

Abstract:
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This paper argues that while radical uncertainty is a common property of post Keynesian approaches, the definition is not standard. This longstanding debate over the meaning and role of radical uncertainty in post Keynesian analysis has been revived by the latest exchange over the competing Human Abilities and Characteristics approach advocated by O'Donnell (1990; 2014-5; 2016a; 2016b) and the Ergodic / Non-Ergodic framing of radical uncertainty used by Davidson (1996; 2015). While clarifying some ambiguities in the use of the terms as well as highlighting substantive issues about domain (cf. Rosser, 2015), rhetorical strategy has done much to determine substantive analytical content. The emphasis is on post Keynesian radical uncertainty so this classification is not exhaustive. Rather, we ask whether the demarcations remain the same for post Keynesian uncertainty were a different classifier used.

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A reconsideration of Davidson's taxonomy of uncertainty: Is Shackle's a third way?

Introduction

This paper argues that while radical uncertainty is a common property of post Keynesian approaches, the definition is not standard. This longstanding debate over the meaning and role of radical uncertainty in post Keynesian analysis has been revived by the latest exchange over the competing Human Abilities and Characteristics approach advocated by O'Donnell (1990; 2014-5; 2016a; 2016b) and the Ergodic / Non-Ergodic framing of radical uncertainty used by Davidson (1996; 2015). While clarifying some ambiguities in the use of the terms as well as highlighting substantive issues about domain (cf. Rosser, 2015), still absent from this ongoing debate is a key issue that underlies it, if not in part explaining this division. In particular, a view on the nature of the uncertain agent is under-developed. It does not necessarily follow that this can be supplemented by developments in behavioural approaches¹ though this remains to be systematically explored (cf. Earl and Littleboy, 2014; Jefferson and King, 2010-11).

This paper explores some issues in the framing and classification of uncertainty that is implied by using the categories implied by either approach. Rhetorical strategy has done much to determine substantive analytical content. The emphasis is on post Keynesian radical uncertainty so this is not exhaustive. Rather, we ask whether the demarcations remain the same were a different classifier used. Some frontiers along which extensions and discussions are occurring are then touched on in this light. We consider the extent to which these help clarify the meaning of radical uncertainty, as much as these also point to a changing scope of what constitutes radical uncertainty, and possibly more meanings still.

This paper then does two things. First, even were the point of departure uncertainty in the work of Keynes, then there are alternative perspectives from which to begin. In particular, this paper proposes that one possibility is a reclassification that relies on Shackle's representation of time and so rather proposes that the resultant 'moment in being' can itself be used as a universal classifier. It makes it possible to say something substantial about the

¹ For example see Fung (2006; 2010-11), Davidson (2010a; 2010b), and Holt et al (2011).

properties of fundamental uncertainty itself and show that to claim that radical uncertainty applies to every single decision is in fact a quite modest claim, and does not conflict with existing categorisations of decision, even though different situations are consistent with different properties of uncertainty. This does allow us then to reconsider Davidson's classification in the light of this different classifier, and specifically, to be able to highlight some substantive differences over domain of relevance and type amongst post Keynesian accounts of uncertainty. Implicitly to this argument is that there is a resolution to the critique that radical uncertainty is pervasive but somehow not generalised.

The paper is organized as follows. Section 1 revisits the risk-uncertainty dichotomy to contextualise Davidson's ontological strict single meaning of radical uncertainty and to understand it as juxtaposed with the epistemological approach as advocated by O'Donnell. Section 2 introduces Shackle's view on time and reclassifies theories of risk and uncertainty under the different labelling we develop from it. If uncertainty is a property of time then it should be possible to categorise theories of uncertainty using time as a criterion.

1. On Knight and Keynes: some considerations of the risk-uncertainty dichotomy

Contrary to LeRoy (1997), the distinction between risk and uncertainty has not been rendered obsolete by progress in theory. An illustration of the difficulty of articulating precise tacit meanings is Perlman and McCann's (1996) identification of at least nine interpretations of uncertainty. It is accordingly not altogether surprising that post Keynesians have difficulty in communicating the importance of uncertainty to opposing schools of thought. A further consequence is the general tendency towards more sophisticated reinterpretations so as to preserve hallowed (perceived) links with the usual body of principal informers of post Keynesianism rather than engaging and perhaps incorporating authors outside of the tradition, concerning working principles and definitions from which to proceed.

The most logical place to start a narrative on uncertainty is with the risk-uncertainty distinction (Hamouda and Rowley, 1996). By this we do not imply that there was no reference to uncertainty before Keynes or Knight². This encompasses both the significance of

² In considering writings on uncertainty after Knight (1921); the survey is less extensive than a history of economic thought contribution. Some classifications include Keynes (1921; 1936), Marschak (1949), Hicks

these distinctions and interpretations of Knight and Keynes's (intended) meaning³. Further, this point of origin, by illuminating the relevant issues in considerations of uncertainty, facilitates a comparison of varying taxonomies and an exposition of our preferred schematic.

While Knight (1921) is categorical about the distinction between risk as a quantity susceptible to measurement and uncertainty as not, it is ultimately not a theory of radical uncertainty because Knight suggests that the lack of knowledge about external reality attributable to a lack of real consistency over time in the cosmos is insignificant when compared to humans' cognitive failures to identify the predetermined external reality (Davidson, 1996; p.266, Knight, 1921). Consequently, the functional distinction between risk and uncertainty is reduced, through the extent to which it is possible to group sufficiently homogeneous instances, to deficiency in the human capacity to process knowable information about a pre-existent objective reality. That risk is distinct from uncertainty becomes a "matter of degree" (p.225, *ibid*) to the extent to which it is impossible to assign probabilities to events because the relevant instances are so dissimilar as to preclude classification, implying "a *continuum* of probability situations, depending on the degree of homogeneity of the 'instances' in question" (p.541, Runde, 1998a, emphasis in original) which "must be rejected" (p.544, *ibid*). The extremes are based on a conceptualization of the extent of *homogeneity* (p.225-6, Knight, 1921) and not that of *knowledge* because if probability reasoning is followed out to its conclusion, there is really no probability at all, but certainty, if knowledge is complete (p.219, *ibid*).

The risk-uncertainty dichotomy fails to distinguish between differing accounts of uncertainty which do not imply uniform meaning. Neither does Lawson (1988) nor Lavoie (1992) to the extent that that the observed properties of uncertainty remain implicitly different, and also still fail to eliminate that the internal mechanisms by which they are derived that constitute the causes of uncertainty are also of a specific, mutually exclusive, kind. "There is uncertainty when the probability of an outcome is unknown, when the value of an outcome is unknown, when the outcomes that can possibly result from a choice are unknown, or when the spectrum of possible choices is unknown" (p.44, Lavoie, 1992). This already suggests that uncertainty consists of four inter-connected, but essentially different, conditions if not

(1979), Lawson (1988), Lavoie (1985; 1992), Shackle (1966) and Davidson (1996). This is based on the latter two. Implicitly we are saying that developments in uncertainty do not change the framework.

