subject matter and aims of ecological economics (Baumgartner et al., 2008). Some of their suggestions in

<sup>12</sup> Other arguments he puts forward concern plural methods not variety in methodology, and as a result confuse different conceptual levels and do not support accepting a plurality of methodologies. Methods should be in-line with epistemological understanding and can therefore be inclusive of considerable variety if this is appropriate to the theory of knowledge creation being pursued. In addition, his arguments confuse methodological pluralism with value pluralism. Rejecting the former does not necessitate losing the latter and so value pluralism can exist independently of the position on methodological pluralism.

<sup>13</sup> Those who view scientific facts as social constructions deny that the goal of science is to find facts. As Steup (2010) explains: “Such constructivism, if weak, asserts the epistemological claim that scientific theories are laden with social, cultural, and historical presuppositions and biases; if strong, it asserts the metaphysical claim that truth and reality are themselves socially constructed.”

<sup>11</sup> Similarly, while logical empiricists of the Vienna Circle denied the meaningfulness of ontological questions, in scientific enquiry, they in fact started from a basis in the preoccupations of physicists and mathematicians; so their view of reality appears implicitly based upon some specific ontological preconditions.

this area are potentially progressive.<sup>14</sup> However, they seem to fall foul of the epistemic fallacy, never address the ontological foundations of ecological economics and so miss the opportunity to provide some foundational basis for the argument. Yet the thrust of their position is clearly that structuring epistemology and methodology in ecological economics is necessary for progress.

Dow (2007) argues for “structured pluralism” which she sees as the need for structured methodological approaches within schools of thought and communication across them. This is basically the same approach as proposed much earlier in the context of environmental economics and policy by Söderbaum (1990) under the title of “paradigmatic pluralism”. Like Norgaard, whom he cites, Söderbaum wants to be inclusive, even of mainstream economists’ ideas, but this tolerance rather conflicts with his assessment of their school of thought and its mode of operation. His arguments for being open-minded and respectful of others’ ideas are clear enough, but why then include ideas regarded as creating intolerance and submit to the institutions spreading those ideas? In this regard the mainstream of economics appears as the antithesis of his approach. As he states: “For instance, mainstream economists tend to use their power positions to build cartels and to discriminate against all kinds of economists who represent a threat to orthodoxy” (Söderbaum, 1990: 482). He also believes, on what appear to be ontological grounds, that institutional economics is a better approach for addressing environmental problems. His reasons for suggesting that fruitful dialogue might be possible between those holding orthodox and heterodox economic ideas become increasingly incredulous given the following concluding remarks:

“As I see it, neoclassical environmental economists are wasting scarce intellectual and financial resources by trying to do what is impossible or not meaningful” (Söderbaum, 1990: 490).

“In my experiences, the problem here is that many neoclassical environmental economists are more eager to save their theories and methods than to improve the chances of human survival on this planet” (Söderbaum, 1990: 491).

Elsewhere he has also been highly critical of neoclassical economics (Söderbaum, 1992) and referred to cost–benefit analysis as incompatible with democracy (Söderbaum, 1999: 162).

Here then is the conundrum for methodological pluralists. They must either indiscriminately accept everything, and so lose any meaning for the concept of knowledge, or accept some grounds for rejecting ideas and approaches which they find strongly objectionable. As Söderbaum (1990) notes, heterodox economists are normally versed in the mainstream while the reverse is rare, that is the orthodox are closed-minded. So communication across heterodox schools seems a more reasonable way ahead. For example, linking with institutional economics, especially in the critical mode of Kapp (1970, 1976) and Myrdal (1978), has been suggested by Söderbaum (1992, 2000) and several other ecological economists (Munda, 1997; Röpke, 1998; Spash, 2009b; Spash and Villena, 1999; Vatn, 2005).

More generally, discourse, deliberation and effective criticism are aided if there are some grounds for identifying, understanding and appreciating the principles, perceptions and presuppositions underpinning others’ thought. Awareness of epistemological differences is a precondition for engagement with ideas and such engagement cannot proceed with an unlimited range of methodologies. So with whom discourse is going to be best is a necessary criterion for engagement. For example, in order for the old idea of a fully-informed, rational, atomistic agent to be replaced by the complex, fallible, multiply motivated agent requires dropping mathematical formalism,

which acts as a constraint and perverts concepts. Expressing all theory in terms of individual behaviour which can be captured in formal mathematics prevents a more realistic model from developing. The decision as to where ecological economics should engage seems rather self-evident when given the choice between discourse with close-minded formalists employing outdated behavioural psychology to defend an unrealistic position, and open-minded social psychologists or sociologists sharing common critiques. Similarly, those who have called for paradigm shifts and revolutions in economics would be better-off, and more consistent, looking to heterodox schools of thought rather than pretending there are bridges to be built and fruitful avenues to be walked down with orthodox economists who have already heavily invested in the defence of their paradigm and the existing power structures in society.

Some, who are critical of mainstream economics, remain open to having ecological economists associate with the old conventional framework without realising this is actually detrimental to their desire for the development of a compelling alternative (e.g. Norton and Noonan, 2007). In ecological economics, association with mainstream economic ideas and incorporation of economic formalism have several impacts (Spash, 2009a). First, extension of mainstream thought to the environment means removing specific approaches and concepts and marginalising anything heterodox. For example, Arrow et al. (1996) advocate discounting as an efficiency goal with respect to impacts from human induced climate change and dismiss the necessity for explicit ethical judgement (see discussion by Spash, 2002a). Second, the mix is confusing and involves contradictory elements. For example, value pluralism in ecological economics contrasts with value monism in mainstream economics, and the two are incompatible (Norton and Noonan, 2007). Third, economic imperialism means ecological economics is treated as a subfield of orthodox environmental and resource economics e.g. the *Journal of Economic Literature* classification. Mainstream economics is then identified as having watered down or changed interdisciplinary research and heterodox concepts in order to make the results fit within and conform to its methodology and ideology (Earl, 2005; Lee, 2009). Fourth, the creation of a clear sense of direction and meaning is made far more difficult. This has been particularly problematic for the journal, but also the ecological economics movement more generally. Some organisations have also adopted the title while maintaining an unchanged neoclassical content; the name being used as a marketing device (rebranding for superficial product differentiation). Fifth, and most importantly, there will never be progress in knowledge if what we ourselves deem as better for understanding environmental and socio-economic problems is swamped by that which we openly argue and acknowledge is not.

