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Ecological economics and the politics of knowledge: the debate between Hayek and Neurath

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Hayek's epistemic arguments against planning were aimed not just against socialism but also the tradition of ecological economics. The concern with the physical preconditions of economic activity and defence of non-monetary measures in economic choice were expressions of the same rationalist illusion about the scope of human knowledge that underpinned the socialist project. Neurath's commitment to physicalism, *in natura* calculation and planning typified these errors. Neurath responded to these criticisms in unpublished notes and correspondence with Hayek. These highlighted the epistemological premises his work shared with Hayek's, representing a response to Hayek from Hayek's own assumptions. This paper examines the cogency and continuing relevance of the arguments in this debate.

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Hayek's papers 'The Counter-Revolution of Science' and 'Scientism and the Study of Society' (Hayek, 1941; 1942–44) are of particular significance for the tradition of ecological economics. In those papers Hayek criticises various forms of scientism in the social sciences, in particular what he calls 'objectivism', represented by the physicalism of logical positivism. Those criticisms are directed not just at socialist planning but to also to the tradition of thought that lies behind what is now called ecological economics (Martinez-Alier, 1987). Two assumptions which are central to that tradition are questioned by Hayek: (1) that economics should be concerned with the ways in which economic institutions and relations are embedded within the physical world and have real physical preconditions which are a condition of their sustainability; (2) that rational economic choices between options cannot be founded upon purely monetary valuations but require direct reference to their physical characteristics. Precursors of ecological economics such as Ostwald, Geddes,

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Soddy and Solvay are all objects of criticism, their work on energy units taken to exemplify a 'scientistic objectivism' typical of an engineering mentality. Their objectivism is exhibited in their belief in the desirability for *in natura* calculations in kind in economic choices as against calculations in monetary valuations (Hayek, 1942–44, pp. 90, 171). The work of Otto Neurath becomes a primary target of Hayek's criticism, since in his work objectivism, socialism and *in natura* calculation most clearly come together: 'The most persistent advocate of . . . *in natura* calculation is, significantly, Dr. Otto Neurath, the protagonist of modern "physicalism" and "objectivism"' (Hayek, 1942–44, p. 170).[1]

Neurath responded to these criticisms in a set of unpublished notes and letters to Hayek in 1945, which Neurath had hoped would form the basis for a public exchange (Neurath, 1945A, 1945B). The public exchange never occurred. Neurath died in late 1945, and it is in any case difficult to discern in Hayek's letters much enthusiasm for it. My aim in this paper is to uncover and examine this missing chapter in the socialist calculation debates. My purpose in doing so is not primarily historical, but to examine the cogency of the different arguments and bring out their importance for contemporary debates in ecological and environmental economics. Environmental themes were central throughout the socialist calculation debates, from the arguments of Mises and Neurath through to those with Hayek (O'Neill, 1999, 2002). However, it is Hayek's epistemic arguments that still have particular bite. The problems they raise, for example about choice in conditions of ignorance and the dispersal of practical and local knowledge, still matter for current arguments in environmental economics. Neurath's response is of particular significance in this regard, since he begins from many of the same epistemological premises as Hayek. As I have argued elsewhere, there is a great deal in common between Hayek's criticisms of Cartesian rationalism and Neurath's criticisms of pseudorationalism (O'Neill, 1996; 1999). Neurath's argument starts from a recognition of the limits of expert knowledge and a corresponding scepticism about technocratic pictures of social choice. This similarity in premises is a central theme in Neurath's response to Hayek. His response attempts to answer Hayek from Hayek's own assumptions.

1. Hayek against objectivism and in natura calculation

1.1 Objectivism and physicalism

In his essay 'Scientism and the Study of Society', Hayek claims that scientism in the social sciences provides a central example of an illusion about the scope of human reason and knowledge that underpins the socialist project. The doctrine of 'objectivism', of which Neurath's 'physicalism' is taken to be a typical expression, is an exemplar of such scientism. The terms 'objectivism' and its opposite 'subjectivism' are used in a variety of logically independent senses within the Austrian economic tradition (O'Neill, 1998, ch. 3). In Hayek's scientism essay, 'subjectivism' is used primarily to capture a hermeneutic thesis about the nature of social objects, that they are in part constituted by beliefs and social meanings. The objects of the social sciences are constituted by beliefs and ideas that individuals have about them: 'Neither a "commodity" or an "economic good", nor "food" or "money" can be defined in physical terms but only in terms of views people hold about things' (Hayek, 1942–44, p. 53). Objectivism, in contrast, is the view that such references to mental states can and should be eliminated. The social sciences require the elimination

[1] On the tradition of ecological economics and Neurath's role within it, see Martinez-Alier (1987), O'Neill (1999), Deblonde (2002, ch. 4). For a discussion of the debates between Neurath, Hayek and Popper see Uebel (2000). For a full account of Neurath's philosophy, see Cartwright *et al.* (1996).

of all terms that cannot be given a characterisation in a purely physical language. That eliminativist programme is taken to be typified by Neurath's physicalist programme (Hayek, 1942–44, p. 78).

1.2 In natura calculation

The doctrines of objectivism and physicalism are taken by Hayek to provide support for the belief in the possibility of '*in natura*' calculations in economics. Objectivism is expressed in 'the characteristic and ever-recurrent demand for the substitution of *in natura* calculation for the "artificial" calculation in terms of price or value, that is, of a calculation which takes explicit account of the objective properties of things' (Hayek, 1942–44, p. 170). The term is one that Hayek borrows from Neurath and, in the work of Hayek, it refers to the possibility of economic choices that proceed not through market prices but by direct reference to the physical attributes of objects. The central political implications of Hayek's arguments against objectivism is the denial of the existence of any physical units for planning economic production, including the energy units offered by earlier precursors of ecological economics such as Ballod-Atlanticus, Popper-Lynkeus, Ostwald, Soddy and Solvay (Hayek, 1942–44, pp. 90–1). Hayek rejects the eliminativist physicalist claim that all economic activities 'can be ultimately reduced to quantities of energy, [and] man should in his plans treat the various things . . . as the interchangeable units of abstract energy which they "really" are' (Hayek, 1942–44, p. 91). However, Hayek in rejecting objectivism also defends a logically independent, stronger and less plausible form of subjectivism that inverts the physicalist eliminativism he criticises. Hayek defends a form of radical subjectivism which rejects 'the more widespread . . . conception of the "objective" possibilities of production, of the quantity of social output which the physical facts are supposed to make possible' (Hayek, 1942–44, p. 91). No place is allowed for any purely physical vocabulary in the social sciences. In particular, reference to the real powers of objects in the natural world, resource limits and the like which are central to ecological economics are rejected.