³ This invites invalid claims to legitimacy, for example see LeRoy and Singell (1987) on what "Knight meant". That our own is an interpretation is acknowledged, at issue is the context of the discussion.

kinds, which are generated by different mechanisms or are derived from possibly inconsistent processes of reasoning, not all of which even presuppose the existence of radical uncertainty. As a result, Lavoie's definition allows that theories whose conclusions adequately meet the ultimate presupposition of immeasurability or even partial ordering are complementary.

To the extent that there is "fundamental uncertainty where the individual is ignorant of the available courses of action and or of the extent of the future states of the world" (p.44, *ibid*) these are also satisfactory. As such, uncertainty is only fused with "our relevant knowledge relative to our relevant ignorance" (p.77, Keynes, 1921) or the "degree of completeness of our knowledge" (p.345, *ibid*) as opposed to being isolated as "future events which can only be forecasted with more or less confidence" (p.147, Keynes, 1936) in which agents are "guided to a considerable degree by the facts about which we feel somewhat confident, even though they may be less decisively relevant to the issue than other facts about which our knowledge is vague and scanty" (p.148, *ibid*) and from which the two propositions follow and are indicative.

There is no reason that knowledge about existing phenomena, or more accurately, the past, should be sparse (Dow, 2003). The distinction between knowledge and external material reality is significant (Lawson, 1988). However, Lawson restricts the use of this somewhat profound shift in premise from uncertainty as epistemic to ontological to explain that Knight's estimate of an estimate is illustrative that the "conception of an objectively measurable probability or chance is simply inapplicable" (p.232, Knight, 1921) and that Keynesian uncertainty amounts to the association of "uncertainty not with probabilistic knowledge but with the *absence* of probabilistic knowledge. Uncertainty corresponds to a situation in which probabilities are *not* numerically determinate – or even comparable, in terms of more or less, with other probability relations" (p.48, Lawson, 1988, emphasis in original; Lawson, 1985).

Alternatively, although similar in their approach to uncertainty as "a situation of numerically *immeasurable* probability" (p.48, Lawson, 1988, emphasis in original), Knight and Keynes differed in their view of probability as a property of external reality, also echoed by Davidson

(1996a)⁴ and Greer (2000). This successfully eliminates *numerical* probabilistic risk situations because “underlying reality, relative frequencies, recurrent events, dispositions, propensities, complexity, causal processes and so on” (p.61, Lawson, 1988) are indeterminate because they are incomplete. The emphasis is on a correspondence between the “immediate and the mediated” (ibid) or reason and actuality wherein knowledge is limited because the objects of knowledge are incomplete. Lawson’s approach again is not sufficiently stringent. Crucially, these objects of knowledge a priori *exist* as well as in a form replicated *analogously* in the future (the pre-existence criterion of knowledge objects). This only eliminates Type 1 representations in Davidson, but not Type 2 because not only is underlying reality not fully knowable because it is changeable, but it is also not knowable because it is interpreted. So, barring the (absolute) truth of existence, agents may as well operate as if they are uncertain, even though they are not. Alternatively, these are not features of time but of interdependence.

Davidson (1996a) however achieves both a stricter definition of *fundamental* uncertainty and demonstrates the uniformity in meaning. Davidson’s taxonomic scheme further restricts the situation in which fundamental uncertainty can actually occur. Theories of risk and uncertainty are categorized with reference to external economic reality. Reality is in turn either immutable (Type A) or transmutable (Type B). Within Type A, theories are either Type 1 or 2. Type 1 theories are those in which, in both the short and long run, the future is either known or in principle knowable. Type 2 theories are those in which, in the short run the future is not known because of cognitive limitations. The information is complete but not fully accessible. Type B categories are those in which the future itself is incomplete, or aspects of the future are created through current actions and / or will be created in the future by future actions. It is these latter theories that are categorized as radically uncertain.

While similar to Lawson (1988) in that the properties of knowledge are effectively separate from those of external reality, Davidson articulates the essential properties of fundamental uncertainty, which is a *separate* process from that of the acquisition of knowledge. Fundamental uncertainty *only* applies to a transmutable or creative reality, where “aspects of the...future will be created by human action today and / or in the future” (p.485, Davidson, 1996). Knowledge is consequently uncoupled from uncertainty (Farmer, 1995). “*In the*

⁴ Davidson consequently classifies Knight as pertaining to an immutable concept of external reality, and Keynes as pertaining to a transmutable or creative reality.

ergodic circumstances of objective probability distributions, probability is knowledge, not uncertainty” (p.132, Davidson, 1991, emphasis in original). So the inadequacies of probability are those of the partiality of knowledge, not its absence. This is also true of post Keynesian extensions of the concept of the weight of arguments⁵, where “these conclusions refer to choice (implicit or explicit) as to what degree of uncertainty is recognized or admitted by decision-makers” (p.117, Dow, 1995) and from which “[i]t follows that the notion of confidence is conditional on the degree of uncertainty which is admitted” (ibid). However, Davidson (1999b) remarks that expectations about future outcomes governed by social structures are sensible in a law-abiding community if laws are obeyed and / or enforced, but do not constitute knowledge in the technical sense. The analyses of Keynes, Shackle, post Keynesian monetary theory, Old Institutionalism and post-1974 Hicks are then theories of ontological uncertainty⁶. Nothing can be meaningfully said about the extent of uncertainty, it just is, and we cannot “suggest a distinction where no difference exists” (p.128, ibid). Contrary to Dow (1995) and Crocco (2002) there can be no “understanding of uncertainty as a concept feasible to be graded” (p.12, ibid), much less along the lines that as knowledge means certainty, where there is uncertainty there is no knowledge and knowledge is defined as “the inverse of uncertainty” (p.19, ibid) and absolute uncertainty exists when knowledge is completely absent.

This remains valid even if the problem is rephrased such that in “situations of fundamental uncertainty, the appropriate notion of probability is a degree of belief. There are no long-run relative frequencies. As agents accumulate knowledge, they alter their degrees of belief between competing hypotheses as to the outcome of any given choice. In the limit, complete knowledge would imply that the probabilities of false hypotheses would be zero while the probabilities of true hypotheses would become unity” (p.193, Gerrard, 1995) and where if “fundamental uncertainty exists, probabilities are degrees of belief between zero and unity, credence is incomplete and, hence, a key determinant of human behaviour” (p.194, ibid).

Fundamental uncertainty is not, nor can be, variable in extent. It is distinct from any epistemological formulation where the extent of ignorance can vary, although “ignorance, or bounded knowledge, can only be defined relative to some standard of true and reliable

⁵ For example Lawson (1987), Carabelli (1988; 1992), O’Donnell (1989), Runde (1990), Gerrard (1992), Lavoie (1992) and Fontana and Gerrard (1999).

