

**The links between uncertainty and reality:  
individuals, institutions and technology**

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Abstract

In an attempt to refine the concept of uncertainty, this paper elaborates the ontology of the social world by dealing with individuals, institutions, and technology. In each case, it shows the strong intertwinement between these ontological aspects of the conceptualization of uncertainty and epistemological ones, avoiding an excessive emphasis on their separation. It highlights the ontological and epistemological dimensions of different concepts of uncertainty, such as fundamental uncertainty, procedural uncertainty, ambiguity, and weak uncertainty (or risk). It also comments on a few writings that distinguish varieties of uncertainty with adjectives such as 'ontological' and 'epistemological' or 'epistemic'.

Introduction

The concept of uncertainty has received growing attention from economists. The dominant, neoclassical view on this issue has been challenged on several grounds, and alternative notions have been proposed. The discussion of uncertainty is closely related to probability, and different conceptions of probability underpin the different ways in which uncertainty has been expressed. One important distinction is that between the theories of probability in which probability is a property of the way one thinks about the world, a degree of belief, and those theories where probability is a property of the real world. Keynes's logical theory of *A Treatise on Probability* and the subjective probability theory of Ramsey and de Finetti are examples of the former, while the frequency theory belongs in the second category. Lawson (1988) provides a useful classification of concepts of probability and uncertainty in economics along these lines. He shows that uncertainty has been differently defined as a situation in which probability (in one of those two conceptions) is measurable or immeasurable.

Admittedly, this distinction is not sufficient to capture the variety of approaches to probability and, by extension, to uncertainty. Indeed, the variety of, and discrepancies among, approaches to probability are such that the controversial nature of the subject is evident. In any case, this distinction already provides a first indication of the relevance of ontology and epistemology to the discussion of uncertainty.

In the case of the economic literature, it is necessary to introduce or to discuss more adequately some important ontological aspects of the conceptualization of uncertainty, as well as to show the strong intertwinement between these aspects and epistemological ones, avoiding an excessive emphasis on their separation. The main objective of this paper is to advance along these lines, continuing a broader discussion about the concept of uncertainty in previous articles (Dequech, 1997, 2000). Additionally, some comments will be made on a few writings that, in different schools of economic thought, characterize or distinguish varieties of uncertainty with adjectives such as ‘ontological’ and ‘epistemological’ or ‘epistemic’.

These writings are briefly reviewed in the first section, as a way of presenting some of the issues involved. In contrast with the terminology adopted in these writings, section 2 identifies the general sense in which the conception of uncertainty can be seen as having both an ontological and an epistemological dimension. Always with special concern with the concept of uncertainty, the three subsequent sections elaborate the ontology of the social world and argue that it is strongly connected with epistemology. Section 3 deals with individuals; section 4 deals with institutions; and section 5 deals with technology. Concluding remarks follow.

### 1. Epistemological/epistemic uncertainty versus ontological/aleatory uncertainty

Paul Davidson (e.g., 1996), a leading Post Keynesian economist, distinguishes what he calls ‘ontological uncertainty’ from ‘epistemological uncertainty’. Davidson’s distinction between these two types of uncertainty is based on a distinction between two types of economic reality, which he calls ‘immutable’ and ‘transmutable’ reality, respectively. An ‘immutable’ reality is one in which ‘the future path of the economy and the future conditional consequences of all possible choices are predetermined’; in a ‘transmutable reality’, in contrast, ‘the future can be permanently changed in nature and substance by the actions of individuals, groups ... and/or governments, often in ways not completely foreseeable by the creators of change’ (Davidson, 1996, pp. 479-80, 482). Using the language originally developed in the theory of stochastic processes, Davidson also calls an immutable reality a nonergodic environment. In this type of reality, there is ‘ontological uncertainty’, while in an immutable economic reality there is ‘epistemological uncertainty’ when ‘some limitation on human ability ... prevents agents from using (collecting and

analyzing) historical time-series data to obtain short-run reliable knowledge regarding *all* economic variables (Davidson, 1996, pp. 484-86). Davidson's influence, especially among Post Keynesians, contributes to making other authors also adopt these terms.

Mark Perlman and Charles McCann (1996), two erudite historians of economic thought, argue along similar lines, but with a somewhat different wording, borrowed from a segment of the literature on probability. First, following Lawson (1988), they note that different conceptions of uncertainty have been associated with different conceptions of probability. Then, explicitly following Hacking (1975), Perlman and McCann use the adjectives 'epistemic' to denote probability in the sense of (a degree of) belief and 'aleatory' to denote probability in the sense of a feature of reality. Finally, Perlman and McCann (1996, p. 17) define 'aleatory' and 'epistemic uncertainty' as follows: 'Aleatory uncertainty refers to a factual uncertainty (...). Epistemic uncertainty refers to an uncertainty existing because the mind has its opinions (...) and because it cannot apprehend more than a limited sphere'. Later, McCann and Perlman (1998, p. 185n) also use the adjective 'ontological' to designate what they initially called 'aleatory uncertainty'.