The belief in objectivism and *in natura* calculation is for Hayek an expression of an illusion about the scope of knowledge and reason that is typical of the social engineer. 'The engineer's ideal which he feels the "irrational" economic forces prevent him from achieving, based on his study of the objective properties of the things, is usually some purely technical optimum of universal validity' (Hayek, 1942–44, p. 170). The belief in the possibility of a technical optimum is an illusion, since it fails to acknowledge the limits of knowledge that any particular individual can possess. The social engineer is a victim of the illusion of complete knowledge that underpins the whole project of socialist planning:

> The application of the engineering technique to the whole of society requires . . . that the director possess the same complete knowledge of the whole society that the engineer possesses of his limited world. Central economic planning is nothing but such an application of engineering principles to the whole of society based on the assumption that such a complete concentration of all relevant knowledge is possible. (Hayek, 1942–44, p. 173)

In claiming that objectivism and the belief in *in natura* calculation involves a commitment to the possibility of complete knowledge, Hayek opens both up to his epistemological arguments against planning and in defence of the market.

1.3 The illusions of complete knowledge

The belief in planning involves an erroneous belief in the omnipotence of reason, a belief that Hayek variously calls 'rationalism', 'superrationalism' and 'Cartesian rationalism'.

Against such rationalism Hayek claims that 'it may . . . prove to be far the most difficult and not the least important task for human reason rationally to comprehend its own limitations' (Hayek, 1942–44, p. 162). What are the sources of human ignorance to which this argument appeals? The first is what Hayek calls 'the division of knowledge' in society—that is, the dispersal of knowledge and skills throughout different individuals in society (Hayek, 1937, 1945). While Hayek frames the argument in terms of the division of knowledge in society, the key to his argument is the nature of knowledge dispersed—practical knowledge embodied in skills and know-how that cannot be articulated in propositional form, and knowledge of particulars, local to time and place. Such knowledge cannot be articulated or vocalised in a form that could be passed on to a central planning body. There will be knowledge dispersed throughout society of which any particular individual or subset of individuals will be ignorant. The market is claimed to solve this epistemic problem. The market acts as a coordinating procedure which, through the price mechanism, distributes to different actors that information that is relevant for the coordination of their plans (Hayek, 1937; 1942–44, p. 176–7; 1945).

Central to that coordination is the activity of the entrepreneur who is alert to new opportunities in the market place. The entrepreneur is faced with a second source of ignorance, a future that at the point of decision is unpredictable. Wants change with the invention and production of new objects for consumption. Since the progress of human knowledge is in principle unpredictable—if we could predict future knowledge, we would already have it—and since human invention relies on the progress of knowledge, and wants are created by human invention, future human wants are also in principle unpredictable (Hayek, 1942–44, pp. 157–8; 1960 pp. 40–41; cf., Popper, 1944–45). Hence, at any point in time, we are ignorant about the full range of future human wants. The market is presented as a discovery procedure in which different hypotheses about the future are embodied in entrepreneurial acts and tested in the market place (Hayek, 1978, pp. 179–90; cf., Kirzner, 1985).

Given this view of the price system as a solution to the problem of ignorance, to give up prices for calculation in kind is to give up a solution to the problem of ignorance for the illusion of the possibility of complete knowledge based in planning. There is no *in natura* alternative to the monetary measures. If Hayek is right, this is not just a criticism of socialist planning. It is a criticism of the wider tradition of ecological economics, which is concerned with the physical preconditions of economic activity and in particular its ecological preconditions, and which defends the use of non-monetary measures and indicators of economic activity. How convincing are Hayek's criticisms of the theoretical underpinnings of both socialism and ecological economics? I have argued elsewhere that his arguments in defence of markets are not ultimately successful (O'Neill, 1998, ch. 10). However, there is some power in Hayek's criticisms of central planning. Indeed, there is some common ground between these epistemic arguments against centralised technocratic planning and those offered by its socialist critics. Moreover, there is clearly common ground between Hayek's assumptions and themes that have become central to some recent work in ecological economics—the importance of local knowledge embodied in particular human practices, the existence of ignorance and uncertainty, the limits of predictability. That common ground and the ways in which it can lead to quite different conclusion is illustrated in Neurath's own response to Hayek and the problems these raise for Hayek's position from Hayek's own assumptions.

2. Neurath's response

Neurath notes at the outset of his reply to Hayek, that there is no dispute about whether he defends either physicalism or *in natura* calculation. What is in dispute is whether Hayek properly characterises either and whether, once properly stated, they are open to the objections that he presents.

2.1 Physicalism:

> A few words in advance about 'physicalism' . . . 'Physicalism' . . . starts from everyday language, which avoids elements which the various peoples on earth do not have in common. The assumption is, that Melanesian tribes and European explorers can start to talk on cows and calves, pains and pleasures without difficulties, whereas difficulties appear when expressions like 'cause', 'punishment' 'mind' etc. enter the talk. In this part of our everyday language which physicalism acknowledges one formulates questions with 'where, when, how'. And physicalism suggests to drop discussion which do not allow these three questions reasonably made. (Neurath, 1945A)

Much of Neurath's response to Hayek is taken up with clarification of the meaning of physicalism. Given that this is central to the rest of Neurath's work in the philosophy of science, this is unsurprising. However, I do not want here to enter into a detailed discussion of the concept of physicalism, nor of its evolution and defensibility throughout the protocol sentence debate in the Vienna circle during the 1930s (Uebel, 1992; Cartwright *et al.*, 1996). My comments here will be limited to clarification of its role in the debate with Hayek about the nature and possibility of *in natura* calculation.[1]

'Physicalism' in its basic sense refers to the doctrine that all statements in the sciences, social sciences and everyday life should be capable of translation into terms that refer to spatio-temporal particulars. The concept of physicalism appears in at least three different debates in which Neurath engaged: (1) the protocol sentence debate; (2) debates about the unification of the sciences; (3) debates about the nature of social science.