#### 4. A Preanalytic Vision for Ecological Economics

If different methodologies can be seen to follow from different understandings of reality (Dow, 2007: 453), then we might ask what is the ecological economists’ understanding of reality? A vision seems to be required before we can proceed. In which case we might, as others have suggested, invoke Schumpeter’s (1994 [1954]) concept of vision as the “preanalytic cognitive act”. In practice research is likely to build upon the work of our predecessors, and so their vision. Vision as an explicit cognitive act is less common. Although, “vision of this kind not only must precede historically the emergence of analytical effort in any field but also may re-enter the history of every established science each time somebody teaches us to see things in a light of which the source is not to be found in the facts, methods, and the results of the pre-existing science” (Schumpeter, 1994 [1954]: 42).

Such an approach is consistent with a naturalistic tradition in epistemology. This seeks to define the conditions for obtaining reliable information accepting a variety of sources e.g. testimony, sense perception, reasoning. In some forms this can be seen as a branch of

<sup>14</sup> A useful aspect of their discussion is to highlight the role of concepts, which is something Kapp (1961) also recognised as a key approach for communication and integration if interdisciplinary work is to progress (see Spash, 2012).

cognitive psychology and the issues can be addressed by empirical investigation (Klein, 2005: 4). Schumpeter's description of scientific process appears close to such an epistemology, although in other respects (explored below) he adopts aspects of logical empiricism.

#### 4.1. The Meaning of a Preanalytic Vision

The role and meaning of a preanalytic vision need some clarification before looking at what form this might take for ecological economics. What Schumpeter (1994 [1954]) is discussing parallels calling for an explicit account of ontological presuppositions. This may be understood as answering a series of questions: what do we understand as being the reality with which we are engaging, what are its key features and how do the various elements then fit together, what are their properties? Schumpeter uses Keynes' *General Theory*, from which modern macroeconomics arose, as a prime example of preanalytic vision in practice. In explaining the economic processes of his day Keynes invoked concepts describing the special characteristics of his worldview. Schumpeter (1994 [1954]) notes that there was no question of these characteristics being established by antecedent factual research and quotes Keynes (1936: 250): "They are plausibly ascribed to our world, on our general knowledge of contemporary human nature".

This account seems to diverge from the claim by Pasinetti (2005: 841) that Keynes said 'when the facts changed he changed his mind' and that Keynesian theory is based upon reality and respects facts. The preanalytic vision also diverges from the Post Keynesian concept of stylised facts, first introduced by Kaldor (1961), which are supposed to be empirically based reflections of an objective reality. However, there is no inconsistency here as far as Schumpeter is concerned because the role of facts comes once analytical effort starts and after conception of the vision. As Schumpeter (1994 [1954]: 42) states:

"The first [analytic] task is to verbalize the vision or to conceptualize it in such a way that its elements take their places, with names attached to them that facilitate recognition and manipulation, in a more or less orderly schema or picture. But in doing so we almost automatically perform two other tasks. On the one hand, we assemble further facts in addition to those perceived already, and learn to distrust others that figured in the original vision; on the other hand, the very work of constructing the schema or picture will add further relations and concepts to, and in general also eliminate others from, the original stock."

Schumpeter goes on to mention "the surviving elements of the original vision" as being subject to more rigorous standards of consistency and adequacy. Through such a process he believes that scientific models can be developed and scientific propositions refined. This is strikingly similar to Neurath's repeatedly used analogy of knowledge creation being like completely rebuilding a boat while at sea (Uebel, 1996).

There is a clear divergence between this narrowing and refining and calls for methodological pluralism in ecological economics. Costanza (1996: 12), for example, merely states: "Scholars from various disciplines collaborate side-by-side using their own tools and techniques, and in the process develop new theory, tools, and techniques as needed to effectively deal with sustainability". He seems to regard any potential attempts to reject content or tools as a violation of the transdisciplinary approach. Of course this form of pragmatism and instrumentalism leaves unanswered how scientific progress is meant to be achieved.

Another missing element from previous contributions to a preanalytic vision for ecological economics is the role of ideology. Schumpeter's exploration of the preanalytic vision is embedded within a text concerned about ideological bias. His aim is to describe the role of ideology in forming knowledge, and outline in which areas ideological

bias must be accepted and where and how it might be excluded. As explained earlier, removing the influence of ideology in science was a key aim of logical empiricism and especially the left wing of the Vienna Circle. However, for Schumpeter, ideology enters at the ground floor and the preanalytic vision is ideological by definition. Yet, he also expresses his belief that "there are a large number of phenomena that fail to affect our emotions, one way or the other" (Schumpeter, 1994 [1954]: 42). This allows neutral phenomena to enter which would be uncontroversial. Whether this implies that such phenomena represent an objective reality, and underlying factual element, is unclear.<sup>15</sup>

#### 4.2. Preanalytic Vision and Ontological Presuppositions

Trying to define a preanalytic vision is not an easy task and especially if the hope is to move from ontology through epistemology to methodology. We might start by asking which other approaches we feel have something in common with our still unfocused picture. A rare attempt along these lines in ecological economics is that by Tacconi (1998). The need to jettison the current form of methodological pluralism, as I have argued, is clear. Tacconi (1998: 103) does cite Norgaard (1989) approvingly and states that a "diversity of paradigms" should be maintained, where paradigm is an all encompassing worldview. However, he argues for the rejection of logical empiricism and for developing a more specific ontology and epistemology suited to ecological economics. In this regard he selects post-normal science and strong social constructivism for consideration.

Strong social constructivism faces some problems in providing a position consistent with the preanalytic vision for ecological economists because of its relativist ontology. As Tacconi (1998: 99) notes: "in constructivist ontology being is determined by knowledge. Consider the Earth without human beings. A reality would exist but would not be socially constructed". On this basis Tacconi accepts the existence of a reality independent of human cognition but the proposed epistemology appears inadequate for addressing this. An additional, but related, issue is the treatment of biophysical limits. In social constructivism these are subject to a variety of interpretations dependent upon who is asked, rather than being independent constraints on human society. In addition, Tacconi (1998: 100) is not prepared to accept the total lack of independence of observer and observed as proposed by social constructivists.