It should be noted that, unlike Perlman and McCann, Davidson does not refer to the distinction between 'epistemic' and 'aleatory probability' and can use the term 'epistemic uncertainty' even to characterize notions of uncertainty based on an aleatory concept of probability. If aleatory probabilities are unknown to a decision-maker because of his/her mental and computational limitations, this is a case of 'epistemic uncertainty' for Davidson.

André Orléan, a major exponent of the French school of the 'economics of conventions', uses the expression 'epistemic uncertainty', but he does not mean by it what the authors mentioned in the preceding paragraphs call 'epistemological' or 'epistemic uncertainty'. In addition, he does not define 'epistemic uncertainty' in opposition to 'ontological uncertainty' or the like. For Orléan (1987, p. 154, original emphasis, my translation), 'the historical movement constantly places agents in experiences for which there is no precedent. In other words, *novelty is at the heart of the notion of uncertainty*'. He believes this is also true in the cases of Knight, Keynes and Shackle, but he is not happy with the way in which uncertainty is usually defined. For Orléan (1987, p. 156), the basic problem that defines situations of uncertainty has an *epistemological* nature. 'New events or propositions are those for which there is, in

the constituted body of knowledge, no basis for comparison allowing an assessment of their plausibility'. Orléan then resorts to Popper's (1982) argument that the unpredictability of the future stems from the fact that we cannot predict what our own knowledge will be in the future. 'This is the source of the unpredictable novelty that invalidates the probabilistic approach. ... In order to underline its epistemological nature, we will keep the term epistemic to designate this uncertainty' (Orléan, *idem*).

Orléan (1989, p. 246) explains that his use of the expression 'epistemic uncertainty' is also intended to underline the important influence of Shackle on his conception of uncertainty. The Schaklean influence may also be noted when Orléan (1989, pp. 248-49) argues that under uncertainty there is an irreducible space left to the individual imagination. In this later article, Orléan (1989, p. 243) uses, as examples of novel events, 'qualitative mutations in products and tastes, or technological innovations'. Moreover, he adds that these events could not be considered the result of stationary processes (see also Orléan, 1989, p. 249 on non-stationarity). Thus, although Orléan uses the expression 'epistemic uncertainty' to denote the type of uncertainty he is discussing, his approach bears some resemblance with Davidson's, which, not accidentally, is also influenced by Shackle. It must be noted, however, that no explicit link is established by Orléan between what he identifies as the epistemic nature of the uncertainty problem and the non-stationarity of stochastic processes or, more generally, between epistemology and ontology.

Closer to standard, neoclassical economics, decision theorist Peter Fishburn (1994, p. 137) establishes another distinction between 'aleatory' and 'epistemic uncertainty'. 'Aleatory uncertainty' corresponds to 'chance that affects stochastic phenomena not yet consummated'. This, which seems to correspond to Knightian risk, he distinguishes from 'epistemic uncertainty' or 'uncertainty about the way things really are which is engendered by limited knowledge or lack of understanding'. The examples Fishburn uses to clarify these definitions indicate that, once 'epistemic uncertainty' is solved, one can calculate unambiguous probabilities, and only 'aleatory uncertainty' is left. Epistemic uncertainty refers, for instance, to the fairness of a coin, to the specific contents of an urn with balls of different colours (as in the Ellsberg paradox, which is Fishburn's concern), etc.

The expressions 'aleatory' and 'epistemic uncertainty' have also been used in psychology, most often as synonyms for what Kahneman and Tversky (1982, p. 150) call 'external' and 'internal uncertainty', respectively. Given that these two authors

have published in important economic journals and are known to several economists, it may be interesting to mention them here. Their distinction refers to the loci to which uncertainty can be attributed. ‘External uncertainty’ is attributed to causal systems in the external world, which have ‘dispositions’ to produce different events. In contrast, ‘internal uncertainty’ is attributed to one’s mind, that is, to a factor internal to the individual. According to Kahneman and Tversky (1982, p. 155), who do not refer to ‘aleatory’ and ‘epistemic probability’, [t]here are natural links between the conceptions of probability advanced by different schools of thought on this topic and the modes of uncertainty that we have discussed. Thus, the frequentist or objective interpretation of probability restricts the concept to external uncertainty generated by a sampling process. In contrast, the Bayesian or personal school treats all uncertainty as ignorance [internal uncertainty]’. On a closer look, however, Kahneman and Tversky’s taxonomy of uncertainty does not seem to correspond exactly to the ones found in economics and mentioned in this section. The examples of internal uncertainty presented by these authors refer only to the present or the past. Indeed, Kahneman and Tversky (1982, p. 152) write: ‘Uncertainty about past events is likely to be experienced as ignorance [internal uncertainty], especially if the truth is known to someone else, whereas uncertainty about future events is more naturally attributed to the dispositions of the relevant system’.