⁶ We retain this distinction from Davidson for reasons given below.

knowledge” (p.70, Farmer, 1995). It is conceivable that agents are fully “knowledgeable”⁷ but they remain uncertain such that “knowledgeable action does not always produce predictable action” (p.76, *ibid*). However, in situations “involving many routine decisions, assuming uniformity and consistency of nature over time (that is, assuming ergodicity)” (p.141, Davidson, 1991) these are appropriate simplifications, but are not synonymous with the absence or even the reduction of fundamental uncertainty. Keynes nowhere separates the process of human decision-making with the unknowable future, but does from knowledge. “The terms *certain* and *probable* describe the various degrees of rational belief about a proposition with different amounts of knowledge authorise us to entertain. All propositions are true or false, but the knowledge we have of them depends on our circumstances; and while it is often convenient to speak of propositions as certain or probable, this expresses strictly a relationship in which they stand to a *corpus* of knowledge, actual or hypothetical, and not a characteristic of the propositions themselves” (p.3-4, Keynes, 1921, emphasis in original).

Keynes (p.163-4, 1936) suggests that decisions affecting the future cannot depend on strict mathematical expectation, since the basis for making such calculations does not exist. In that sense, “our ignorance of the future” (p.157; 163, *ibid*) is unequivocal and complete⁸. In spite of what he makes of this realisation, so too does Knight make this distinction. “The doctrine of real probability, if it is to be valid, must it seems rest on the inherent unknowability in the factors, not merely the fact of ignorance. And even then we must always consult the empirical facts, for it will not do to assume out of hand that the unknown causes in a case will distribute themselves according to the law of indifference among the different instances. We seem driven back to a logical *impasse*. The postulates of knowledge generally involve the conclusion that it is really determined in the nature of things...The logic which we actually use, however, assumes that the result is really indeterminate, that the unknowable causes actually follow a law of indifference” (p.219, Knight, 1921, emphasis in original).

This longstanding debate on whether Keynesian ergo post Keynesian uncertainty is epistemological or ontological has been revived by the recent exchange between O’Donnell (2014-15; 2016a; 2016b) and Davidson (2015). O’Donnell (2014-15) questions whether this distinction made in post Keynesian views is actually even relevant since both the ontological

⁷ Farmer (1995) attributes the term to Giddens (1984).

⁸ That is, knowing much about the material but not how history will cut the garment (Shackle, 1972).

Ergodic / Non-Ergodic distinction used by Davidson (1996a) as well as his own epistemological Human Abilities and Characteristics approach (O'Donnell, 1990) both have ontological and epistemological dimensions (also echoed by Dequech, 2004; 2011; 2014). In particular, if all links between uncertainty and probability theory are severed, then only probabilistic knowledge can exist, never probabilistic uncertainty (the domain of Keynes, 1921).

While O'Donnell's critique, and Davidson's counter, relate to a broader set of issues, the focus here is on the arguments made about agents' ability to learn. In particular, the suggestion is that an ontological view such as that adopted by Davidson makes it impossible for agents to obtain any knowledge of the relevant state of reality since this is only a property knowable at infinity. The account then given of how agents learn is incoherent and internally inconsistent. That fundamental uncertainty is a specific iteration of a general kind of procedural uncertainty (Dequech; 2014) bypasses the use of the above concepts to define radical uncertainty, but that it explicitly appeals to a particular view of underlying social reality quite distinct from that which O'Donnell (1990) argues for means that it is difficult to assess how to contextualise the post Keynesian dichotomy on uncertainty. Dow (2016) sees this dichotomisation as happening on a different dimension, namely that fundamental uncertainty is coupled with ignorance, and so argues for a non-dualistic grading using degrees of uncertainty. Rosser (2015) reconsiders the relationship between ergodicity and fundamental uncertainty, clarifies that the Knightian and Keynesian definitions of radical uncertainty differ and that a Keynesian account such as the HAC one cannot be used to make sense of a series of intermediate cases that lie between two extreme spectrums in a Knightian understanding, but also explicitly reintroduces another distinction that complicates things somewhat: that between the short and the long run.

While explicit about the inadequacy of Neoclassical theory in its conception of rational action and its incorporation of real, irreversible time, post Keynesians typically fail to recognise the full implications of re-conceptualizing the nature of human action, and that of the social human world itself, for the treatment of human knowledge (Farmer, 1995) including relating concepts of knowledge, uncertainty and predictability; and how these are attached to actors or systems. This arbitrariness of agency, knowledge, uncertainty and time, where all properties are determined more or less simultaneously, is not exclusive to post Keynesianism but accounts for much of the confusion surrounding the risk-uncertainty dichotomy and the

recognition of fundamental uncertainty (relative to other views of uncertainty which are not all equivalent to risk). We accept that while there are complementary notions of agency and knowledge related to specific views of time and uncertainty, the inability for post Keynesians to distinctly articulate fundamental uncertainty is because the recognition of the mechanisms of time are subsumed in spite of the awareness of historical time as integral. This, in turn, accounts for the restricted practical application of radical uncertainty and its concepts despite a general theoretical appeal to the latter.

2. Reclassifying theories of risk and uncertainty

Shackle's (1955; 1958; 1961; 1972) categorisation of uncertainty begins with a consideration of time. Roughly, time is separable into three types of instances: the (uniquely realised) past, the (uniquely constituted) present and the (plural notional) future. The present functions to partition the changeable from the unchangeable. It is the watershed delimiting the objects of choice and what can no longer constitute an object of choice respectively. What lies in the past can be known in virtue of having already happened; what lies in the future is unknowable, in virtue of it having to be determined. So the past is in principle knowable, even if it is not known, but the future is unknowable, irrespective of how complete knowledge may be, in virtue of it being plural in possibility until it obtains. So agents are neither ignorant nor irrational; they are uncertain. Alternatively, there are limits to reason (in a common usage sense) inherent in the possibility of what can be known. Only the constitutionally complete, that which resides in the past, can be known. This however has repercussions for the content of decisions, an exclusive reference to a possible future, since its referents are notional. As such, a future is imagined and constitutes 'rival, mutually exclusive hypotheses', of which one must be chosen. From this then emerges the conclusion that the future is radically uncertain. There is no reason that when a future comes to pass, it should as imagined, or even that it would have been imaginable.

The implicit treatment of time (as *experience*) accounts for the differences in emphasis and content of approaches to uncertainty. The explicit use of time in the analysis of uncertainty is a feature of Austrian approaches. That we use this as a means to distinguish between theories of risk and uncertainty is neither a pre-commitment to the universality of Austrian theory; nor a claim that Shackle was an Austrian (Latsis, 2015); nor one that it is because Davidson's approach to uncertainty is analogous to Austrian accounts (Runde, 1993). They cannot be, at

least not consistently so, since they differ substantially over the domain of relevance and in substantive content. This classification would imply that they would fall in different time systems. It is simply in virtue of a precedent for using time as a means of talking about uncertainty already existing and for clarification.