A foundational issue is then that, unlike other social sciences and most other heterodox areas of economics, there is a primary concern for a physical reality and how the mix of natural and social sciences should be addressed. The idea that all reality is socially constructed conflicts with the status given to the Laws of Thermodynamics as scientific realisations of biophysical reality which are central to the conceptualisation of what is wrong with economics (a repeated core concern in ecological economics Daly and Farley, 2004; Georgescu-Roegen, 1971; Martinez-Alier, 1990; Munda, 1997). Yet, at the same time there is awareness that we cannot know 'the truth' about that reality (Røpke, 1998: 144), and hence the status given to ignorance and social indeterminacy (what Spash, 2002b terms strong uncertainty). That reality can be understood or interpreted in different ways does not mean humans may construct their own reality at will. The search is for an approach which captures both realism and the inadequacy of our ability to know.

This is presumably why post-normal science has been popular amongst ecological economists and especially those who have struggled with finding an epistemology (e.g., Munda, 1997; Özkaynak et

<sup>15</sup> The other area where ideology is believed potentially absent is in the rules of procedure for conducting analytical research. Here something of a verificationist approach seems to be behind the text. Schumpeter (1994 [1954]) talks of new facts accumulating, leading to new concepts and relations being formulated and these either verifying or destroying ideological positions. This is consistent with his empiricism, both of which seem to hold elements of early Vienna Circle reasoning.

al., 2002; Tacconi, 1998).<sup>16</sup> Post-normal science postulates that knowledge about a physical reality can be known through experimentation under restricted conditions (broadly in accord with logical empiricism) but that the realm of such knowledge creation is limited, and increasingly so. Thus, as we move away from the controlled laboratory, and physics, towards complex interactive global systems, and environmental problems, we need a different basis for creating knowledge which involves broad participation by the lay public, as an extended peer community (Funtowicz and Ravetz, 1991, 1994). The problem with this approach, in the current context, is that it does not provide a clear theory of science, but is rather an attack on the practice and rhetoric of modern science. There is in part a prescriptive epistemology in that critique, but one that leaves unanswered the role of traditional science (i.e. is even restriction to some physics laboratory valid, or is all science really post-normal?). The ontological presuppositions are vague but seem to cluster around complex systems theory (Kay et al., 1999). Then, as Tacconi (1998) notes, the methodology is under-developed leaving the on-going task of putting the abstract argument on science quality assurance into practice (although some progress in this direction has been made, see van der Sluijs et al., 2005). So post-normal science is struggling with some of the same definitional issues as being discussed here for ecological economics (for a review see Turnpenny et al., 2011).

Some defining ontological features can be drawn from this discussion. Anyone who accepts evolution theory must believe in the existence of a world prior to the emergence of humans. So we may take as given the existence of a non-human reality. The problem then arises that reality may differ from how humans conceive it and this human perspective on reality may change over time. This raises the philosophical difficulties surrounding a correspondence theory of truth, i.e. that a belief is true if and only if it corresponds to reality. As Mackie (1970: 332) explains “A correspondence theory of truth is analogous to representative realism as a theory of perception, whereas what we want, at least with regards to truth, is direct realism”. His answer is a modest proposal: “To say that a statement is true is to say that things are as the statement states”. The importance of this lies in enabling beliefs or statements to be answerable to how things are, something outside themselves, to reality. Acceptance of this position means we look to reality for confirmation of truth rather than, for example, justifying statements on the basis of their current usefulness or coherence with other statements.<sup>17</sup>

Next we might engage with the challenge from environmental ethics to explore how we relate to the non-human world. I believe, as I think Tacconi does, that ecological economists should accept the importance of recognising that a reality without humans is meaningful. This raises questions as to our value commitments to the non-human. Here the last person example is relevant (Sylvan, 2009 [1973]). That is, does willfully destroying life on Earth matter if you are the last human on the planet, is it wrong? If ecological economists answer in the affirmative, as I believe they should, then they call for a change in the ethics, attitudes, values and evaluations of economics. In contrast, environmental and resource economists, for example, would be committed by their theory to accepting the last persons' preferences. So, in terms of a preanalytic vision for ecological economics I think the

case is strong for including commitment to aspects of realism, empiricism and ethical significance of the non-human. This connects in part with a feminist and Green ideological position reflected in a concern to care for and respect Nature beyond the purely instrumental reasons for meeting human ends.

Then there is the issue of the distinction to be drawn between natural and social science investigation or, less dichotomously, between different sciences moving from the natural to the social. For ecological economists, such as Tacconi, the case for the rejection of logical empiricism (if narrowly defined) appears clear with regard to the social sciences, but for the natural sciences there is an implicit begrudged acceptance of its potential relevance, if a highly qualified one. For example, anyone invoking post-normal science accepts the role of normal science, as defined in that literature, in having achieved advances in human understanding and for curiosity driven research. The strong constructivist position is therefore rejected. The qualifier is that normal science is of limited use for addressing modern environmental problems because of their specific characteristics, e.g. strong uncertainty, high decision stakes.

Ecological economists struggling with epistemological issues are aware of the need for something of a middle path (Baumgartner et al., 2008; Tacconi, 1998). As Jacobs (1996: 16) explains, ecological economics requires an approach that “accepts neither the scientific reduction of the natural environment to its physical characteristics, nor the constructivist position which denies biophysical constraints on social life”. Ecological economics, like post-normal science, is trying to steer a course between the postmodern temptation to be nihilistic, while avoiding the modernist temptation to claim a single optimal answer or truth (Spash, 2002b: 144). The latter is prevalent in mainstream economics but also common in science policy. The exaggeration of the scope and power of scientific knowledge leads to institutionalised censorship of critical opinions (Spash, 2010). This creates “a vacuum in which should exist a vital social discourse about the conditions and boundaries of scientific knowledge in relation to moral and social knowledge” (Wynne, 1992: 115). These epistemological concerns raise a broader ontological question as to how we distinguish between natural and social realities.