## 2. Uncertainty as ontological and epistemological: an initial statement

In principle, the so-called epistemic theories of probability and the associated theories of uncertainty are not interested in the nature of reality; neither are the so-called aleatory or ontological theories of probability and uncertainty particularly concerned with knowledge. It can be argued, however, that the conception of uncertainty has both an ontological and an epistemological dimension. In my view, the notion of uncertainty is always epistemological in the sense that it is associated with the lack of some kind of knowledge, and knowledge is the subject matter of epistemology; at the same time, the notion of uncertainty always has an associated view of reality, and therefore has an ontological counterpart, given that ontology refers to the study of the nature of reality. Accordingly, it is possible to derive some ontological claims from the so-called epistemic theories of uncertainty, as well as some epistemological claims from the so-called ontological theories.

An ontological characterization of reality as subject to non-predetermined

structural change implies, as its epistemological counterpart, a lack of knowledge. Thus, Davidson's notion of 'ontological uncertainty' *implies* an *epistemological* statement about what people cannot know.

This is one example of my previous argument that the notion of uncertainty has both an ontological and an epistemological dimension: a feature of reality – the possibility of non-predetermined structural changes – has as its epistemological counterpart some lack of knowledge – a type of uncertainty which may be called *fundamental uncertainty*, following Dequech (2000).

Similarly, Davidson's notion of 'epistemological uncertainty' *implies*, or is implicitly based on, an *ontological* characterization of reality, because it implies that *reality is complex*, at least to some degree. If the world were very simple, people's limited mental capabilities would not matter, and what Davidson calls 'epistemological uncertainty' would not exist. Thus, what users of this notion of 'epistemological uncertainty' are really saying is that people's mental capabilities are limited *relative to* the complexity of the environment where they act.

This is in fact what Herbert Simon (1959, p. 273, among several writings), North (1990, p. 25) and others maintain. Thus, it is not quite right to say that Simon's theory of bounded rationality, for example, relates "uncertainty" to the decision-maker and not to the nature of the environment (Bianchi, 1990, p. 150; Quinet, 1994, p. 165), even if Simon himself may have occasionally suggested that (Simon, 1976, p. 79). Simon's theory compares the complexity of the situation with people's capabilities. The lack of knowledge that results from this is as much reality's fault as it is the agent's, if we have to blame someone or something.

This is another example of the previous argument about the two dimensions of the notion of uncertainty: a feature of reality – complexity, in the present case – has as its epistemological counterpart some lack of knowledge – a type of uncertainty for which an alternative label could be *procedural uncertainty*, following Dosi and Egidi (1991).

It is true that, in contrast to procedural uncertainty, fundamental uncertainty is in no way a result of some deficiency on the agent's part. However, this should not be taken to mean that the notion of fundamental uncertainty has no epistemological content, if we understand 'epistemological' in the usual philosophical sense. Likewise, the notion of procedural uncertainty also has some ontological content. In other words, such a notion is also ontological, if by that one means that it is based on

a specific ontology.

Although less clear in some respects, an ontology may also be said to underlie the notion of ambiguity, defined as ‘uncertainty about probability, created by missing information that is relevant and could be known’ (Camerer and Weber, 1992, p. 330). As discussed in Dequech (2000), this type of uncertainty is associated with a reality in which the list of possible future states of the world is predetermined, even if not known. One may add to this characterization of reality the existence of some obstacle or barrier that prevents decision-makers from knowing the missing information. Some recent papers connect ambiguity with complexity (see Dequech, 2001, for references), but this connection does not exist in the Ellsberg paradox, the classic example in the ambiguity literature.

### 3. More on the ontology of the social world: individuals

When one is dealing with the *social world*, *the features of the social actors are also part of the ontological characterization*. Among these features are the ones related to the human ability to think and to know. In this specific sense, therefore, the ontology of the social world is inevitably connected with epistemology.

Thus, in (at least some variants of) neoclassical economics, there is an (often implicit) assumption that the ontology of the social world is such that either this world is *not complex* or it is inhabited by people with *extremely powerful minds and/or computers*. A possible exception is the ‘as if’ version of the maximization hypothesis, according to which people may just act ‘as if’ they processed all the information and performed all the calculations necessary to maximize expected utility or profit. Nevertheless, to the extent that proponents of this approach claim that reality is indeed inhabited by people who behave ‘as if’ they did something, one might say that there is in fact an underlying conception of reality. This conception attributes some characteristics to people or to their actions; moreover, it can be said to include the existence of a selection mechanism or incentives for agents to behave (as if) in a particular way – competition, for example, is supposed to stimulate firms to act as if maximizing profit.