“The crucial difference between the static and dynamic conceptions of time lie in memory and anticipation...Time as lived, time as experience, is inextricably linked to memory of the past and anticipation of the future...[A]n experience is a triadic relationship: retention or immediate memory, primal sensation, and protention or immediate expectation. (The idea of primal sensation is merely a limiting notion between retention and protention)...The linking together of the remembered past, present and anticipation of the future in this has been called ‘dynamic continuity’” (p.112-3, Rizzo, 1994). Theories differ in the emphasis of one of the three aspects of time as experience. Action and decision are distinct in that “planning takes place in time as lived (the dynamic view of time) while the contents of the plan themselves are in a spatialized and intellectualized time (the static view of time)” (p.111, *ibid*; p.12-3, Davidson, 1972).

The distinction of theories relative to time matters for several reasons. First, to the extent that theories permit time to elapse, it is not in a uniform manner. Second, the nominal features of reality that theories seek to explain are themselves uniform, but the implicit conception of material external reality differs as does the view of agency, suggesting that theories are neither universal nor translatable across differing uncertainty situations. As such, there is some inconsistency and arbitrariness in the adoption (or exclusion) of features of alternative theories, derived from different (or similar) premises (respectively). Further, while aspects of differing accounts on uncertainty may well be complementary, the criteria for the selection of theories in different uncertainty situations may not always be consistent, raising the question of how explanatory theories actually are of the outcomes they seek to clarify. Alternatively, the explanatory models of economic behaviour are more subjective than is usually acknowledged. Thirdly, that different theories are applicable in different situations must be identifiable and qualified⁹.

⁹ *If* any single theory can be said to be general for realist explanation, as yet generality is not premised on system element generality that is consistent with system outcome generality.

2.1 Systems of time (time as an independent property) and their complementary systems of the perception of time (consciousness as the realisation of time)

We identify four ‘states’ of time and an associated formulation of motion (or the passage of time) as an independent property. These are contrasted with impression (or the perception of time) as experience. As a discussion on post Keynesian uncertainty, this paper does not discuss several of these categories. In particular, ‘timeless’ categories and ‘chaotic and complex time systems with ex post consciousness’ are not included here. Examples of the former include Rational Expectations Hypothesis / New Classical Theories, Game Theory, the Game Theoretic branch of New Institutional Economics and Subjective Expected Utility Theory. Examples of the latter include Austrian theories (with the exception of Schumpeterians), the (non-Schumpeterian) Austrian branch of New Institutionalism, as well as Chaos, Sunspot and Bubble theories. We draw on ‘timelessness’ for illustrative purposes rather than to show that our schematic implies that these theories are deficient with respect to it¹⁰. That these fail to qualify for representation is the issue (cf. Shaikh, 2010).

2.1.1 The absence of time

Neoclassical theory adopts the Newtonian conception of time as spatialised whose passage is symbolized by movements along a line, whose central features are homogeneity, mathematical continuity and causal inertness (Capek, 1961 cited in O’Driscoll and Rizzo, 1985). Homogeneity in that in the geometry of lines each point is identical to others except for its position implies that spatialized time is merely temporal position and time is independent of its contents and other moments. That time is a static category means that it can elapse without anything happening. Mathematical continuity is not an interrelation between successive instants but merely continuous divisibility, which is contradictory with the occurrence of change – any stable (and so predictable) disequilibrium adjustment process must occur instantaneously and since each period is in temporary equilibrium, any alternative set of data is exogenously imposed on the system (Myrdal, 1939 cited in *ibid*). Lastly, causal inertness is a reformulation of time is independent of its contents. Importantly, any requirements for the production of change must be determined in the *initial* state of the

¹⁰ See Minsky (1996).

system. “Real” time is then characterised by dynamic continuity, heterogeneity and by casual efficacy.

In the absence of time the essence of the scheme of thought is the fully abstract idea of function. Time is a purely mathematical variable, in which some working model or coded procedure which, applied to any particular and specified value or set of values of one or more independent variables, generates a value of the dependent variable. For the independent variable of this kind, time is a misnomer. The solution to the differential equation, if it can be found, is complete in an instantaneous and timeless sense. This timelessness abolishes the distinction between past and future. Within the stated limits knowledge is complete, perfect and indisputable. Fully rational action (in the Neoclassical sense) can only occur in a momentary or timeless system because were time to pass the choice of actions is allowed to be anterior and posterior and violates the scheme of general exchange of commitments (Shackle, 1966). Axiomatics defines information, knowledge and expectations as identical constructs (Potts, 2000). However the very nature of human consciousness depends on ignorance of the future and the necessity to live in one moment at a time (Shackle, 1958).

Shackle’s moment in being is a statement that individuals cannot conceive of existence as being separated from time (Shackle 1955; 1958; 1961; 1972). In the presence of time, the passage of time is an internal property (a rejection of the actuality of the future and past). Agents live *in* one moment at a time (there *is* no other place in time as the individual *experiences* it). For individual human consciousness, time is not a mathematician’s space or a historian’s panorama but a unique moment as far as the thoughts of and feelings, perceptions, judgements, decisions and actions of the individual are concerned. In this solitary moment all the consequences that the decision-maker seeks or accepts must necessarily be contained. These consequences must therefore be experienced by *imaginative* anticipation and comparison of the individual’s *actual* experiences at two distinct moments is impossible and meaningless (Shackle, 1961). The present is at the front edge of time, moving continuously forward with an ever lengthening past behind it (Robinson, 1980).

The interpretation of the solitary moment is significant. Its constitution is different in experience as well as that in each independent property of time there is a further difference in the nature of the complementary representation of the passage of time. In short, how time as an independent property enters into as well as progresses between solitary moments differs in

different time systems. In each of the following time systems we refer to time as experienced by the individual in each time system a moment at a time. So effectively, at any moment in time, including that of decision, there are two features of the solitary moment which are important. First, the past is available in the construction of any decision process at a particular present moment in time. It is this which we refer to as knowledge, all constituents of the past which are formed and available for use in the imaginative construction of the future in any present moment, be they known or unknown in their totality to any given agent, and is related to the definition of knowledge given below. However, the proximate future moment in time is only visible to agents as an imaginary construct.

A further distinguishing feature is that any imagined moment beyond the proximate future moment is an imaginary construct premised on intermediary imagined moments (has no actual content; it exists only in imagination). Crucially, the past is progressive up to the present in actual content but the future only consists of imagined content and so is progressive from the present but in imagined content in the construct of decision. At issue in the varying time systems is the representation of such, in particular, that it is not apparent that such a break in actual content exists in the series of moments over time. The way in which agents perceive the passage of time is related to that in which they perceive the onset of the future. The past, its present, and possible futures are mediated through consciousness in different ways in different time systems.