(1) In the 'protocol sentence' debates within the Vienna Circle 'physicalism' is employed against the view that phenomenalist sentences describing an individual private experiences could provide the empirical basis of science. The central argument in this context is a private language argument for the primacy of public intersubjective language of a kind that came to greater prominence through the later and better known work of Wittgenstein. Against the early Carnap's attempt to distinguish a 'monologising' (phenomenalist) language and an 'intersubjective' (physicalist) language, where the latter can be deduced from the former, Neurath argues that a monologising language is not possible since the speaker has to appeal to public tests of correctness and constancy in the use of terms: 'the person who supposedly is in isolation already makes use of the intersensual and 'intersubjective' language' (Neurath, 1931A, p. 55).[2] Since the constancy of language use requires that terms be open to public criteria of correctness, they cannot be defined in terms of the phemonenalist's private experiences of solitary individuals, but rather require a physicalist characterisation in terms of spatio-temporal particulars. The terms must answer to the questions—'when?' and 'where?' The terms of science must answer to public and hence physicalist criteria.

(2) Physicalism was also central to the debates about the unification of the sciences. Subsequent accounts of the project of a unified science have tended to oversimplify the

[1] My comments in this section also correct my own earlier account of the debate (O'Neill, 1997B), which accepted Hayek's characterisation of the Neurath's physicalism.

[2] See also Neurath (1941B, p. 226ff.) For a discussion, see Uebel (1992, chs 6, 7 and 10).

programme. The project could take a number of forms: (i) a reductionist project in which all the sciences would be logically derivable via bridge-laws from physics; (ii) a programme for a unified method which would be followed by all sciences; (iii) a project for a unified language of science; and (iv) a project that would integrate the different sciences, such that, on any specific problem, all relevant sciences could be called upon—a project for the 'orchestration of the sciences'. All four projects were defended by some positivists at different moments in the history of the movement. However, in subsequent critical accounts of the doctrine, and Hayek is typical in this regard, the first has tended to be taken to define the project. The picture again ignores the heterogeneity of the positivist movement and the arguments within it. In this context, it is important to note that Neurath rejects the first reductionist project completely: 'would it not be preferable to treat all statements and all sciences as coordinated and to abandon for good the traditional hierarchy: physical sciences, biological sciences, social sciences and similar types of "scientific pyramidism"?' (Neurath, 1944, p. 8). Neurath also rejected the second doctrine, the possibility of a unified method for the sciences. On method, Neurath was a pluralist, for reasons to which I return below. In defending the programme for a unified science, Neurath was concerned to defend the third and fourth projects, that of unifying the language of science and that of the coordination of the sciences. He believed two were related: the task of coordination required a unified language.

In the context of his debate with Hayek, the significant point is that physicalism in the sense that Neurath employed it was not the view that all the science could be reduced to physics, nor that all the terms of language could be translated into those of physics. The universal jargon includes all ordinary language that refers to objects and events with a spatio-temporal location. Indeed, it is the everyday jargon that has primacy. In defending this claim Neurath is committed to a form of eliminitivism. There are terms that are to belong to what Neurath elsewhere calls, as a joke, his *Index verborum prohibitorum* (Neurath, 1941B, p. 217). The index includes for example in his *Foundations of the Social Sciences* 'existence', 'entity', 'reality', 'thing', 'fact', 'concept', 'mind', 'mental world', 'physical world', 'meaning', 'progress', 'the beautiful', 'the good.' (1944, p. 18). That form of eliminativism is untenable. Neurath's own work breaks his index and is none the worse for it. Neither is it consistent with the holism that Neurath defends elsewhere, which insists that 'we always have to do with a whole network of concepts and not with concepts that can be isolated' (Neurath, 1921, p. 198). If this is the case, then, even from Neurath's empiricist assumptions, there is no reason to suppose any particular term or statement answers directly to a 'where, when, how' question, as long as it belongs to a network that does. However, while Neurath's eliminativism is not I think ultimately defensible, what is important in the present context is that, whatever its plausibility, it is not a form of eliminativism that Hayek criticises. It is not a form of physicalist eliminativism which insists on the elimination of all 'mental' vocabulary or the reduction of mental vocabulary to the physical terms:

> I never tried to 'explain mental processes by physical ones' because I do not have the means in my language to distinguish between 'mental' and 'physical'—all my terms are when, where how terms therefore what Professor von Hayek and others call 'mental' appear manifestly in my language as 'speech behaviour' or 'arguing' etc. i.e. a good where, when, how item. (Neurath, 1945A)[1]

[1] The point is made forcibly in a published passage: '"Yesterday I was awed and moved as I entered the gigantic cave". Only spatio-temporal expressions are covered by the proposal of Logical Empiricism. ("A person was moved entering a cave" is such a spatio-temporal expression of course!) and therefore we speak of the "physicalist" approach to Logical Empiricism, but not because it is suggested to reduce all statements to so-called "physical" ones' (Neurath, 1941A, p. 148).

Physicalism does not involve the elimination of all language that cannot be translated into that of the physical sciences. It starts rather as Neurath notes with the everyday jargon with references to events and objects that have a particular spatio-temporal location. Hayek misses the meaning of physicalism in the particular sense that Neurath uses it, and this becomes apparent in the subsequent correspondence, as Hayek acknowledges: 'you tend to give these doctrines a particular twist which makes it very difficult to follow you'(Hayek to Neurath 1.1.1945, in Neurath, 1945B).[1]

(3) That physicalism does not entail the elimination of all intentional or mental vocabulary is also important for the third context in which the term physicalism appears, namely in debates about the nature of the social sciences. Neurath's physicalist approach to the social sciences is aimed against certain anti-naturalist forms of interpretative social science and in defence of a naturalist social science. He writes in response to Hayek: 'We do not distinguish between "man" and "nature" if one were using the term "nature", "man" would be part of it, like animal, plant etc' (Neurath, 1945A). This naturalism is developed in terms of a social behaviourism which refuses to make a strong distinction between the study of human and non-human societies (Neurath, 1931B, p. 69). Neurath develops this position in opposition to the hermeneutic conception of the social sciences, defended in the tradition of interpretative social science from Dilthey through Rickert to Weber. Hence, one of Neurath's better known passages: 'Empathy, understanding (*Verstehen*) and the like may help the research worker, but they enter the totality of scientific statements as little as does a good cup of coffee which also furthers a scholar in his work' (Neurath, 1931C, p. 357). There are two main points to Neurath's criticism of this tradition. The first is the rejection of their use of reifications such as 'the spirit of age' or 'Protestantism' divorced from spatio-temporal particulars: 'Sociology deals with human behavior, i.e. with spatio-temporal events'(Neurath, 1931C, p. 359). There are protestants with their particular habits, ways of life etc. which may have particular effects 'but there is no Protestantism'(Neurath, 1931C, p. 358). The second point Neurath is making here is a rejection of an empathetic model of interpretation which involves seeing oneself in the 'mind' of another. His argument against that view is that it is untestable. If there are public data available that ground empathetic claims, one can use those data directly without recourse to empathy (Neurath, 1931C, p. 357).