In Simon’s theory, to use this important example again, the ontological conception of social reality is such that this reality is not just complex, but also inhabited by people with *limited mental and computational abilities*. Davidson’s (1996) notion of ‘epistemological uncertainty’ is implicitly based on a similar

ontology.

Another example is the notion of ambiguity: it implies that agents are not creative, but their mental capabilities may be unlimited and yet some information may be kept hidden from them.

A connection between ontology and epistemology also appears in Lewis and Runde's (1999, p. 37) observation that Davidson treats the ability of agents to understand economic reality as an ontological question, even though it 'involves epistemological considerations concerning how and to what extent actors apprehend and understand their reality'. Lewis and Runde (*idem*) seem to support Davidson's treatment with the statement that 'claims to the effect that there are economic actors who understand economic reality – who have perfect knowledge, rational expectations, "sensible expectations", and so on – are ontological claims'.

The argument that the ontology of the social world is linked to epistemology is actually broader than what has been discussed so far, even in relation to the characteristics of social actors. The fact that what people know changes and that there is no way of knowing in advance what is going to be known in the future is also a crucial aspect of the ontological characterization of reality. Put differently, this ontological characterization includes social actors who not only think and know, but also *learn*, that is, create or acquire *new knowledge*. Thus, the ontological *changeability* (or *transmutability*, in Davidson's terms) of the social world is also connected with epistemology. To put it differently, the argument of the unpredictability of future knowledge is related not only to epistemology, as in Orléan's (1987, 1989) discussion of 'epistemic uncertainty', but also to ontology.

Accordingly, in the ontological conception of social reality underlying the notion of fundamental uncertainty, this reality is subject to structural changes at least in part because it is inhabited by *potentially creative* people – who should *also* be described as having limited mental and computational abilities.

A suggestion of the argument developed in this section appears in Dequech (1997), with a combination of: (1) a definition of uncertainty on the basis of an ontological characterization of reality as subject to structural change and creativity; and (2) the choice of the change in knowledge as the first example of a source of this type of uncertainty. This is a good example to start with because future knowledge is not knowable in advance, by definition. The future is affected by our knowledge and we cannot know now what is going to be known later (Dequech, 1997, p. 29). The



link between ontology and epistemology concerning the characterization of social actors as thinking, knowing and learning is made more explicit and discussed in more detail in the present paper. This can be identified as a missing link in Orléan's (1987, 1989) contribution.

#### 4. More on the ontology of the social world: institutions

The ontology of the social world can be further elaborated by bringing institutions into consideration. In other words, there is more to social ontology than saying that reality is complex or that it is subject to non-predetermined structural change, and characterizing social actors accordingly.

The concept of fundamental uncertainty presented in Dequech (2000), for example, is based on the characterization of social reality not only as subject to non-predetermined structural changes and inhabited by potentially creative individuals, but also as including institutions. Among the latter are legal institutions such as contracts and market-makers, which affect the nominal value of important economic variables, and informal institutions or conventions. The epistemological counterpart of the possibility of non-predetermined structural change is fundamental uncertainty, as a lack of knowledge, while the inclusion of institutions has as its epistemological counterpart the possibility of some kind of knowledge (for example, about the future value of some nominal variables), so that fundamental uncertainty does not imply complete ignorance. Accordingly, one can speak of (ordinal) degrees of fundamental uncertainty, which vary with institutions. As this has been discussed in some detail in Dequech (2000), it need not detain us here.

In an analogous manner, several authors (e.g.: Simon, 1958; Langlois, 1986; North, 1990, p. 25) have suggested that institutions contribute to reducing complexity – and therefore, I would say, to reducing procedural uncertainty. When arguing that institutions reduce complexity, these authors do not necessarily or explicitly refer to ontology, but it is worth noting that some of them characterize institutions as 'structures' (Langlois, 1986, p. 247) or as 'providing a structure to everyday life' (North, 1990, p. 3).

The consideration of institutions in the ontology of the social world implies another connection between ontology and epistemology. Institutions may be defined as socially shared and/or prescribed standards of behaviour and thought. Based on the work of several institutionalists, I have suggested elsewhere that one of the types of

influence that institutions have on economic behaviour is through their *cognitive function*. This cognitive function refers, firstly, to the information that institutions provide to the individual, including the indication of the likely action of other people. I call this *the informational-cognitive function* of institutions. Secondly, the cognitive function of institutions includes also their influence on the very perception that people have of reality, that is, on the way people select, organize and interpret information. I call this their *deeper cognitive function*.