In the presence of time, theories differ in two respects; the relevant property of time (and nature of motion) and the relevant impression (and experience of time). The former consists in three sub-categories which we call complex or chaotic; reflexive or self-referential; and historical or unidirectional¹¹, wherein Post Keynesian accounts of uncertainty are of the latter two kinds. These categories reflect the idiosyncratic representations of the dynamic continuity or passage of time. Contrasted with these are three notions of impression, namely ex post, contemporaneous and ex ante respectively. These are determined separately, and each reflecting the conscious form of time. In short, agents that experience time in a distinct manner, which itself manifests differently, cannot be said to experience comparable forms of uncertainty. So then post Keynesian writings on uncertainty fall into two main categories in

¹¹ Historical (or linear) time is as per Robinson's (1962) distinction between logical and historical time (see Setterfield, 1995; Robinson, 1980). The others are our own as defined and conceptualised as is the attachment of the particular view of consciousness to the historical passage of time.

the implicit representation of time, and so only two are discussed here. The first is ‘reflexive or self-referential time systems with contemporaneous consciousness’, of which there are two types of cases: first, the static and second, the convergent, divergent or spiralled. The second is ‘linear or historical time with ex ante consciousness’. It is really the neglect of individual consciousness, or sensation, which follows from the neglect of individuals as meaningful for understanding economic and social phenomena, which makes it difficult to distinguish between post Keynesian accounts of uncertainty.

Moments in time cannot have equal and simultaneous validity. This present constitutes an evidentiary and epistemic frontier partitioning the past from the future. While both the past and future are constructs of the imagination, the cognitive process by which the past is accessed is distinct from that with which we conjure the future (Bausor, 1982-3). It is possible to observe that which is past, which is *in principle* (completely) knowable, independently of whether past events are actually known, but not that which has yet to be created (the future)¹². This knowability of observation automatically places the objects of observation in the past. Equivalently, observation identifies the present as later than the observed event (p.164, *ibid*). It is in this sense that ignorance about the future is absolute, a distinct claim from the claim that agents are ignorant. Given this complete ignorance or evidentiary void that characterizes the future what is expected to happen can only be imagined, but while the future has no actual content, agents can still assess the plausibility of their ruminations about it.

2.2 Reflexive or self-referential systems of time

There are four cases of reflexive time as an independent property. These differ in the independent property of time (time paths differ), but are identical in the concept of the impression of time as contemporaneous. Time is termed reflexive because it bends back on itself. Time is not merely non-linear it can potentially repeat itself (time eventually repeats in the same spatial plane). In the static case time eventually everywhere repeats itself (continuously revolving on the same trajectory). It does so at an accelerating rate in the

¹² A disagreement on the causes and explanations of extant phenomena, alternatively, hermeneutical concerns remain well in the domain of knowability since they relate to things that have happened, so it is in this sense that Shackle in particular is deterministic about the past (cf. Parsons, 2000). This rather relates to a different claim that knowability is not a property of the future since it has yet to be formed.

convergent case and at a slowing rate in the divergent case. Time intersects on itself in the same spatial plane at discrete intervals in the spiralled or dynamic case. Alternatively, in any given space-time, any event (even a repetitive event) is a unique position at a unique time. In self-referential time, an event is a multiple position at a unique point in time or a unique position at multiple points in time. As such, the continuously differing content embodied by different moments in time is not appreciatively distinguishable as anterior or posterior to any moment in time and so cannot strictly be cumulative from the perspective of individual decision (considering the constitution of the solitary moment).

Consciousness is contemporaneous because it simultaneously registers all space-time combinations on any given spatial plane as equivalent or substantively similar. However, the relevant deterministic features of time and so the content of decision from present to the future are in the present but crucially at different moments in time which are on a constantly changing trajectory. As time trajectories converge, that any solitary moment is a moving reference, the speed at which any such moment moves is variable (as time as an objective property or time in motion is constantly twisting), which, in the present, gives the impression of time as moving more or less slowly. At the limit, time is either moving very fast (apparent chaos) or moving extremely slowly (apparent determinism). Alternatively, the content of moments in time is self-reinforcing in any one direction. As moments in time proceed along a curvature, any moment in time causes subsequent moments to deflect, causing a time path that tilts further so affecting the speed of time, that is, causes time to accelerate or decelerate. A deviating time path presents difficulties of comparison of moments in time and their respective content. The exception is the static case below in which time rotates at a constant rate and at the same tilt on the same orbital plane, implying that in time, repetitive moments are so because their substantive content is so (is given).

The impression of time as contemporaneous means that the content of time at any single moment is perceived as existing at or occurring in, so in a sense belonging exclusively to, the same period of time and no other as it is occurring but this content of time is merely a belief because the content of time is as differentiated as the frequency with which any time path intersects with a given spatial plane. In the case of static time, time and search will reveal this to be the case when the same body of knowledge embodied in all moments of time is finite and in time reoccurs as originally defined. However, in the dynamic cases (convergent, divergent and spiralled cases) this is not necessarily so because the content of external

material reality is changeable because the time path in which decision occurs is changeable. If, as Keynes (1921) describes, knowledge as rational belief comprises direct (that part of rational belief which agents know directly) and indirect (known by argument) components, it is the latter which becomes inaccessible in a changeable world. As this distinction is equivalent to that between foundational and inferential knowledge is explained by three theses (O'Donnell, 1990).

First, agents have direct acquaintance of three main classes of objects, namely sensations, meanings and perceptions, where direct acquaintance is defined as “a state of unmediated, error-free awareness in which the object itself is directly apprehended” (p.335, *ibid*). Agents are acquainted in perception and thought with things themselves and not merely with their impressions of ideas of these things. Direct acquaintance does not however itself constitute knowledge. The second thesis therefore is that the contemplation of these objects of direct acquaintance produces direct knowledge of them in the form of propositions. The third is that the passage from direct to indirect knowledge is by means of an argument requiring the perception of logical relations between propositions. Such relations are probability relations¹³ and are consistent with the first thesis as their perception is a matter of direct acquaintance. Direct knowledge, whether of sensations, meanings or logical relations, provides the foundation of Keynes's theory of knowledge upon which is erected the “superstructure” of indirect or probabilistic knowledge (O'Donnell, 1990)¹⁴.

Knowledge, truth and certain rational belief are intertwined in Keynes's epistemology (Carabelli, 1988; O'Donnell, 1990). The “knowledge of a proposition always corresponds to certainty of rational belief in it at the same time to actual truth of a proposition. We cannot know a proposition unless it is in fact true” (Keynes, 1906 quoted on p.336, O'Donnell, 1990). O'Donnell (1990 citing Keynes, 1921) suggests that the correspondence between these is evident in the necessary conditions for rational belief in a proposition (p). One of two conditions must hold in the case of certain rational belief. Either p is known directly or a set of propositions (h) and some secondary proposition (q) asserting a certainty relation between p and h. In the case of less than certain rational belief, it is necessary to know a set of propositions h, as well as some secondary proposition q which asserts a probability relation

¹³ See Keynes (1921); Carabelli (1988; 1985; 1992) and Gerrard (1995) on the nature of probability in Keynes's thought.

¹⁴ Direct knowledge is significant in being an anchor against infinite regress (O'Donnell, 1990).

between p and h. As such, degrees of rational belief less than certainty originate from knowledge which in this instance is that of secondary propositions asserting probability relations (Keynes, 1921; O'Donnell, 1990). O'Donnell (1990) then suggests that, first, knowledge in Keynes's writings means true propositions, regardless of whether direct or indirect knowledge, or primary or secondary propositions are in question; second, that Keynes's theory accepts all rational belief as grounded on knowledge, and so on truth. Also refer to O'Donnell (2014-5).