One possible aid in developing an ecological economic preanalytic vision of those boundaries is to appeal to critical realism,<sup>18</sup> which also aims to provide an understanding of the interaction between physical and social systems. Critical realism accepts that we can never demonstrate that we have discovered the truth even if we have (fallibilism), but does not reject the idea of there being an underlying objective reality. The description under critical realism is of an ordered hierarchy of sciences e.g. molecular sciences, biological sciences, social sciences (Collier, 1998b). There is real (ontological) difference in the strata so they are not regarded as just cognitively (epistemologically) convenient. The real distinctions between the strata, and their irreducibility one to another (contra reductionism), are used to explain distinctions between the various sciences and the reason for a plurality of sciences to exist. So, for example, everything is governed by the laws of physics, all biological entities are physical but not vice versa, so biological sciences are embedded within the physical and likewise the social within the biological and the economic within the social. This type of embeddedness is one of the key messages ecological economists have been at pains to communicate i.e., the economy is embedded in the Natural environment and subject to the Laws of Thermodynamics. Yet, embeddedness should not be confused with reductionism. That elephants are constructed of physical and chemical components does not mean elephants' behaviour can be understood by analysis of or reduction to those components (Georgescu-Roegen, 2009 [1979]: 109). Similarly, irreducibility means society is not merely a collection of individuals

<sup>16</sup> Silva and Teixeira (2011) claim that “ecological economics is evolving unambiguously towards a post-normal science”. This seems to misinterpret both post-normal science and their data. For example, the increase of abstract mathematical formalism in the journal, which they note and misleadingly associate with rigour, is hardly consistent with this. Neither is the spread of monetary valuation or much else that they present. For an informative overview of the content and meaning of post-normal science see Turnpenny, Jones and Lorenzoni (2011).

<sup>17</sup> Mackie (1970: 332) notes that a correspondence theory stands opposed to such “sceptical or otherwise evasive theories as the coherence theory and Pragmatist theory”. The former requires coherence amongst statements and is associated with logical empiricists who thought comparing statements with facts was metaphysics. A Pragmatist theory regards statements as useful, e.g. scientific theories are open to refutation or change but may still enable us to achieve certain tasks such as building and flying aeroplanes.

<sup>18</sup> I have found only two references to such a potential link by ecological economists. One was in a footnote to a book chapter by Røpke (1998: 144) and the other a brief mention in the book on institutions and the environment by Vatn (2005: 55–56).

and cannot be understood by simple aggregation on the basis of knowledge about individuals. Such an approach seems more in line with ecological economics than other epistemologies.<sup>19</sup>

The hierarchical ontology of critical realism contrasts with single level ontologies. These come in three forms (Collier, 1998a). (i) Those claiming parts are mere aspects of some whole, so that ultimately there is only the Absolute, of which everything is an aspect. This is the position put forward by Daly and Farley (2004). (ii) The wholes are mere collections of parts, understood only when broken down into their components, which alone are ultimately real, e.g. atomistic mechanism. (iii) Some intermediate level entity (e.g. selves) are the only reality, their parts being mere aspects, and the larger entities, which they make-up, being mere collections, e.g. some forms of methodological individualism. The critical realist position rejects all these single level ontologies.

A negative interpretation of the hierarchical division between types of knowledge is worth mentioning at this point, due to its practical implications. This is the belief that truth lies in natural science while social sciences are merely a means of communication for that truth. Indeed a few ecologists claiming to have placed economic values on the environment have been known to acknowledge their lack of economic training as if to signify that 'anyone can do this stuff'. Social and economic research is then regarded as instrumentally important by such individuals (i.e., pragmatically justified), because politicians and the press listen. This denies the importance of non-natural science subjects, or strata, and their independent contribution to knowledge. So we should be clear that the distinction required is not one of dichotomous division (social vs. natural), nor ranking (physics is best or hard, economics is Queen of the social sciences because it emulates physics, and so on). This is not a matter of superiority, but rather of substance.

If we pursue contributions to critical realism a bit more, some further insights arise of relevance to ecological economics as a policy or issue driven movement. Social science, including economics, can be differentiated on a substantive basis from the natural because it involves (contra Hume) an inseparability of facts and values. In order to explain this I borrow from Collier (1998a).

Social science presents ideas claimed to be true of the object studied. Unlike the natural sciences, the object (i.e. society) includes ideas. Society can only exist on the basis of human agents acting, reproducing and transforming social structure. Human agents act in accordance with ideas (e.g. religions, political ideologies). This means that an account of structure requires an account of ideas. Collier (1998a) gives the example that there can be no understanding of the English Civil War without an account of Puritanism (i.e., explanation of economic and class structure may be primary but inadequate). Significant ideas in any society include ideas about features of that society. Understanding social phenomena (e.g. unemployment) requires addressing the real structural causes (e.g. financial institutions, government policy, world markets) and prevalent ideas. Those ideas appear as social attitudes and political behaviour. Thus, explanations arising from a social-scientific study entail criticism of some ideas in society.

This means, if the social science is correct then the people it describes who have an opposite explanation must be wrong. Social science criticises part of its object and is different from natural science. For example, that black holes exist is no criticism of them, even if we find them unpleasant. In contrast, as Collier (1998a: 446) explains:

"To say that some institution causes false beliefs is to criticise it. Given that (other things being equal) it is better to believe what is

true than what is false, it is also better (other things being equal) that institutions that cause false beliefs should be replaced by, or transformed into, those that cause true ones."

Furthermore, there is often a functional relationship between institutions that cause false beliefs and beliefs about those institutions. False beliefs may be spread in order to preserve the institution and its power. Thus, the rhetoric of the liberating character of 'free-markets' and benefits of material growth may be used by corporations and governments extracting resources, dislocating indigenous populations and creating environmental destruction. In such cases to propound the truth is not just to criticise, but to undermine the institution.

"Hence, the production of explanations of social institutions is not only, as a general rule, a precondition of criticizing and changing them; sometimes, it is criticizing them, and beginning the work of their subversion" (Collier, 1998a: 446).

Open realisation and acceptance of this position makes ecological economics far more radical than orthodox economics, which pretends to give objective value free advice while actually supporting the existing institutional structures. As Söderbaum (2011) points out:

"Neoclassical economics is science but at the same time ideology. As ideology, neoclassical economics can be described as the ideology of the present capitalist system. Some other institutional arrangement or kind of capitalism appears to be needed if we wish to deal constructively with present problems."

Being open about these fact-value relationships means ecological economics has a clear role in communicating its findings—concerning the character of social and environmental problems, the structures behind them and the institutions involved—to those who will implement institutional change and address the false beliefs in society. Indeed this can already be witnessed as happening (see Martinez-Alier et al., 2011). There are then fundamental differences in ontological presuppositions between ecological economics and the mainstream, leading to very different approaches to the science-policy interface.