Through this cognitive function, in either of its two forms, institutions contribute to the stability of the social world, by stabilizing people's way of acting. They can do this directly, through a process of tacit knowledge transmission or learning by doing (that is, learning by taking part in institutions), and indirectly, through their influence on people's explicit way of thinking. This in turn helps reproduce institutions.

The deeper cognitive function of institutions, in particular, means that learning takes place within a specific institutional structure. Moreover, this deeper cognitive function (together with what I call the motivational or teleological function of institutions) means that institutions are not reducible to individual thought and practice, because it implies that individuals are not given in relation to institutions.

The intertwinement between ontology and epistemology (and between action and cognition) in relation to institutions becomes perhaps even stronger if institutions can be said to *embody* knowledge. While such a characterization is not often made explicit in the economic literature (for an exception, see Langlois, 1992, p. 167), it may emerge from a combination of two ideas comparatively widespread in some heterodox circles. First, habits and routines embody 'tacit' or 'practical' knowledge. Second, institutions are sometimes described as social habits (e.g.: Veblen, *apud* Hodgson, 1988, p. 126; Neale, 1987).

#### 5. More on the ontology of the social world: technology

Another important way to elaborate on the ontology of the social world is by discussing technology. Again, we may begin with the characterization of reality underlying the concept of fundamental uncertainty. Indeed, technological innovation (together with managerial or organizational innovation) is arguably the best example of non-predetermined structural change and of human creativity in the economic sphere (Dequech, 1997, 2000). To put it differently, if technological innovation is

properly considered, then the uncertainty associated with it is of the fundamental kind.

While the possibility of technological innovation is an important example of the changeability of social reality, and therefore leads to fundamental uncertainty, some features of the process of technological innovation contribute to creating some order and an ontological basis for some kind of knowledge, even in such a changeable reality. In this sense, technology performs a role similar to that of institutions. Accordingly, even the uncertainty regarding innovations can be a matter of degrees, as argued by Freeman (1982, pp. 149-50) and other neo-Schumpeterian economists.

Indeed, the question of whether there are regularities in the process of technological innovation and progress has been examined in detail in the so-called neo-Schumpeterian or evolutionary economics. In this regard, Dosi (1982) has proposed the concept of 'technological trajectory', which is in turn based on the concept of 'technological paradigm' (see also Nelson and Winter, 1982, pp. 258-59 on 'natural trajectories' and 'technological regimes'). By analogy with Thomas Kuhn's famous notion of scientific paradigm, Dosi (1982, p. 148) defines a technological paradigm as 'an "outlook", a set of procedures, a definition of the "relevant" problems and of the specific knowledge related to their solution'. He then calls a technological trajectory 'the direction of advance within a technological paradigm'. More specifically, a technological paradigm is '[a] "model" and a "pattern" of solution of *selected* technological problems, based on *selected* principles derived from natural sciences and on *selected* material technologies'. A technological trajectory is then defined as 'the pattern of "normal" problem solving activity (i.e. of "progress") on the ground of a technological paradigm' (Dosi, 1982, p. 152). Incremental technological innovations take place within previously existing technological paradigms, whereas radical innovations may also happen which are associated with the establishment of new technological paradigms.

The relatively ordered character of the patterns of technological change is explained mostly by the paradigmatic cumulative nature of technological knowledge (Dosi, 1988, p. 1129).

Still according to Dosi's (1988) survey of the innovation literature, before a technological paradigm is established, the uncertainty involved in innovative search is highest. Afterwards, there is a reduction in uncertainty, as the paradigm constrains the development of technology over time, allowing the prediction of likely patterns of

innovative activities in firms, industries, and countries: ‘However, even in the case of “normal” technical search (as opposed to the “extraordinary” exploration associated with the quest for new paradigms) strong uncertainty is present’, so that the list of possible events is still unknown, as are the consequences of particular actions for any given event (Dosi, 1988, p. 1134). Consequently, one could add, even in this case technological change is an example of non-predetermined structural change – this is important to stress the point that fundamental uncertainty may be reduced but not eliminated.

Regarding the reduction of uncertainty by the establishment of a technological paradigm, it is worth noting that this paradigm proposes a set of heuristics or prescriptions, including a ‘negative heuristic’, which leads to the exclusion of some technological possibilities: ‘the efforts and the technological imagination of engineers and of the organizations they are in are focussed in rather precise directions while they are, so to speak, “blind” with respect to other technological possibilities’ (Dosi, 1982, pp. 152-53). A parallel may be established between this and the idea that the existence of some institutions, depending on how widespread they are, may reduce uncertainty by ruling out at least some events or outcomes which would be possible or more likely otherwise (Dequech, 2000).