The difficulty arises in self-referential time systems because while direct acquaintance with the objects of knowledge is possible at any moment in time, inference may not be accurate if inferences drawn at a particular point in time refer to even the same nominal events occurring at a different moment in time. Any given lapse in time entails differentiated content which in of itself is sufficient to ensure that nominal events may transpire differently from any given moment onwards. This presents problems for the formulation of decisions on the basis of existing knowledge as moments converge in space because first their content is not meaningfully distinguishable as belonging to a different *sequence* of moments in time and second the content contained by these convergent moments cannot strictly be isolated as relevant at any particular point in time. As such, neither can the passage of time preclude the reoccurrence of an identical set of conditions associated with decisions at different moments in time nor can it avoid the reoccurrence of the non-isolability of relevant knowledge which causes an intractable problem for decision. In short, decision in self-referential time systems is functionally meaningless.

In time, the same time path or trajectory (eventually) passes through space either repeatedly at the same locale (the static case); or at different locations in space (the convergent and divergent cases) and at least twice in exactly the same place in space (the spiralled case). The former implies that time will have registered as a lapse and the event to which another time refers to is a different event in space and that the event (by virtue of its different locale in space) in a later time is different. However, as is addressed below, the latter situation, in which time repeats (potentially crosses on itself in the same space-time locale), does not allow this distinction to be made, with consequences for decision and uncertainty.

(i) The static case

In the first, 'static', case, time is stasis and entropic. The motion of time is such that the system is fully closed. This is because the relevant independent property of time is orbital. Solitary moments are indefinitely continuous (no end and no beginning), but are completely pre-determined and determinate in a system where nothing ever leaves or enters and time is infinitely repetitive. 'Everyday (or full rotation) is Groundhog Day', removed in time but exactly the same. Agents' perception of time is contemporaneous as they learn with time and that, at any given moment, they possess a body of knowledge that is definite and operational. Each new solitary moment continuously involves a different epistemic content, and so different knowledge. Perception of time and perspective is determined by where individuals entered the circle so that it is possible to accumulate knowledge in the strict sense but agents will necessarily 'see it for themselves' with the passage of time for as long as they remain on the same orbital plane.

Consider two moments in time on the spatial plane. Suppose one is a stationary moment (to which the moving solitary moment will revert in time) and the other the current position of a shifting solitary moment. These are separated by a temporal lapse (extent of the arc or a partial revolution). A full revolution is occurring indefinitely in constant orbit (the passage of time) implying that the system is fully defined or that reality is fixed. The content of the knowledge of the system is contained in lengthening time such that the extent to which the arc is realised is the extent to which the knowledge of the system is known at that particular moment in time. However, as the content of the system is defined, deliberate search would in principle reveal the content of the system in its totality (which would have been revealed in time the moving moment approaches the solitary moment). While this content is only fully defined in a full rotation aspects of knowledge may be fully or partially defined at any intermediate point as discovery rates may differ through the course of a revolution. The search associated with the stationary moment, reveals complete knowledge of a complete system while search procedures at any intermediate point may reveal partial knowledge but of the same system for any given individual.

There is an accompanying notion of agency, although somewhat distorted. Agents perceive their experience as identical to one that they historically know. In principle, there is neither a reason precluding that all the relevant information in the system is known by the population, nor that all is known by any particular individual at any moment in time. The second condition is however premised on agents' capacity to process information relative to the

existing body of information. Complexity is then a matter of having ‘too much information’ and ‘too few (currently known) benchmarks’ and is distinct from the complexity described above.

Further, choice is preferential in this system based on personal experience and accumulated information. But rationality is bounded precisely because of this reason. This behavioural characteristic of agents denotes the range of limitations on human knowledge and computation but there are feasibly pre-programmed choices upon which, were they known, agents could rely on (Dunn, 2001). So Dosi and Egidi’s (1991) claim that the origins of uncertainty are the incompleteness of the information set are unfounded. In principle all the information exists – search procedures would reveal as much¹⁵. The second observation, that of “knowledge incompleteness” (p.145, *ibid*), or the competence gap (“the gap between an agent’s competence and the difficulty of the decision problem to be resolved” (p.562, Heiner, 1983) is relevant here¹⁶. So too are explanations such as ignorance breeding stability¹⁷ (p.581-2, *ibid*) and predictable behaviour (*ibid*) are compatible with notions of coordination failure. However, deterministic complexity in this sense does not in any way imply uncertainty¹⁸. “*Bounded rationality refers to a specific view of behaviour. Fundamental uncertainty refers to a specific view of time*” (p.584, Dunn, 2001, emphasis is in original).

The relevant theorization is why the system would move from one orbital plane to another¹⁹. These systems would have to independently theorize a competitive process that is not implied by its behavioural aspects. In principle, reflexivity or self-referential processes of reasoning that are even slightly variable imply that the system may spontaneously move onto a different orbital plane given that the extent to which epistemological content is allowed to interact and

¹⁵ Agents are able to initiate search procedures because they know in advance what to search for.

¹⁶ Radical uncertainty does not have multiple causes associable with the degree of knowledge as suggested by Dequech (2000) premised on Camerer and Weber’s (1992) notion of ambiguity. A significant limitation of ambiguity is that it does not address creativity or the unintended consequences of actions.

¹⁷ A complex cooperative system must somehow limit the occurrence of serious coordination failures yet it cannot prevent these (See Heiner, 1983).

¹⁸ Dunn (2001) cites Rosser (1999) but acknowledges its difference to Simon (1972). Rosser (1998; 1999) notes that deterministic complexity models impute epistemological problems to agents because of computational limitations, but omnipotent agents, by definition, cannot be confronted with epistemological problems. Invoking Davidson (1991; 1996a) he demonstrates that deterministic models of decision making (stochastic or otherwise) are conducted in logical time and require Savage’s ordering axiom. Then agents can in principle learn and discover the ontology that governs the system.

¹⁹ Bewley (1989) illustrates that entrepreneurship and innovation can only be treated narrowly within this framework. Heiner (1983) suggests that the viability of an evolving system originating novel change is sensitive to uncertainty in avoiding disruptive novelty; the very processes which generate and select it will also be organized in a hierarchical structure of increasingly flexible rule-mechanisms.

change both meaning and content implies it is ontological. This conceptual problem is common to all self-referential systems. There is *new* information to learn (from the perspective of the subjective consciousness) not necessarily more or less (from the perspective of the universe) which is dependent on a further qualification about what exists in the same form in the old relative to the new knowledge system, etc. as too is there an explicable 'reason' (knowable path) as to how the system came to be there.