Whether or not this line of criticism is adequate against the interpretative tradition in the social sciences I leave aside here. What is important to note is that Neurath's approach to sociology is not physicalist in the sense that Hayek outlines. His physicalism is not committed to the elimination of all 'intentional' vocabulary or mental terms from social science or to the absence of interpretative activity on the part of the social scientist. Neurath's social theory is institutionalist. It is a form of social behaviourism which takes public institutions and social orders as the starting point for analysis. Hence, for example, his insistence that monetary exchanges be understood as parts of particular institutional arrangements like others and their study be approached anthropologically (Neurath, 1944, p. 39). In developing the point, Neurath exploits the now well-trodden analogies between monetary exchange and games such as chess which are constituted by certain public rules (Neurath, 1944, p. 39).

2.2 Physicalism and in natura calculation

Clarification of the senses of 'physicalism' matters to the debate about the possibility of *in natura* calculation. Because Hayek mischaracterises Neurath's physicalism, much in

[1] For example, where Neurath explains that the terms 'terms' and 'statement' are physicalist, whereas the term 'concept' is not, Hayek responds that he cannot 'make sense of such propositions as that "The terms 'statement' or 'term' are physicalist terms also"' (Hayek to Neurath 1.1.1945, in Neurath, 1945B).

Neurath's account of *in natura* calculation is untouched by many of Hayek's criticisms. The doctrine that Hayek criticises is that which claims that there are some purely physical units, like units of energy, which are independent of human use or belief and which could be employed for planning. This doctrine he takes to have a basis in physicalism understood as the view that one could eliminate all 'mental' or intentional terms from the social sciences. Not only does Neurath not defend physicalism in this sense, he similarly rejects the doctrine that there are purely physical units that could be employed for socialist planning, and with it the technocratic idea that there is any optimum solution to social problems. This is most clearly evident in his 'International Planning for Freedom', in which Neurath opposes 'what is called the "technocratic movement" which assumes there exists "one best solution with its "optimum happiness", with its "optimum population", with its "optimum health", with its "optimum working week", with its "optimum productivity" or something else of this kind' and which 'asks for a particular authority which should be exercised by technicians and other experts in selecting "big plans"'(Neurath, 1942, pp. 426–7). There is no scientific unit that will do the job here, including physical energy units (Neurath, 1942, pp. 426–7). I return to epistemological arguments behind Neurath's rejection of the technocratic movement below.

A number of points about the elements of *in natura* calculation deserve notice here. First, they are plural. Central to Neurath's work is the rejection of any single unit for decision-making—monetary or non-monetary (Neurath, 1919, p. 146)—a point to which I return below. Second, they are not purely 'physical' in the sense that Hayek assumes. The material preconditions of human activity do feature in Neurath's account of in kind calculations. But so also do the social dimensions of life. The inventory of the conditions of life includes 'everything about work load, morbidity, mortality, food, clothing, housing, educational possibilities, amusement, leisure time etc.' (Neurath, 1925) It includes what Neurath elsewhere describes as 'the environment in its broadest sense' (Neurath, 1937, p. 149). In discussing real wealth, Neurath is not abstracting from human relations and human conditions. Correspondingly, institutional arrangements matter: 'a change in a man's food and shelter is of less importance than a change in his state of being bullied or humiliated by certain institutions' (Neurath, 1942, p. 425). Self-government and freedom and other human relations belong to the 'happiness conditions' of human beings (Neurath, 1942, p. 427). Neurath's account of *in natura* is consistent with the institutionalist character of his approach to economics and social science in general.

However, while Hayek mischaracterises both Neurath's physicalism and his account of *in natura* calculation, it does not follow that the argument between them over *in natura* calculation was mere misunderstanding. There were clear differences over the nature of economic theory, the use of monetary measures in social choice and the possibility of rational choice in non-market economic institutions.

2.3 In natura calculation

In one sense, there was no dialogue between Hayek and Neurath about *in natura* calculation. Hayek simply refused to take the idea as a remotely viable option: 'I should have . . . thought at this day the proposal of an *in natura* calculation could not possibly be seriously defended' (Hayek to Neurath 1.1.1945, Neurath, 1945B). Neurath complains in reply that Hayek substitutes gestures for arguments (Neurath to Hayek 25.6.45, Neurath, 1945B). However, in response to Hayek's refusals, Neurath reiterates a series of distinctions that are implicit in his early work and which are significant today not just for arguments about socialism but also for recent debates around ecological economics: he distinguishes between

the role of monetary and non-monetary measures in economic theory, in social decision processes, and in economic institutions.

Economic theory in kind. Neurath distinguishes between forms of economic theory in which the concepts of real wealth and the analysis of particular social relations of individuals are central, and those in which economic relations are described purely in terms of 'monetary and credit relations' (Neurath, 1916). The former, economic analysis in kind, is taken to be typified by work on economics from Aristotle through to Smith, and in the work of Marx and of Popper-Lynkeus and Ballod; the latter is typified by mainstream economics since Smith. The distinction here is between different theoretical approaches to economies, not between different types economic institution: 'Reckoning in kind as a scientific technique of analysis [is] applicable to societies with and without money' (Neurath to Hayek, 26.7.45, in Neurath 1945B).

Decisions in kind. Economic theory in kind is distinct from the use of in kind reckoning to make decisions. 'I distinguish always carefully between RECKONING IN KIND as a scientific technique . . . [and] RECKONING IN KIND as a social tool, used within a society by human beings when making decisions' (Neurath to Hayek, 26.7.45, in Neurath 1945B). Decisions in kind contrast with decisions with monetary units or indeed any other single unit. The distinction here is roughly that which would now be made between decision tools such as multi-criteria decision analysis, which work directly with many different dimensions of value, and cost benefit analysis, in which a single monetary unit is employed.