The intertwining of ontology and epistemology is also quite strong in the case of technology. Perhaps the least controversial argument supporting this claim is that technological knowledge is in part embodied in physical objects, such as machines. By the same token, technological innovations consist of the application or *materialization* of new knowledge (Dequech, 1997).

Moreover, the above-mentioned idea that tacit or practical knowledge may be embodied in habits and routines also applies to, and in some cases was originally formulated with special concern with, technological knowledge.

Habits and routines may be specific of an individual or a small group of people, so that they are not necessarily institutions. However, some aspects of technological knowledge and of the process of technological learning and development are institutionally shared, and help define a technological paradigm. For example: ‘It quite often happens that prototypical problem-solving models, rules on how to search and on what target to focus, and beliefs as to “what the market wants” become the shared view of the engineering community’ (Dosi, 1988, p. 1128). In this sense, the discussion here intersects with that about institutions, in the previous

section. In particular, the informal institutions that are part of the social ontology in Dequech (2000) include those related to technology. Furthermore, if institutions are broadly defined so as to include organizations, then, as Dosi (*idem*) argues, ‘a paradigm is economically exploited and reproduced over time also through the development of institutions [schools, for example] that train the would-be practitioners’.

The link between ontology and epistemology appears not only in the *existing* technology, but also in the process of technological *change*, which is particularly relevant to a discussion of uncertainty. First, the physical characteristics of the material technology used within a technological paradigm can, in my view, be treated as part of the constraints that bound a technological trajectory within this paradigm. Indeed, according to Dosi (1988, p. 1127), among the defining characteristics of a technological paradigm are the technical properties of an ‘exemplar’, an artifact to be developed and improved, such as a car, an integrated circuit, etc. Second, as seen above, the *cumulative* nature of technological *knowledge* (or, in other words, of the underlying *learning* process) is a crucial source of relative order in the pattern of technological change.

## 6. Conclusion

This paper has discussed the conception of economic reality underlying some different notions of uncertainty. Four aspects of reality have been highlighted. The first is whether reality is subject to non-predetermined structural change or not. This is the main concern of Davidson (1996). Second, the individuals that populate the economic world should also be seen as part of reality. Their characterization, which is often implicit in the literature, may attribute different qualities to them: individuals may be potentially creative or not; and they may have limited mental and computational capabilities or not. Third, institutions may be included or not, and their influence on individual behaviour may be understood in different ways. Finally, technology and the characteristics of the process of technological change may be included or not.

In the case of fundamental uncertainty, economic reality is subject to non-predetermined structural changes. This is essentially the same aspect emphasized in the conception of reality underlying Davidson’s (1996) notion of ‘ontological uncertainty’. Such a conception of reality has been explicitly elaborated here in three

related senses. First, the world is inhabited by potentially creative individuals, who not only think and know, but also learn, i.e. acquire or create new knowledge. Second, there are formal (legal) and informal institutions that may generate stability and order even in such a reality. They influence economic behaviour in different and, in some cases, fundamental ways. Of particular interest for a discussion of uncertainty is the cognitive function of institutions. Third, technology and the characteristics of the process of technological change also may, like institutions, generate relative stability and order.

In the case of procedural uncertainty, economic reality is complex and populated by individuals with limited mental and computational capabilities. This characterization is compatible with different conceptions of reality in terms of the (im)possibility of non-predetermined structural change and of creative individual behaviour. There are two alternative view of procedural uncertainty. If that possibility is recognized, the notion of procedural uncertainty is compatible with, and complementary to, the notion of fundamental uncertainty. This is the view defended here. Alternatively, that possibility may not be recognized. This variant of procedural uncertainty is incompatible with fundamental uncertainty. In either variant of procedural uncertainty, the underlying conception of reality may include institutions. The complexity of technology and technological change may also be considered. However, only the first variant of procedural uncertainty is compatible with a proper treatment of technological innovation, as an important example of non-predetermined structural change and creativity.

In the case of standard, weaker notions of uncertainty, either economic reality is not complex or it is inhabited by people who have (or behave as if they had) extremely powerful minds and/or computers. Institutions are only constraints to individual behaviour and do not matter much. Technological innovation is not properly considered either.

These different conceptions of reality have different counterparts in terms of the lack and/or the possibility of knowledge, particularly knowledge about the future.

If reality is subject to non-predetermined structural change and its inhabitants are potentially creative, some lack of knowledge about the future inevitably follows. If this conception of reality is not elaborated, this ignorance may be complete and not a matter of degrees. In contrast, it has been argued here that institutions and technology do create the basis for some knowledge about the future even in such a

reality. Fundamental uncertainty, then, does not imply complete ignorance and comes in degrees. As the degree of perceived fundamental uncertainty varies with the knowledge of institutional and technological factors, this knowledge can be a determinant not only of expectations, but also of uncertainty perception and, consequently, of the confidence held in expectations (Dequech, 1999).