Ecological economics can also be seen as sharing aspects of heterodox economic thought in its ontological presuppositions. For example, in a comparison with Post Keynesian economics the state of the world is seen in common as one involving strong uncertainty, social indeterminacy, emergent properties and historical dynamic process (Holt and Spash, 2009). In contrast the mainstream can be seen as treating individuals as passive agents in a static closed system with an ontology of isolated atomism. This justifies the orthodoxy in their formulation of social reality as typified by regularities so allowing the methodology of deductive reasoning and mathematical formalism. Ecological economics, like other heterodox traditions, accepts the transformative power of human agency with emergent properties arising from a dynamic interconnected process of multi-layered social interactions. Modern heterodoxy is then distinguished from the mainstream by allowing theory and method to be informed by insights into social reality. Heterodox economists resist the mainstream reformulation of their concepts (e.g. uncertainty, evolutionary developments, institutions, motives, ethics) not so much through being committed to them per se, as insisting on their possessing specific ontological properties (Lawson, 2006). My contention is that our ontological presuppositions interact with our ideological positions to determine the epistemological approaches suitable for adoption, and in turn lead to a methodology suitable for ecological economic enquiry.

## 5. A Tentative Vision for Ecological Economics

In order to bring various elements of the argument together I list here, in summary form, some of the key aspects of what could form a preanalytic vision for ecological economics. I split this into the

<sup>19</sup> For example, Bromley (2008) in recommending his personal form of American Pragmatism to ecological economists states that: "[P]ragmatists regard truth as a belief—a warranted assertion—that it is no longer reasonable to doubt. Truth is not a property of objects or events." He then appears to argue that truth, and so reality, is just a set of beliefs captured in sentences. While fallibilism seems generally accepted, I do not believe the approach Bromley advocates actually addresses the ontological presuppositions of ecological economics.

ontological, epistemological and methodological. The list is neither comprehensive nor definitive. In addition I have added a set of ideological beliefs, because, as explained, a preanalytic vision is ideological by definition, and mostly ideology remains implicit when it should and could usefully be made explicit.

#### Ontological Presuppositions

- An objective reality exists independent of humans;
- Humans create social reality;
- Facts about social reality are inseparable from values;
- Biophysical and social realities are distinct but are interconnected;
- A hierarchical ontology is accepted in which there is an ordered structure (e.g. biophysical, social, economic);
- Society and the individual are distinct in that the former cannot be reduced to the latter nor the latter merely aggregate to create the former;
- Complex systems and their interactions create emergent properties and are inherently unpredictable;
- Systems are continually subject to change and interaction.

#### Epistemological Claims

- Our scientific knowledge is always subject to strong uncertainty (i.e., partial ignorance, social indeterminacy);
- We can never prove that we have discovered the truth in our scientific understanding;
- Understanding and interpreting reality are in part social processes in which knowledge is often contested;
- Knowledge comes in different forms and is not the exclusive domain of the expert; indigenous and lay knowledge may challenge or complement expert knowledge;
- Knowledge is subject to reasoned critique and empirical investigation;
- Critique can take a variety of forms leading to the need for plural methods;
- Advancing knowledge requires accepting and rejecting information and being open to revising beliefs.

#### Methodological Positions

- Ecological economics is an interdisciplinary approach to understanding;
- Successful interdisciplinarity requires integration having understood the ontological and epistemological basis for cooperation between different bodies of knowledge;
- Unstructured methodological pluralism is the antithesis of creating knowledge and understanding;
- Structured methodological pluralism requires working across fields of knowledge with those who share a common ontology and epistemology;
- Creation of mutually understood concepts is necessary for interdisciplinary understanding;
- Methods of evaluation must match the requirements of value pluralism.

#### Ideological Beliefs

- Ethical neutrality should be rejected and ethical positions made explicit;
- Both human and non-human inhabitants of Earth are morally considerable;
- Action is required to address gender inequity, and inequity between, within and across social groups, time periods and spatial dimensions;
- There are more meaningful aspirations for human existence than hedonism (e.g. invoking philosophical concepts such as flourishing, a 'worthwhile life', the 'good-life');
- Restrictions are necessary on population growth and the scale of human activity;

- Levels of material and energy consumption per capita prevalent in the industrialised world are excessive and its social and environmental consequences unacceptable;
- Opposition is required to the wanton destruction of war and the military-industrial complex;
- We should uphold democratic principles of fairness and justice, including international human rights and protection of the innocent from harm;
- Ecological economics can change the world by creating better understanding of the structure of the social and environmental reality in which we live and communicating its findings to help achieve that change.
- Ecological economists should act personally in ways consistent with their environmental and social values.

## 6. Conclusions

Officially, economists follow a rigorous and scientific epistemological approach which has been connected to logical empiricism. From this epistemological basis a methodology of deduction in economics has developed. This sets a procedure for gaining knowledge on the basis of theory development leading to hypotheses which are meant to be tested by observation resulting in confirmation or falsification. A summary of the key failures in mainstream economics which have been outlined is that (i) economists do not actually follow their supposed epistemology, (ii) their approach lacks an explicit ontology, (iii) the philosophy of science from which this approach is derived has been caricatured in a single form when it was a diverse and contested body of work.

The continued support for mathematical formalism and quantification as providing the sole means to scientific rigour and validity is damaging to an alternative vision for ecological economics. The main reason Norgaard made his, somewhat flawed, case for pluralism appears to have been his concern that ecological economics in its infancy should avoid domination by a prescriptive epistemology, and so lose the opportunity to develop and experiment with other approaches. After over two decades the time for a more progressive stance on the philosophy of science appropriate for ecological economics is overdue. Ecological economics has an empirical aspect and some possible intellectual roots amongst members of the left Vienna Circle. That mainstream economics is not following logical empiricism seems more of a problem than the claim that it is following some form of highly restrictive positivism. Ecological economics is, and should be in part, an empirically based subject, but the form of that empiricism needs development and should not be restricted to a narrow, dogmatic, anti-pluralist, prescriptive caricature, nor based upon appeals to the most popular methodology. There seems no hope for progress if all that is done is to follow a rejected methodology on the grounds that it is believed to be dominant amongst those whom one opposes.

This paper is a first tentative step in a project aiming at some coherence as we move from ontology to method. Pursuit of that project should aid the avoidance of holding totally contradictory positions simultaneously. The argument put forward denies the claim that everything can be included and that failing to include all other disciplines and their tools in an indiscriminate manner is paramount to an 'intellectual turf war'. Ecological economics is not free from ontological or epistemological positions which have methodological implications. The aim here has been to explore these issues and their relevance and to show we can start to formulate a substantively different vision from that of orthodox economics as a school of thought.