Economies in kind. An economy in kind refers not to a specific decision-making tool, but to a set of institutional arrangements in economic life:[1] 'the in-kind economy [is] an institutional order of society' (Neurath, 1916). The contrast here is with a money economy also understood as a set of institutions: 'We should suggest looking at markets and finance and at the whole reckoning in money as an institution like any other . . . We should treat this whole field of money reckoning anthropologically as a piece of modern ethology' (Neurath, 1944, p. 39). Economies in kind feature in two distinct ways in Neurath's work. First, much of his early work in economics was concerned with the functioning of different kinds of non-monetary economies in the ancient world and during periods of war (Neurath, 1904, 1909/18, 1910). Second, and politically more significant for the socialist calculation debates, Neurath's own contributions to the socialisation debates both during the Bavarian revolution after the First World War in which he acted as director of socialisation and in red Vienna of the 1920s, centred on the advocacy of a radical in-kind economy of associations in which monetary units disappeared: 'We must at last free ourselves from outmoded prejudices and regard a large-scale economy in kind as a fully valid form of economy which is the more important today in that any completely planned economy amounts to an economy in kind. To socialize therefore means to further an economy in kind. To hold on to the split and uncontrollable monetary order and at the same time to want to socialize is an inner contradiction.' (Neurath, 1919, p. 145: cf., 1920A, 1920B, 1925) The advocacy of the need to consider at least the possibility of a fully socialised economy in kind remained central to Neurath's work up to his final writings, even when, as he notes in *Foundations of Social Sciences*, it had become a 'left deviation' in the Soviet Union (Neurath, 1944, p. 39). It is still defended in his correspondence with Hayek. However, Neurath

[1] '[T]he question of the CALCULUS *IN NATURA* and the ECONOMY *IN NATURA* are two different things' (Neurath to Hayek 25.6.45, in Neurath, 1945B)

> reiterates these distinctions in his reply to Hayek to capture what might still be defensible, even if, with Hayek, one believes that an economy in kind is not possible in modern conditions. Even if one rejects an economy in kind, economic theory in kind and social decision procedures in kind might still be defensible.

Arguments in defence of decision-making in kind were central to Neurath's earlier engagement in the socialist calculation debates with Mises. Mises had rejected the possibility of an economy in kind by rejecting the possibility of decisions in kind. Rational economic decision-making, involving 'higher order' production goods, requires a single cardinal measure on the basis of which the worth of alternative states of affairs could be calculated and compared. Environmental examples were already at the centre of this debate. Thus, for example, given the choice 'whether we shall use a waterfall to produce electricity or extend coal and better utilize the energy contained in coal' (Mises, 1981, p. 98), we need some way of calculating the advantages and benefits of alternatives, and this in turn required a common unit of measurement. A common cardinal unit of measurement is provided by monetary prices in the market: 'calculations based upon exchange values enable us to reduce values to a common unit' (Mises, 1981, p. 99). Prices form, indeed, the only adequate unit of comparison. Comparability between options requires monetary prices that measure exchange values such that one is able to have a determinate answer to the advantages of alternatives by way of simple rules.

> The practical man . . . . must know whether what he wants to achieve will be an improvement when compared with the present state of affairs and with the advantages to be expected from the execution of other technically realisable projects which cannot be put into execution if the project he has in mind absorbs the available means. Such comparisons can only be made by the use of money prices. (Mises, 1966, p. 208)

On this view, the non-existence of monetary measures in a socialist economy rules out the possibility of rational economic decisions.

Neurath's response focused specifically on a questioning of the assumptions about economic decision-making that informs Mises' critique: rational practical thinking need not involve any single unit that reduces decision-making to a purely technical procedure of calculation. It requires ethical and political decisions. Neurath criticises not only the use of market prices, but also socialist alternatives to the market that employ single units in making decisions, be these labour hours or the energy-units. 'There are no units that can be used as the basis of a decision, neither units of money nor hours of work. One must directly judge the desirability of the two possibilities' (Neurath, 1919, p. 146). The socialist responses to Mises which still required a single unit were mistaken:

> Even some socialists have agreed with Mises' thesis—without calculation with *one* unit, an economy is *not* possible; socialism does not acknowledge any calculation with *one* unit; it follows that socialism is impossible—and therefore try to establish that in the socialist society there also can be such a calculation. For us it is essential that *calculation in kind in the economic plan has to be the moneyless basis of socialist calculation of economic efficiency*. (Neurath, 1925)

Neurath's arguments against the picture of decision-making that Mises employs turns both on specific arguments about the limits of monetary measures and some more general arguments about the nature of rational choice.

The specific argument on the limits of monetary measures turn principally on the inadequacy of monetary measures—or indeed any single measure—to capture changes in welfare. First, monetary measures cannot capture adequately the multidimensional nature

of welfare concepts, such as standard of living or pleasure: 'The attempts to characterize the standard of living are like those which try to characterize the "state of health". Both are multidimensional structures' (Neurath, 1937, p. 146). Neurath's arguments here go back to a 1912 lecture, 'The Problem of the Pleasure Maximum', in which he criticises the assumption that there is a single scale of value according to which options can be uniquely ordered somewhat surprisingly, from within a hedonist perspective. While Neurath defends a social Epicurean position which takes the goal of social policy to be the increase of happiness understood as pleasure, he rejected the assumption that differences in distinct pleasures, say of listening to music or contemplating a painting, were themselves comparable in terms of some single unit. Hence, there were no units of pleasure on which calculations could be made (Neurath, 1912).

This point about the multidimensionality of the concepts of standard of living is combined with a second, namely the non-separability of those different dimensions: 'We cannot regard [the standard of living] as a weight made up of the sum of the weights of the various parts' (Neurath, 1937, p. 143). The argument against separability and in defence of a form of holism about values was developed thus by Neurath in an early paper, 'Remarks on the Productivity of Money', delivered to a seminar of Max Weber's in 1909:

> Suppose a civil servant has the choice between two places of residence, A and B. In A, he receives a larger quantity of food and accommodation, in B on the other hand a larger quantity of honour. Is it possible to have a calculus such that it summarises for us food and accommodation as one magnitude, and honour as another? Impossible! We are not able to compute such a complex, containing both pleasure and pain, by first separately establishing the magnitude of pleasure, then the magnitude of pain and finally doing the sum. On the contrary, we can only look at such a complex as a whole. Therefore the conversion into money is of no help in this case . . . [*T*]*he calculus of value* reaches its limits, because the value of a sum of goods is not derivable from the sum of the value of the individual goods. Indeed the question may be raised as whether it is possible to ascertain the value of *individual* objects in social life without looking at the social life in its entirety at the same time, that is, whether all goods might be complementary. If this is the case, it is impossible to capture the individual phenomenon by separate calculation, independently of whether one uses monetary calculation or any other kind of calculus. (Neurath, 1909)

Given that the value of different goods across different dimensions is not separable, an aesthetic model of ascertaining this is preferred to the book-keeping model: 'Neither do we compare the artistic achievements of architecture so as to say: this hall is more functional that that one, but less beautiful; let us add up advantages and disadvantages. In comparing two works of art we look at one as a whole and the other as a whole' (Neurath, 1909).