Likewise, institutions may also generate some knowledge in a complex reality, and procedural uncertainty too is a matter of degrees.

Much more knowledge is possible in the reality associated with weaker notions of uncertainty. Uncertainty is then measured by probability degrees.

The characterization of economic reality in terms of the aspects mentioned above and possibly others corresponds to the ontological dimension of the concept of uncertainty. Its epistemological counterpart is the lack and the (im)possibility of knowledge in a reality with the respectively specified characteristics. In this sense, uncertainty is always ontological and epistemological, given the definitions of ontology and epistemology. Going beyond this rather general point, it has been argued here that the ontology and epistemology of the social world are strongly intertwined, particularly in relation to uncertainty. First, the characteristics of the individuals who inhabit this world include the ability to: (a) think and know; and (b) learn, creating or acquiring new knowledge, which is especially relevant to a discussion of uncertainty. Second, institutions perform a cognitive function (in two forms, one deeper or more fundamental than the other); moreover, institutions embody knowledge. Third, regarding the existing technology, technological knowledge is embodied not only in physical objects but also, tacitly, in habits, routines and institutions; regarding technological change, which is a vital source of (fundamental) uncertainty in economic contexts, its relatively ordered character is to a large measure due to the paradigmatic cumulative nature of technological knowledge.

The points summarized so far can be made regardless of which nouns or adjectives one chooses to denominate the different types of uncertainty. These points are more important than those regarding the labelling of uncertainty. The importance of labelling is not negligible, though. The fact that the terms ‘aleatory’ and ‘epistemic’ have been used in part of the literature on probability may provide an incentive to use them when dealing with uncertainty, as Perlman and McCann (1996) do. In this specific sense, these terms may facilitate communication, at least among those familiarized with the distinction between ‘epistemic’ and ‘aleatory probability’.

On the other hand, as suggested above, using the term ‘epistemic’ to describe a type of uncertainty may be confusing. The same applies to the term ‘ontological’, if not to the term ‘aleatory’. Different features of reality may imply a lack of knowledge (uncertainty). The expression ‘ontological uncertainty’ does not indicate *which* ontological characterization of reality is being employed. Moreover, using the terms ‘ontological’ and ‘epistemic’/‘epistemological’ to characterize uncertainty may obscure the intertwinement of ontological and epistemological issues. For these reasons, alternative labels have been used here.

## References

- Beckert, J. 1996. What is sociological about economic sociology? Uncertainty and the embeddedness of economic action, *Theory and Society*, 25(6): 803-40.
- Bianchi, M. 1990. The unsatisfactoriness of satisficing: from bounded rationality to innovative rationality, *Review of Political Economy*, 2(2): 149-67.
- Butos, W. and Koppl, R. 1997. The Varieties of Subjectivism: Keynes and Hayek on Expectations, *History of Political Economy*, 29(2): 327-59
- Camerer, C. and Weber, M. 1992. Recent Developments in Modelling Preferences: Uncertainty and Ambiguity, *Journal of Risk and Uncertainty*, 5(4): 325-70.
- Clark, A. 1997. Economic Reason: The Interplay of Individual Learning and External Structure, in Drobak, J. and Nye, J. (eds.), *Frontiers of New Institutional Economics*, San Diego, Academic Press.
- Coricelli, F. and Dosi, G. 1988. Coordination and order in economic change and the interpretative power of economic theory, in Dosi *et alli* (eds.).
- Crocco, M. 2000. The future’s unknowability: Keynes’s probability, probable knowledge and the decision to innovate, in Louçã, F. and Perlman, M. (eds.), *Is Economics an Evolutionary Science?*, Aldershot, Elgar.
- Davidson, P. 1996. Reality and economic theory, *Journal of Post Keynesian Economics*, 18(4): 479-508.
- Dequech, D. 1997. Uncertainty in a strong sense: meaning and sources, *Economic Issues*, 2(2): 21-43.
- Dequech, D. 1999. Expectations and confidence under uncertainty, *Journal of Post Keynesian Economics*, 21(3): 415-30.
- Dequech, D. 2000. Fundamental uncertainty and ambiguity, *Eastern Economic Journal*, 26(1): 41-60.
- Dequech, D. 2001. Bounded Rationality, Institutions, and Uncertainty, *Journal of Economic Issues*, 35(4): 911-29.
- Dosi, G. 1982. Technological paradigms and technological trajectories, *Research Policy*, 11: 147-62.
- Dosi, G. 1988. Sources, Procedures, and Microeconomic Effects of Innovation, *Journal of Economic*



*Literature*, 26: 1120-71.