If however the elements and process of reasoning are invariant, then the system remains on the same orbital plane because of the constancy of accumulation of an *identical*, finite body of knowledge. So it is possible to know things but knowledge is differentiated and bounded. Equilibrium exists but so too do periods of disequilibrium (which are not synonymous with 'anti'-equilibrium) and are part of the transition to equilibrium. There is, however, no uncertainty involved even in the extent to which it is impossible to predict when all this occurs (cf. Davidson, 2010b; Asso and Fiorito, 2008). Examples include Knight, New Institutional Economic Theory (except the Game Theoretic branch of New Institutionalism), New Keynesian models and Bounded Rationality Theory.

(ii) The convergent, divergent and spiralled cases

When time in motion is continuous but coiled as in the systems represented below, convergent and divergent time systems are a case of lesser violation as moments in time do not ever intersect. Time itself intersects in the dynamic instance posing a chronic problem. First consider the convergent case. Time can be represented as an inward spiral repeatedly passing through the same spatial plane, XY, but at different locales. With more time, this happens at an increasing rate as well as nominal events occurring at any one time-space locale being separated by successively shorter (distance) intervals. The latter gives knowledge of the content of the system different *hues* (in addition to different substance) which are more subtle and nuanced the shorter the interval separating two points in space. As time accelerates the content embodied in moments in time is revealed at a quickening pace. For example, if the content of a present moment allows for the formulation or revelation of a next, in time this occurs at a faster rate. At the limit, time and its content implode. Content is revealed at a rapidly increasing rate until the system to which it pertains becomes almost trivial. Anything not known is (re)discovered and anything not formed is (re)constituted almost instantaneously. At this moment, (such as at the solitary moment illustrated by the

circle) while the contents of time and so of the system and so the objects of knowledge are instantaneously revealed, the hues and so possible interpretations of the same are infinite, presenting difficulty in decision formation given (perceived) lack of constancy and certainty in the predicates of decision.

In the divergent case almost the opposite occurs. As time spirals outwards it repeatedly passes through the same spatial plane also at different locales, but at successively longer distances in space and a constantly slowing rate. As time slows, agents perceive that the content of time, as well as the constitution of the system and so the objects of knowledge, is increasingly less variable such that the expectation of future stability; to the extent that the past resembles the future; allows for the assertion that given certain parameters, it is possible to infer the future path of economic processes. That is, these are self-congruent under all similarity transformations.

Outward spiralling time tends to determinism, inward spirally time to chaos. That is, because slower moving time is increasingly associated with persistence whereas faster moving time is increasingly associated with less persistence, these tendencies remain so even though the former implies that the knowledge content of the system is actually increasing (time is exploding) and the latter that it is shrinking (time is imploding). Perceptibly though, the former allows for increasing fixity in the referents of decision while the later does the opposite. This is only an apparent paradox if it is considered that chaos is consistent with the absence of any operationally reliable knowledge and determinism the converse.

In the dynamic case, time is a spiral. This conception of time is the most awkward merely because moments removed in time intersect at identical locations in any space locale such that time repeats itself. These points of intersection in the path of time reoccur on different spatial planes through which the time trajectory passes at moments removed in time. Alternatively, now, moments removed in time can have identical content despite being removed in time, and in spite of being preceded and succeeded by a different sequence of lapses in time (prior moments). To the extent that the dynamic case of self-referential time is convergent and divergent in exactly the same sense as the above instances it comprises aspects of both temporal implosion and explosion (and the associated respective tendencies to chaos and determinism).

The points of temporal intersection can now also be interpreted as the points of reconstitution of order in the dynamic case of self-referential time. It is precisely because these theories steer a path between determinism and chaos that temporal intersection maintains a balance that sustains the movement of time. As time approaches a point of intersection in any spatial plane, it is convergent (spirals inwards) and as it exits the same point in the same spatial plane, it is divergent (spirals outwards). In the absence of the point of intersection time would exponentially and continuously deviate (suggesting that it would not merely be absent, it would be incomprehensible from the perspective of individual decision). This is because the scale on which time could be calibrated would be so vast and incomparable to the temporal span (in calendar time) of any horizon in individual thought, the order of magnitude so large as to render the time span of agents' thoughts as perpetually and infinitely fractional. In short, decision would be futile.

So intersecting points effectively function so as to suspend the passage of time and render it comprehensible. In agents' decision processes, the accompanying suspension of decision is comparable. However, these points of intersection are not the last haven of the individual that decides in time. These theories actually require an onerous cognitive capacity. The high cognitive burden arises because while the points of intersection are separated in time, time passes through the same spatial plane in exactly the same location as it reverts. This means that at the moment that this occurs, the content of time is identical. Agents however have no means of distinguishing that these moments with identical content are necessarily different because these form part of a differing series of moments in time. In belonging to a different sequence, the intermediate moments (between repetitions) of every intersection are different because those preceding and succeeding points of intersection have unique differentiated content. At the moment of intersection time is undefined and at any intermediate point knowledge is indefinite.

Note that convergent and divergent as opposed to spiralled time systems refer to hysteretic and hermeneutic approaches respectively. The implication is that Critical Realist and Organicist post Keynesians (as defined below) have more in common with hysteretic and especially hermeneutic approaches (as defined below) than they do with fundamental uncertainty approaches (as defined in linear time with ex ante consciousness). Agents in these versions of contemporaneous consciousness in self-referential time act knowledgeably but what they can know is not exclusive to any unique decision in time and space. That is, agents

act when they feel more confident because they know more about the relevant course of action that they want to take. It is here that ranking systems generate their first level of incomprehensibility and incompleteness. When is there enough knowledge to necessitate action? Is the highest ranked course of action that which is ultimately chosen or is there some kind of illative functional trigger rule which, once reached, signals action?

By Critical Realist post Keynesians we mean those who hold that social reality is open in a “significant” way (Lawson, 2003). Patterns relating events standing in causal sequence do occur in the form of demi-regularities but are rare in the social realm. These regularities are not highly restricted but are also partial and unstable (Lawson, 1997). In addition to being open, social reality is structured. It comprises not only actual events and states of affairs, some of which agents may directly experience, but also deeper structures, powers, mechanisms and tendencies, and so on which produce, facilitate and other condition those events and states of affairs. Refer to Lawson (1994; 1997; 2003), Dow (1999), Downward (2003), Fleetwood (1999), Runde (1998b), Lewis and Runde (1999) and Walters and Young (1999, 2001). This ontological conception is immediately a methodological guide in the direction of causal explanatory research or causal explanation. Whether or not given phenomena are correlated with others at any one level of social reality, they can be explained in terms of (meaning shown to have been produced by or facilitated by) their underlying causal structures and conditions (Lawson 1997; 2003).

Organicism refers to the possibility of the fallacy of composition and is in contrast to methodological individualism. The ontology and method are based on holism and Organicism respectively (Lavoie, 2006), where Organicism refers to the evolving complexity within systems which are, themselves open and involve heterogeneous entities²⁰. Given an organic reality, the issue becomes how should theory be constructed, segmenting reality in order to generate general statements, wherein what is meant by generality becomes important. Reality can take a number of different methods as well as economic theories may appear to rival one another suggesting pluralism both in theories and method. For example refer to Lawson (1985), Brown-Collier (1985), Wilmslow (1986), Rotheim (1988), Davis (1989), Dow (1991), Hillard (1992), Chick (1995 cited in Chick and Dow, 2000) and Fontana and Gerrard (2004).