Alongside these particular arguments is a more general argument concerning the nature of practical reason which Mises and others assume. One of the central concepts of Neurath's work in both economics and the philosophy of science is that of 'pseudorationalism'. The concept initially appears his 1913 paper 'The Lost Wanderers of Descartes and the Auxiliary Motive'. A rationalist who believes in reason must recognise the boundaries to the power of reason in arriving at decisions: 'Rationalism sees its chief triumph in the clear recognition of the limits of actual insight' (Neurath, 1913, p. 8). It is a mark of the pseudorationalist to believe that there exist rules of insight that determine answers to all decisions. Pseudorationalism exists in the domains of both action and thought. Indeed, Neurath rejects a tight distinction between them: 'argumentation itself—which is set apart by Descartes—must also be regarded as an action . . . '(Neurath, 1940). In the sphere of theory, it is exhibited in the belief that there exist rules for the scientific method which if followed eliminate falsehood and lead to ever nearer approximations to the truth. Popper's falsificationism is

taken to exhibit that view (Neurath, 1935A). In the sphere of practice, it is exhibited in the belief that there exist decision-making rules which, if followed, will lead to an optimal decision. Mises' argument exhibits pseudorationalism in the sphere of action. While Mises is clearly a fallibilist about knowledge and recognises that economic actors operate in an uncertain world (Mises, 1966, ch. 15), he assumes an algorithmic conception of practical reason in the economic sphere. Rational decision-making requires the application of mechanical procedures of calculation on cardinal measures which will arrive at a determinate answer to the question of the optimum use of productive resources (Mises, 1981, pp. 96–105; 1966, chs.10–11, 15). For Neurath, the assumption that practical reason requires such algorithmic procedures is a mark of 'pseudorationalism'.

2.4 Neurath, Hayek and pseudorationalism

Neurath's remarks about the limits of reason, and indeed his specific attack on Cartesian rationalism, find a remarkable echo in Hayek's later remarks in the scientism essay against Cartesian rationalism—that 'it may . . . prove to be far the most difficult and not the least important task for human reason rationally to comprehend its own limitations' (Hayek, 1942–44, p. 162). The parallels between their views are taken up by Neurath in his notes and correspondence with Hayek. The point is made thus in his notes:

> should think that even [though] disagree[ing] with many of von Hayek's remarks and his historical outlook, I should describe him as a research worker, who together with us physicalists, fights the pseudorationalism of our period, which tries to use science as a kind of idol, and scientists and quasi-scientists regarding as a kind of born leaders, who may direct our life according to so-called 'tests'. Who tests the testers? (Neurath, 1945A)

The central theme of Neurath's response is the complaint that Hayek mischaracterises the views of Neurath and other logical empiricists and fails to acknowledge their shared rejection of pseudorationalism and the assumption that actors can have complete knowledge: 'I am the arch-enemy of the "illusion of complete knowledge" and from this point of view I think Professor von Hayek should praise me and appreciate my never ceasing efforts to destroy such illusions' (Neurath, 1945A).

In his correspondence with Hayek, Neurath links the rejection of pseudorationalism with his logical empiricism. Thus he invokes a series of claims about science that he was in part responsible for placing at the centre of the philosophy and sociology of science. Scientific theory is underdetermined by empirical evidence. Evidence itself is uncertain and provisional—observation or protocol statements are open to revision. Theories are a mass of statements that are logically interconnected and confronting the world as a whole not individually.[1] In the metaphor he uses at a variety different places, we are like sailors who have to patch up their boat at sea. There are no methods or rules of science that can be employed definitively to confirm or falsify theories. Popper's philosophy of science exemplifies pseudorationalism (Popper, 1935A). Indeed, Neurath takes Hayek to task for mixing in bad company.[2]

[1] 'The correctness of each statement is related to that of all others. It is impossible to formulate a single statement about the world without making tacit use at the same time of countless others' (Neurath, 1913, p. 3).

[2] 'You see Logical Empiricism . . . is essentially 'pluralist', whereas Karl Popper is essentially 'absolutist'—remember he think that there is *one* world picture "the best" etc. He thinks we can isolate instances of a negative character and destroy a hypothesis definitively by that etc. . . . I am wondering how you the fighter for freedom and toleration feel yourself in full agreement with scholars who are absolutists and not in full agreement with scholars, who like me, destroy the totalitarian outlook with the roots' (Neurath to Hayek 26.7.45, in Neurath, 1945B).

Popper's falsificationism exhibits pseudorationalism in being driven by the belief that valid scientific argument is fully capturable in a set of deductive rules that unequivocally eliminate candidates for the truth. Against that view, Neurath notes the now much repeated observation that the historical development of the sciences required that we hold onto theories despite the mass of falsifying evidence (Neurath, 1935A, p. 127). Against both 'the absolutism of falsificationism . . . and the absolutism of verificationism' (Neurath, 1935A, p. 131) Neurath defends a principle of methodological pluralism and tolerance (Neurath, 1935A, pp. 122–3). Neurath also points out that 'older successful theories are not always approximations to later ones' (Neurath, 1935A, p. 130). Neurath's critique of Popper anticipates much of more recent post-Kuhnian philosophies of science. The rejection of falsificationism on the grounds that it is inadequate to the history of science pre-dates Kuhn. The belief in the impossibility of a simple general method for science pre-dates Feyerabend, a point that Feyerabend acknowledged in his later writings in reference to Neurath (Feyerabend, 1995, p. 91). However, unlike Feyerabend, Neurath recognises that this position is quite compatible with a proper rationalism, since such rationalism is consistent with the recognition of the limits of rules of reason.

In attacking pseudorationalism, Neurath also rejects the Laplacean ideal of a system of equations from which all events could be predicted (Neurath, 1935B, p. 116). A sign of pseudorationalism is the failure to acknowledge the underdetermination of theory by evidence and uncertainty in prediction. Neither can such uncertainty and ignorance be resolved by treating them as if they could be translated into quantifiable probability statements (Neurath, 1941A, pp. 147–8). This general scepticism about predictability is taken by Neurath to have particular relevance when it comes to social decision-making. The unpredictability in science in general underpins his rejection of the technocratic ideal of the discovery of an optimal solution to social decisions that we noted earlier: 'If science enables us to make more than one sound prediction, how may we use science as a means of action? We can never avoid a "decision", because no account would be able to show us one action as 'the best', no computation would present us with any 'optimum', whatever actions have to be discussed' (Neurath, 1946, p. 80).