In criticising unstructured and uncritical pluralism (with respect to methodology) my aim has been to point out that knowledge creation requires refining and rejecting information and approaches. This does not mean that all pluralism is to be thrown out. Rather, grounds for making pluralism meaningful are required and that implies finding common ground for interaction and communication using

common concepts. I have argued that those commonalities lie between ecological economics and heterodox economic schools of thought. Neoclassical approaches are in fact then detrimental to developing an alternative economic vision and conflict with epistemological progress. If people wish to undertake such approaches they should do so elsewhere, and so free ecological economics from having to pretend to agree with a series of orthodox fallacies, including: the pretence that there is no biophysical reality imposing limits and economics can be value free. Ecological economics can either develop a more rigorous approach and establish a theoretical structure or become increasingly eclectic, unfocussed and irrelevant. Ecological economics as a conservative movement is an unnecessary waste of time, merely shadowing environmental and resource economics. Ecological economics as a radical movement is required today, more than ever, in order to criticise and change the social organisations and institutions that spread false beliefs about economic, social and environmental reality.

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### Appendix A. The Vienna Circle and Logical Empiricism

Logical empiricism was most strongly developed due to meetings held over about three decades at the start of the 1900s by a group of intellectuals, referred to as the Vienna Circle. The original group started meeting in 1907. An interlude occurred around the First World War. The second phase and height of development was in the interwar period. Nazi support and its eventual dominance in Austria caused the Circle to end its meetings, with Neurath going into exile in England (where he died in 1945) and many others settling in America (e.g. Carnap, Frank). As a result ideas continued development in America during the 1950s and 1960s. As an active research field in philosophy of science the movement was finally over by 1970 (Creath, 2011). However, while few may claim to be logical empiricists today many philosophers of science were trained in this mode of thought and pursue its projects. It has also had a much wider influence in how science has been and continues to be perceived.

The original aim was to pursue the ideas of physicist Ernst Mach. The founding group—Otto Neurath, Hans Hahn and Philipp Frank—was socialist/Marxist in orientation and with the later addition of Rudolph Carnap is now referred to as the left wing of the Vienna Circle. When the group was expanded in the 1920s a more conservative wing was added, led by Moritz Schlick (Uebel, 2011). Hans Reichenbach has been cited as representing a right wing (Howard, 2009: 200). Moritz Schlick was not the founder as claimed by Caldwell (1980), but rather chaired sessions of the Verein Ernst Mach (Ernst Mach Society) from 1922 after having been invited to join by Hans Hahn. As this indicates, the Circle had some complex dynamics and internal divisions. There was considerable variety and change over time in ideas and a broad membership outside the core of people who associated with or attended Circle meetings, discussions and lectures in Vienna in the 1920s and 1930s. The Circle was not closed to debating or developing its ideas. Before the movement in Europe disintegrated and dispersed, members of the Circle had recognised most of the problems later cited as criticisms.

The philosophical underpinnings for a radical form of Marxian socialism which had been part of the left wing did not sit well under American McCarthyism. After moving to the United States both Carnap and Frank were under observation by Hoover's FBI. More generally, the socialist and explicit political aspect disappeared from logical empiricism. Today the poor state of science policy debate in the USA evidences the legacy of McCarthyism on American philosophers of science and

their fear of entering the public policy debate—having been exiled to the icy slopes of logic (Howard, 2000, 2009; Reisch, 2005).