- Dosi, G. and Egidi, M. 1991. Substantive and procedural uncertainty - an exploration of economic behaviour in changing environments, *Journal of Evolutionary Economics*, 1(2): 145-68.
- Dosi, G. and Orsenigo, L. 1988. Coordination and transformation: an overview of structures, behaviours and change in evolutionary environments, in Dosi, G. *et alli* (eds.).
- Dosi, G. *et alli* (eds.) 1988. *Technical Change and Economic Theory*, London, Pinter.
- Fishburn, P. 1994. A variational model of preference under uncertainty, *Journal of Risk and Uncertainty*, 8: 127-52.
- Forstater, M. 2001. Technology and transsubjective structural context, presented at the Association for Evolutionary Economics Annual Meeting, New Orleans.
- Freeman, C. 1982. *The Economics of Industrial Innovation*, London, Pinter, 2nd edition.
- Hacking, I. 1975. *The Emergence of Probability*, Cambridge, Cambridge University Press.
- Hodgson, G. 1988. *Economics and Institutions*, Philadelphia, University of Pennsylvania Press.
- Hodgson, G. 1999. Structures and Institutions: Reflections on Institutionalism, Structuration Theory and Critical Realism, presented at the EAEPE Conference, Prague.
- Kahneman, D. and Tversky, A. 1982. Variants of uncertainty, *Cognition*, 11: 143-57.
- Langlois, R. 1985. Knowledge and Rationality in the Austrian School: an Analytical Survey, *Eastern Economic Journal*, 9(4): 309-30.
- Langlois, R. 1986. Rationality, institutions, and explanation, in Langlois, R. (ed.), *Economics as a process: essays in the new institutional economics*, Cambridge, Cambridge University Press.
- Langlois, R. 1992. Orders and organizations: toward an Austrian theory of social institutions, in Caldwell, B. and Boehm, S. (eds.), *Austrian Economics: Tensions and New Directions*, Boston, Kluwer.
- Lawson, T. 1985. Uncertainty and the Keynesian Revolution in America, Cheltenham, Elgar.
- Neale, W. 1987. Institutions, *Journal of Economic Issues*, 21(3): 1177-1206.
- Nelson, R. 1994. The Co-evolution of Technology, Industrial Structure, and Supporting Institutions, *Industrial and Corporate Change*, 3(1): 47-63.
- Nelson, R. and Winter, S. 1982. *An Evolutionary Theory of Economic Change*, Cambridge, MA, Harvard University Press.
- North, D. 1990. *Institutions, Institutional Change and Economic Performance*, Cambridge, Cambridge University Press.
- Orléan, A. 1987. Anticipations et conventions en situation d'incertitude, *Cahiers d'Économie Politique*, 13: 153-172.
- Orléan, A. 1989. Pour une approche cognitive des conventions économiques, *Revue Économique*, 40 (2): 241-72.
- Perlman, M. and McCann Jr., C. 1996. Varieties of uncertainty, in Schmidt, C. (ed.), *Uncertainty in Economic Thought*, Aldershot, Elgar.
- Popper, K. 1957. *The Poverty of Historicism*, Boston, Beacon Press.
- Popper, K. 1982. *The Open Universe*, London, Hutchinson.
- Quinet, C. 1994. Herbert Simon et la rationalité, *Revue Française d'Économie*, 9(1): 133-81.

- Rosser Jr., J. B. 1999. On the Complexities of Complex Economic Dynamics, *Journal of Economic Perspectives*, 13(4): 169-92.
- Runde, J. 1995. Risk, uncertainty and Bayesian decision theory: a Keynesian view, in Dow, S. and Hillard, J. (eds.), *Keynes, Knowledge and Uncertainty*, Aldershot, Edward Elgar.
- Simon, H. 1958. The Role of Expectations in an Adaptive or Behavioristic Model, in Bowman, M. (ed.), *Expectations, Uncertainty, and Business Behavior*, New York, Social Science Research Council. Reprinted in Simon 1982. *Models of Bounded Rationality*, vol. 2, Cambridge, MA, MIT Press.
- Simon, H. 1959. Theories of Decision-Making in Economic and Behavioral Sciences, *American Economic Review*, 49(1): 253-83.
- Simon, H. 1976. From substantive to procedural rationality, in Latsis, S. (ed.), *Method and Appraisal in Economics*, Cambridge, Cambridge University Press. Reprinted in Hahn, F. and Hollis, M. (eds.) 1979. *Philosophy and Economic Theory*, Oxford, Oxford University Press.
- Vanberg, V. 1993. Rational Choice, Rule-Following and Institutions: An Evolutionary Perspective, in Maki, U., Gustafsson, B. and Knudsen, C. (eds.), *Rationality, Institutions and Economic Methodology*, New York, Routledge.