In addition to this general pluralist scepticism, Neurath also appeals to special features of the unpredictability of human knowledge that were central to Popper's case against historicism and to Hayek's view of the market as a discovery procedure. It is a feature of human knowledge and invention that we cannot predict what will be novel and, since social change depends in part on theoretical and practical invention, that we cannot predict social change (Neurath, 1943, p. 148). In his reply to Hayek Neurath points out that this is central to the final sections of the *Foundations of the Social Sciences* in which the unpredictability of the future of knowledge and its implications is stressed in the closing remark of the book. His much used analogy of the development of knowledge, that scientists are like sailors at sea who cannot put into dock but must modify the ship with materials at hand to shore up the vessel, is here used precisely to deny the possibility of anticipating the future of knowledge: 'A new ship grows out of the old one, step by step—and while they are still building, the sailors may already be thinking of a new structure, and they will not always agree with one another. *The whole business will go in a way we cannot even anticipate today.* That is our fate' (Neurath, 1944, p. 47, my emphasis).

3. Physicalism, knowledge and ecological economics

How adequate is Neurath's response to Hayek's criticisms of both socialism and the tradition of ecological economics? There are clear weaknesses and lacunae. His account of

practical knowledge is underdeveloped. While he allows that not all knowledge can be articulated,[1] he never really deals with practical knowledge or judgement adequately. Neurath fails to respond directly to Hayek's argument from the division of knowledge, although his account of unified science addresses some of the same problems (O'Neill, 1999). Finally, it would be a mistake simply to paint Neurath as an environmental thinker. There are many themes in his work, such as his defence of mono-culture in agriculture (Neurath, 1931D), with which most recent ecological and environmental economists would disagree.

However, Neurath does offer an important defence of the central two claims of the tradition of ecological economics which Hayek criticises. He allows that the economy is physically embedded without falling for the kinds of physicalist reductionism that Hayek properly criticises, for example, of treating all decisions through energy units. Hayek, in contrast, clearly overstates his case. Hayek's minimal subjectivism that one cannot give a purely physical characterisation of economic categories such as 'commodity', 'economic good' and 'money' is, I think, correct, as is his argument that one cannot treat economic activity in purely physical terms such as the exchange of energy units. However, his stronger claim, that we should reject 'the more widespread . . . conception of the "objective" possibilities of production' (Hayek, 1942–44, p. 91), does not follow from his minimal claims and is far less plausible. That one cannot give a physicalist reduction of economic categories does not entail that there is not a perfectly good role for physical descriptions and indicators in economic analysis.

Correspondingly, Neurath is right that monetary measures of productivity and growth have to be kept distinct from measures of the physical and institutional changes that are relevant to human welfare, and that what in more recent terms would be called material flow analysis of economies and physical indicators of sustainability have a role in economic theory and policy analysis (Martinez-Alier *et al.*, 2001). He properly notes that monetary measures fail adequately to capture changes in human welfare. Whatever one thinks of Neurath's schemes for an economy in kind, and these in themselves have a strong ecological component (O'Neill, 1999), he does offer against Hayek a rich defence both of economic theory that deals in real wealth, and of non-monetary decision aids that employ in-kind information directly. What Neurath calls in-kind decision-making is close in conception to what would now be called multi-criteria decision analysis, and share the advantages of that approach against attempts to reduce choices to single monetary units through cost–benefit analysis (Martinez-Alier *et al.*, 1998, 1999).

Finally, where Neurath's work on problems of uncertainty and unpredictability does have real strengths against Hayek is in his realisation of the ubiquity of those problems. Ignorance and unpredictability are universal features of social choice:

> Professor von Hayek thinks people think too much of the society as of a factory, as if we were able to predict so much better in a factory. I want to stress the point that in the factory we are not able to predict as comprehensively as Professor von Hayek thinks. I have to over Hayek Professor Hayek, we are not in a position of comprehensive prediction either. (Neurath, 1945A)

The problem of decision-making in conditions of uncertainty is a general feature of social life. All action is 'an anticipation of unpredictable events' (Neurath, 1921, p. 159).

[1] 'I fully accept with professor von Hayek that therefor the community life will be based on COMMON ACCEPTANCE OF CERTAIN RULES the results of which we cannot PROVE in a strict way' (Neurath, 1945A).

The problems of choice in conditions of necessarily uncertain and incomplete knowledge are not new. However, they are coming increasingly to the fore in ecological problems. So also is the recognition of the problem that our decision-making needs at the same time both to rely on scientific expertise and to be open to proper scepticism about its limits: 'Our life is connected more and more with experts, but on the other hand, we are less prepared to accept other people's judgements, when making decisions' (Neurath, 1945C, p. 251). There is no solution to such conflicts—while institutional conditions for social trust are important, scepticism of expertise is not something to be eliminated. Democracy is 'the continual struggle between the expert . . . and the common man' (Neurath, 1945C, p. 251). Democratic deliberative processes are in part about ways of living with that conflict and guarding against the recurrent dangers of technocratic pseudorationalism.

Bibliography

Cartwright, N., Cat, J., Fleck, L. and Uebel, T. 1996. *Otto Neurath: Philosophy Between Science and Politics*, Cambridge, Cambridge University Press

Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel

Cohen, R. S. and Uebel, T. (eds) forthcoming. *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer

Deblonde, M. 2001. *Economics as a Political Muse*, Dordrecht, Kluwer

Feyerabend, P. 1995. *Killing Time: The Autobiography of Paul Feyerabend*, Chicago, University of Chicago Press

Hayek, F. 1937. Economics and knowledge, in *Individualism and Economic Order*, London, Routledge & Kegan Paul

Hayek, F. 1941.'The counter-revolution of science, [*Economica*, vol. 8, 1941, pp. 9–36, 119–50, 281–320] reprinted with revisions in Hayek, F. 1979. *The Counter-Revolution of Science* Indianapolis, Liberty

Hayek, F. 1942–44. Scientism and the study of society, [*Economica*, vol. 9, 1942, pp. 267–91; vol. 10, 1943, pp. 34–63; vol. 11, 1944, pp. 27–9] reprinted with revisions in Hayek, F. 1979. *The Counter-Revolution of Science*, Indianapolis, Liberty

Hayek, F. 1945. The uses of knowledge in society, in *Individualism and Economic Order*, London, Routledge & Kegan Paul