### References

- Archer, M., Bhaskar, R., Collier, A., Lawson, T., Norrie, A., 1998. *Critical Realism: Essential Readings*. Critical Realism: Interventions. Routledge, London.
- Arrow, K.J., Cline, W.R., Maler, K.-G., Munasinghe, M., Squitieri, R., Stiglitz, J.E., 1996. Intertemporal equity, discounting, and economic efficiency. In: Bruce, J.P., Hoesung, L., Haites, E.F. (Eds.), *Economic and Social Dimensions of Climate Change*. Cambridge University Press, Cambridge, pp. 125–144.
- Baumgartner, S., Quaas, M., 2010. What is sustainability economics? *Ecological Economics* 69, 445–450.
- Baumgartner, S., Harald, D., Faber, M., Proops, J., Schiller, J., 2001. The concept of joint production and ecological economics. *Ecological Economics* 36, 365–372.
- Baumgartner, S., Becker, C., Frank, K., Muller, B., Quaas, M., 2008. Relating the philosophy and practice of ecological economics: the role of concepts, models, and case studies in inter- and transdisciplinary sustainability research. *Ecological Economics* 67, 384–393.
- Blaug, M., 1980. *The Methodology of Economics: Or How Economists Explain*. Cambridge University Press, Cambridge, England.
- Bourdeau, M., 2011. Auguste Comte, in: Zalta, E.N. (Ed.), *The Stanford Encyclopedia of Philosophy*, Stanford.
- Bromley, D.W., 2008. Volitional pragmatism. *Ecological Economics* 68, 1–13.
- Caldwell, B., 1980. Positivist philosophy of science and the methodology of economics. *Journal of Economic Issues* 14, 53–75.
- Caldwell, B.J., 1991. Clarifying Popper. *Journal of Economic Literature* 29, 1–33.
- Caldwell, B.J., 1994. Beyond Positivism: Economic Methodology in the Twentieth Century. Routledge, London.
- Callicott, J.B., Grove-Fanning, W., Rowland, J., Baskind, D., French, R.H., Walker, K., 2011. Reply to Norton, re: Aldo Leopold and Pragmatism. *Environmental Values* 20, 17–22.
- Cartwright, N., Cat, J., 1996. Neurath against method. In: Giere, R.N., Richardson, A.W. (Eds.), *Origins of Logical Empiricism*. University of Minnesota, Minneapolis, pp. 80–90.
- Collier, A., 1998a. Explanation and emancipation. In: Archer, M., Bhaskar, R., Collier, A., Lawson, T., Norrie, A. (Eds.), *Critical Realism: Essential Readings*. Routledge, London, pp. 444–472.
- Collier, A., 1998b. Stratified explanation and Marx's conception of history. In: Archer, M., Bhaskar, R., Collier, A., Lawson, T., Norrie, A. (Eds.), *Critical Realism: Essential Readings*. Routledge, London, pp. 258–281.
- Common, M.S., Stagl, S., 2005. *Ecological Economics: An Introduction*. Cambridge University Press, Cambridge.
- Costanza, R., 1989. What is ecological economics. *Ecological Economics* 1, 1–7.
- Costanza, R., 1991. Ecological economics: a research agenda. *Structural Change and Economic Dynamics* 2, 335–357.
- Costanza, R., 1996. The importance of envisioning in motivating change towards sustainability. *The Ecological Economics Bulletin* 1, 11–13.
- Costanza, R., Perrings, C., Cleveland, C.J., 1997. In: Blaug, M. (Ed.), *The Development of Ecological Economics*. International Library of Critical Writings in Economics, 75. Cheltenham, England.
- Costanza, R., Cumberland, J., Daly, H., Goodland, R., Norgaard, R., 1998. *An Introduction to Ecological Economics*. St. Lucie Press, Boca Raton.
- Creath, R., 2011. Logical empiricism. In: Zalta, E.N. (Ed.), *The Stanford Encyclopedia of Philosophy*.
- Daly, H.E., 1991. Elements of environmental macroeconomics. In: Costanza, R. (Ed.), *Ecological Economics: The Science and Management of Sustainability*. Columbia University Press, New York.
- Daly, H.E., Farley, J., 2004. *Ecological Economics: Principles and Applications*. Island Press, Washington.
- Dow, S.C., 2007. Variety of methodological approach in economics. *Journal of Economic Surveys* 21, 447–465.
- Earl, P.E., 2005. Economics and psychology in the twenty-first century. *Cambridge Journal of Economics* 29, 909–926.
- Ehrlich, P.R., 2008. Key issues for attention from ecological economists. *Environment and Development Economics* 13, 1–20.
- Faber, M., 2008. How to be an ecological economist. *Ecological Economics* 66, 1–7.
- Fleetwood, S., 1999. *Critical Realism in Economics*. Routledge, London.
- Friedman, M., 1953. The methodology of positive economics. In: Friedman, M. (Ed.), *Essays in Positive Economics*. Chicago University Press, Chicago.
- Funtowicz, S.O., Ravetz, J.R., 1991. A new scientific methodology for global environmental issues. In: Costanza, R. (Ed.), *Ecological Economics: The Science and Management of Sustainability*. Columbia University Press, New York, pp. 137–152.
- Funtowicz, S.O., Ravetz, J.R., 1994. The worth of a songbird: ecological economics as a post-normal science. *Ecological Economics* 10, 197–207.
- Georgescu-Roegen, N., 1971. *The Entropy Law and the Economic Process*. Harvard University Press, Cambridge, Massachusetts.
- Georgescu-Roegen, N., 2009 [1979]. Methods in economic science. In: Spash, C.L. (Ed.), *Ecological Economics: Critical Concepts in the Environment*, 4 Volumes. Routledge, London, pp. 105–115.
- Holt, R.P.F., Spash, C.L., 2009. Post Keynesian and ecological economics: alternative perspectives on sustainability and environmental economics. In: Holt, R.P.F., Pressman, S., Spash, C.L. (Eds.), *Post Keynesian and Ecological Economics: Confronting Environmental Issues*. Edward Elgar, Cheltenham, pp. 3–24.
- Howard, D., 2000. Two left turns make a right: on the curious political career of north American philosophy of science midcentury. In: Hardcastle, G.L., Richardson, A.W.