Hayek, F. A. 1960. *The Constitution of Liberty*, Routledge & Kegan Paul

Hayek, F. A. 1978. Competition as a discovery procedure, pp. 179–90 in *New Studies in Philosophy Politics, Economics and the History of Ideas*, Chicago, The University of Chicago Press

Kirzner, I. 1985. *Discovery and the Capitalist Process*, Chicago, The University of Chicago Press

Martinez-Alier, J. 1987. *Ecological Economics*, Oxford, Blackwell

Martinez-Alier, J., Munda, G. and O'Neill, J. 1998. Weak comparability of values as a foundation for ecological economics, *Ecological Economics*, vol. 26, 277–68

Martinez-Alier, J., Munda, G. and O'Neill, J. 1999. Commensurability and compensability in ecological economics, in Spash, C. and O'Connor, M. (eds), *Valuation and Environment: Principles and Practices*, Aldershot, Edward Elgar

Martinez-Alier, J., Munda, G. and O'Neill, J. 2001. Theories and methods in ecological economics: a tentative classification, in Cleveland, J., Stern, D. and Constanza, R. (eds), *The Economics of Nature and the Nature of Economics*, Aldershot, Edward Elgar

Mises, L. von 1966. *Human Action*, Chicago, Henry Regnery

Mises, L. von 1981. *Socialism: An Economic and Sociological Analysis*, Indianapolis, Liberty Press

Neurath, O. 1904. Interest on money in antiquity, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming

Neurath, O. 1909/1918. Economic history of antiquity, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming

Neurath, O. 1909. Remarks on the productivity of money, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming

Neurath, O. 1910. War economy, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming

Neurath, O. 1912. The problem of the pleasure maximum, in Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel
Neurath, O. 1913. The lost wanderers of Descartes and the auxiliary motive, in Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel
Neurath, O. 1916. Economics in kind, calculation in kind and war economics, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming
Neurath, O. 1919. Through war economy to economy in kind, reprinted in Neurath, O. 1973. *Empiricism and Sociology*, Dordrecht, Reidel
Neurath, O. 1920A. Total socialisation, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming
Neurath, O. 1920B. A system of socialisation, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming
Neurath, O. 1921. Anti-Spengler, in Neurath, O. 1973. *Empiricism and Sociology*, Dordrecht, Reidel
Neurath, O. 1925. Economic plan and calculation in kind, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer, forthcoming
Neurath, O. 1931A. Physicalism, in Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel
Neurath, O. 1931B. Sociology in the framework of physicalism, in Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel
Neurath, O. 1931C. Empirical sociology, in Neurath, O. 1973. *Empiricism and Sociology*, Dordrecht, Reidel
Neurath, O. 1931D. The current growth in global productive capacity, in Cohen, R. S. and Uebel, T. (eds), *Otto Neurath: Economic Writings 1904–1945*, Dordrecht, Kluwer forthcoming
Neurath, O. 1935A. Pseudorationalism of falsification, in Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel
Neurath, O. 1935B. The unity of science as a task, in Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel
Neurath, O. 1937. Inventory of the standard of living, *Zeitschrift for Sozialforschung*, vol. 6, 140–51
Neurath, O. 1940. Argumentation and action, *The Otto Neurath Nachlass in Haarlem*, vol. 198, K. 41
Neurath, O. 1941A. The danger of careless terminology, *The New Era*, vol. 22, 145–50
Neurath, O. 1941B. Universal jargon and terminology science, in Cohen, R. S. and Neurath, M. (eds) 1983. *Otto Neurath: Philosophical Papers*, Dordrecht, Reidel
Neurath, O. 1942. International planning for freedom, in Neurath, O. 1973. *Empiricism and Sociology*, Dordrecht, Reidel
Neurath, O. 1943. Planning or managerial revolution (Review of J. Burnham *The Managerial* Revolution), *The New Commonwealth*, 148–54
Neurath, O. 1944. *Foundations of the Social Sciences*, Chicago, University of Chicago Press
Neurath, O. 1945A. Physicalism, planning and the social sciences: bricks prepared for a discussion v. Hayek, 26th July, 1945, *The Otto Neurath Nachlass in Haarlem*, vol. 202, K. 56
Neurath, O. 1945B. Neurath–Hayek correspondence, 1945, *The Otto Neurath Nachlass in Haarlem*, vol. 243
Neurath O. 1945C. Visual education: humanisation versus popularisation, in Nemeth, E. and Stadler, F. 1996. *Encyclopedia and Utopia*, Dordrecht, Kluwer
Neurath, O. 1946. After six years, *Synthese*, vol. 5, 77–82
O'Neill, J. 1993. *Ecology, Policy and Politics: Human Well-Being and the Natural World*, London, Routledge
O'Neill, J. 1996. Who won the socialist calculation debate?, *History of Political Thought*, vol. 27 431–42
O'Neill, J. 1997A. King Darius and the environmental economist, in O'Neill, J. and Hayward, T. (eds), *Justice, Property and the Environment: Social and Legal Perspectives*, Aldershot, Avebury
O'Neill, J. 1997B. Hayek and the positivists, in Frowen, S. (ed.), *Hayek the Economist and Social Philosopher: A Critical Retrospect*, London, Macmillan
O'Neill, J. 1998. *The Market: Ethics, Knowledge and Politics*, London, Routledge
O'Neill, J. 1999. Ecology, socialism and Austrian economics, in Nemeth, E. and Heinrich, R. (eds), *Otto Neurath: Rationalität, Planung, Vielfalt*, Weiner Reihe, Vienna

O'Neill, J. 2001. Markets and the environment: the solution is the problem, *Economic and Political Weekly*, vol. 36, 1865–73

O'Neill, J. 2002. Socialist calculation and environmental valuation: money, markets and ecology, *Science and Society*, vol. 66, 137–51

Popper, K. 1944–45. The poverty of historicism [*Economica*, vol. 11, 1944, 86–103 and 119–37; vol. 12, 1945, 69–89] reprinted with revisions in *The Poverty of Historicism*, London, Routledge, 1986

Uebel, T. 1992. *Overcoming Logical Positivism from Within: The Emergence of Neurath's Naturalism in the Vienna Circle's Protocol Sentence Debate*, Amsterdam, Rodopi

Uebel, T. 2000. Some scientism, some historicism, some critics: Hayek's and Popper's critiques revisited, in Stone, M. and Wolff, J. (eds), *The Proper Ambition of Science*, London, Routledge