- (Eds.), *Logical Emoiricism in North America*. University of Minnesota, Minneapolis, pp. 25–93.
- Howard, D., 2009. Better red than dead—putting an end to the social irrelevance of postwar philosophy of science. *Science Education* 18, 199–220.
- Hutchinson, T.W., 1938. *The Significance and Basic Postulates of Economic Theory*. Macmillan & Co. Ltd., London.
- Jacobs, M., 1996. What is socio-ecological economics. *The Ecological Economics Bulletin* 1, 14–16.
- Kaldor, N., 1961. Capital accumulation and economic growth. In: Lutz, F., Hague, D. (Eds.), *The Theory of Capital*. Macmillan, London, pp. 177–222.
- Kapp, K.W., 1961. *Toward a Science of Man in Society: A Positive Approach to the Integration of Social Knowledge*. Martinus Nijhoff, The Hague.
- Kapp, K.W., 1970. Environmental disruption: general issues and methodological problems. *Social Science Information* 9, 15–32.
- Kapp, K.W., 1976. Nature and significance of institutional economics. *Kyklos* 29, 209–232.
- Kay, J.J., Regier, H.A., Boyle, M., Francis, G., 1999. An ecosystem approach for sustainability: addressing the challenge of complexity. *Futures* 31, 721–742.
- Keynes, J.M., 1936. *The General Theory of Employment, Interest and Money*. Macmillan, London.
- Klein, P.D., 2005. Epistemology. In: Craig, E. (Ed.), *Routledge Encyclopedia of Philosophy*. Routledge, London.
- Lawson, T., 1997. *Economics & Reality*. Routledge, London.
- Lawson, T., 2006. The nature of heterodox economics. *Cambridge Journal of Economics* 30, 483–505.
- Lawson, T., 2008. Social explanation and Popper. In: Boylan, T., O’Gorman, P. (Eds.), *Popper and Economic Methodology: Contemporary Challenges*. Routledge, London and New York, pp. 87–112.
- Lee, F., 2009. *A History of Heterodox Economics: Challenging the Mainstream in the Twentieth Century*. Routledge, London.
- Mackie, J.L., 1970. Simple truth. *The Philosophical Quarterly* 20, 321–333.
- Martinez-Alier, J., 1990. *Ecological Economics: Energy, Environment and Society*. Basil Blackwell, Oxford, England.
- Martinez-Alier, J., Healy, H., Temper, L., Walter, M., Rodriguez-Labajos, B., Gerber, J.-F., Conde, M., 2011. Between science and activism: learning and teaching ecological economics with environmental justice organisations. *Local Environment* 16, 17–36.
- Mayumi, K., 1997. Information, pseudo measures and entropy: an elaboration on Nicholas Georgescu-Roegen’s critique. *Ecological Economics* 22, 249–259.
- McCloskey, D.N., 1983. The rhetoric of economics. *Journal of Economic Literature* 31, 434–461.
- Munda, G., 1997. Environmental economics, ecological economics, and the concept of sustainable development. *Environmental Values* 6, 213–233.
- Myrdal, G., 1978. Institutional economics. *Journal of Economic Issues* 12, 771–783.
- Norgaard, R.B., 1987. Economics as mechanics and the demise of biological diversity. *Ecological Modelling* 38, 107–121.
- Norgaard, R.B., 1989. The case for methodological pluralism. *Ecological Economics* 1, 37–57.
- Norgaard, R.B., 1994a. *Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future*. Routledge, London.
- Norgaard, R.B., 1994b. The philosophical roots of the betrayal. In: Norgaard, R.B. (Ed.), *Development Betrayed: The End of Progress and a Coevolutionary Revisioning of the Future*. Routledge, London, pp. 61–74.
- Norton, B.G., 2011. What Leopold learned from Darwin and Hadley: comment on Callicott et al. *Environmental Values* 20, 7–16.
- Norton, B.G., Noonan, D., 2007. Ecology and valuation: big changes needed. *Ecological Economics* 63, 664–675.
- O’Connor, M., 2000. Pathways for environmental evaluation: a walk in the (Hanging) Gardens of Babylon. *Ecological Economics* 34, 175–193.
- O’Neill, J., 2003. Unified science as political philosophy: positivism, pluralism and liberalism. *Studies in History and Philosophy of Science* 34A, 575–596.
- O’Neill, J., 2004. Ecological economics and the politics of knowledge: the debate between Hayek and Neurath. *Cambridge Journal of Economics* 28, 431–447.
- O’Neill, J., Uebel, T., 2004. Horkheimer and Neurath: restarting a disrupted debate. *European Journal of Philosophy* 12, 75–105.
- Özkaynak, B., Devine, P., Rigby, D., 2002. Whither ecological economics? *International Journal of Environment and Pollution* 18, 317–335.
- Pasinetti, L.L., 2005. The Cambridge school of Keynesian economics. *Cambridge Journal of Economics* 29, 837–848.
- Pheby, J., 1988. *Methodology and Economics: A Critical Introduction*. Macmillan, London.
- Reisch, D.A., 2005. *How the Cold War Transformed the Philosophy of Science*. Cambridge University Press, Cambridge.
- Røpke, I., 1998. Sustainability and structural change. In: Faucheux, S., O’Connor, M., Van Der Straaten, J. (Eds.), *Sustainable Development: Concepts, Rationalities and Strategies*. Kluwer, The Hague, pp. 141–155.
- Røpke, I., 2005. Trends in the development of ecological economics from the late 1980s to the early 2000s. *Ecological Economics* 55, 262–290.
- Sandelin, B., Trautwein, H.-M., Wundrak, R., 2008. *A Short History of Economic Thought*. Routledge, London.
- Schumpeter, J.A., 1994 [1954]. *History of Economic Analysis*. Routledge, London.
- Silva, M.C.E., Teixeira, A.A.C., 2011. A bibliometric account of the evolution of EE in the last two decades: is ecological economics (becoming) a post-normal science? *Ecological Economics* 70, 849–862.
- Söderbaum, P., 1990. Neoclassical and institutional approaches to environmental economics. *Journal of Economic Issues* 24, 481–492.
- Söderbaum, P., 1992. Neoclassical and institutional approaches to development and the environment. *Ecological Economics* 5, 127–144.
- Söderbaum, P., 1999. Values, ideology and politics in ecological economics. *Ecological Economics* 28, 161–170.
- Söderbaum, P., 2000. *Ecological Economics*. Earthscan, London.
- Söderbaum, P., 2011. Sustainability economics as a contested concept. *Ecological Economics* 70, 1019–1020.
- Spash, C.L., 2002a. Loading the dice?: values, opinions and ethics. *Greenhouse Economics: Value and Ethics*. Routledge, London, pp. 184–200.
- Spash, C.L., 2002b. Strong uncertainty: ignorance and indeterminacy. In: Spash, C.L. (Ed.), *Greenhouse Economics: Value and Ethics*. Routledge, London, pp. 120–152.
- Spash, C.L., 2009a. Ecological economics: a subjective opinion. In: Spash, C.L. (Ed.), *Ecological Economics: Critical Concepts in the Environment*, 4 Volumes. Routledge, London, pp. 1–27.
- Spash, C.L., 2009b. *Ecological Economics: Critical Concepts in the Environment*, 4 Volumes. Routledge Major Work. Routledge, London.
- Spash, C.L., 2009c. The new environmental pragmatists, pluralism and sustainability. *Environmental Values* 18, 253–256.
- Spash, C.L., 2010. Censoring science in research officially. *Environmental Values* 19, 141–146.
- Spash, C.L., 2012. Towards the integration of social, economic and ecological knowledge. In: Gerber, J.F., Steppacher, R. (Eds.), *Towards an Integrated Paradigm in Heterodox Economics*. Palgrave Macmillan, Basingstoke, pp. 26–46.
- Spash, C.L., Villena, M.G., 1999. *Exploring the Approach of Institutional Economics to the Environment*. Department of Land Economy, Cambridge.
- Steup, M., 2010. Epistemology, in: Zalta, E.N. (Ed.), *The Stanford Encyclopedia of Philosophy*, Stanford.
- Sylvan, R., 2009 [1973]. Is there a need for a New Environmental Ethic? In: Spash, C.L. (Ed.), *Ecological Economics*. Routledge, London, pp. 264–272.
- Tacconi, L., 1998. Scientific methodology for ecological economics. *Ecological Economics* 27, 91–105.
- Turnpenny, J., Jones, M., Lorenzoni, I., 2011. Where now for post-normal science?: a critical review of its development, definitions, and uses. *Science Technology & Human Values* 36, 287–306.
- Uebel, T.E., 1996. The enlightenment ambition of epistemic utopianism: Otto Neurath’s theory of science in historical perspective. In: Giere, R.N., Richardson, A.W. (Eds.), *Origins of Logical Empiricism*. University of Minnesota Press, Minneapolis, pp. 91–112.
- Uebel, T.E., 2011. Vienna Circle. In: Zalta, E.N. (Ed.), *The Stanford Encyclopedia of Philosophy*.
- van der Sluijs, J.P., Craye, M., Funtowicz, S., Klopogge, P., Ravetz, J., Risbey, J., 2005. Combining quantitative and qualitative measures of uncertainty in model-based environmental assessment: the NUSAP system. *Risk Analysis* 25, 481–492.
- Vatn, A., 2005. *Institutions and the Environment*. Edward Elgar, Cheltenham.
- Wynne, B., 1992. Uncertainty and environmental learning: reconceiving science and policy in the preventive paradigm. *Global Environmental Change* 111–127.