²⁰ Lavoie (2006) refers to the presupposition being ontology and method and the paradigm being holism and Organicism.

Hysteretic systems evolve according to the principle that earlier systemic states affect subsequent ones (cf. Sardoni, 2008; Caldari, 2010; Lang and Setterfield, 2006-7; 2008; Boylan and O’Gorman, 2009). Specifically, hysteresis exists if the long run or final value of a variable depends on its past values which determine current exogenous variables, coefficients and structural equations, and characterize the system that presently determines the same variable. This definition has several features. First, hysteresis causes the long run or final outcome of a system to depend on its previous outcomes. This distinguishes hysteretic systems from other dynamic systems whose short run outcomes are path specific, but which ultimately converge to configurations defined independently of the precedent path. Second, the above definition is consistent with Elster’s (1976) observation that the past has no being in the present. It only influences the present in its current or extant residual capacity, reflected in the sensitivity of the current structural model to past values of the particular variable.

Hysteretic systems differ from orthodox (deterministic) models in that the latter treats the structure of a system as a set of ‘timeless’ data, whereas hysteretic accounts, in contrast, treats it as historically specific. Any theoretical model of the system at a particular point in time is conditional on the current structure of the system (including tastes, preferences, technology and institutions) and must reflect the propensity of this structure to change over time in response to the unfolding history of the system (Setterfield, 1995). While there is some similarity between hysteresis and cumulative causation these concepts are not formally equivalent. Cumulative causation emphasizes understanding historical continuity; hysteresis and emergent properties give some insight into historical change (Hargreaves-Heap, 1989 cited in *ibid*).

Cumulative causation involves a circular interaction between variables. An initial change in a variable X induces supporting change in the vector of variables Z, which reinforce the initial change in X. This two-way interaction continues indefinitely. It does not, for example, lead to an equilibrium position defined and reached independently of the path taken towards it. Cumulative causation implies that the behaviour of the relevant variable is self-reinforcing (successive changes in that variable are positively correlated) but this is not necessarily a property of hysteretic systems which merely suggest that the present value of a variable will influence its future value. With hysteresis, then, an increase in X today may promote changes

in the system determining X, which causes its value to *decline* in some subsequent period. In this sense cumulative causation is a special case of the more general concept of hysteresis.

Systems which display cumulative conditions crucially depend on initial conditions. Once these are specified, what results is historical continuity. It is possible to qualitatively predict the future with certainty (precisely given the definition of cumulative causation) because in the absence of exogenous shocks, only these are historically relevant (ibid). The limitations of hysteretic approaches derive from this condition, precisely that “an initial increase in a variable subject to cumulative causation will foster subsequent increases in this variable *ad infinitum*” (p.530, Setterfield, 1998, emphasis in original; Setterfield, 1997).

Lock in is a less tractable variation on the theme, occurring when sequential patterns become entrenched. Repetition itself becomes self-reinforcing, making systemic deviation difficult. Because present choices are conditioned by prior choices decision makers may rationally pursue certain activities today whilst experiencing regret; the awareness that the type of activities being undertaken is demonstrably inferior to an available alternative. Were choice unconditional (free of the legacy of past choices) then decision makers might change their behaviour. Lock in prevents this. These feelings of regret are not irrational (regret is substantive). Alternatives only become available after an initial choice has been made but whilst the original decision is made *ex ante*, regret is realized *ex post*. What separates *ex ante* and *ex post* is the accumulation of a stock of experience that the decision maker did not previously possess. In all other respects lock in is similar to cumulative causation.

This time system is compatible with the introduction of new knowledge, which can only be partial to the extent that the system is ‘open’ and new information is continuously being generated. However, for all intents and purposes the convergent case implies that agents could potentially act as in the static case, although whether they can be aware of this (and thus act differently to agents in the above instance) is a separate issue, and which then implies that the relevant theorization for this particular family of theories is to reconcile the implication that time has the properties of a black hole with continuous replenishing of information. Whether time as an independent property spirals inwards or outwards is contingent on specific specifications.

Two interrelated and intractable problems arise for theories where time spirals inwards and outwards or winds. As time is non-linear, the passage of time reverts. That is, it does not continuously move in any single direction, even if the overall pattern is unidirectional. This is a function of the continuous reflexivity of the agents, which theories of this kind tend to allow, violating the principle that the passage of time is an independent property. Because these agents make meaningful choices (in the post Keynesian sense), they are also imputed a type of knowledge and agency that they do not possess. Relevant here is that the ability to make meaningful choices (with all the connotations about the nature of the future) does not mean that individuals are free in a strict (ontological) sense. It merely means precisely that: they choose. Hence it becomes problematic in these theories as to how to represent the subjective consciousness of an uncertain future as an independent property from the uncertain future agents are contemplating.

Alternately, because agents choose, the property of time in motion is distorted. Consciousness is such that incorporating new knowledge destroys old benchmarks (of a past which should be immutable) or new knowledge redefines existing knowledge. An identical set of circumstances can feasibly be treated differently by the same agent with the passage of time. Equivalently, two different sets of circumstances can also feasibly be treated as identical. This is the dilemma. As a function of the nature of contemporaneous consciousness, the past is not effectively closed off from the future, even though the passage of time implies that one moment has been destroyed and can never reoccur. So, in addition to the impression of time or the point of reference that is continuously variable, there is the more critical concern that time is allowed to repeat itself (as implied by an intersection).

Repetitive time is paradoxical as intersection further implies that time is itself effectively undefined in that moment because the same moment cannot be lived twice if the content of the future is not allowed to be identical to that of the past, especially if agents know this much. However, the partial nature of knowledge, as well as the continuous synthesis and revision of knowledge, implies that agents cannot know as much not just that the information does not yet exist. While knowledge is introduced into this system, it is not accumulated per se. That is, uncertainty is unbounded and inconsistent with any intentional action much less any predictability or stability in the system. It is because a self-reflexive system destroys both the paradigm and the particular kind of awareness (means of accessing the paradigm) continuously and simultaneously.

As such, there is an ambiguous conception of agency. Presumably there exists some “reciprocal” (p.160, Hamouda and Smithin, 1988) relationship between uncertainty and certainty as conceived of by individuals and as suggested by Lawson (1985)²¹. It is in also in this sense that the paralytic issues of relative and absolute knowledge (Lawson, 1987; Loasby, 2000)²² lead to a conflation of what can be said about properties of time in this system. Ironically it is the systems where consciousness is contemporaneous that require the highest individual cognitive capacity. The reflexive property of reason and not strictly linear time and its potential intersection implies that a system that is self-referential precludes any meaningful progression in time²³. Information can enter and does by virtue of the realization of an ‘additional’ or even sequential solitary moment in time, but the past is allowed to co-exist with the present to the extent that time (more specifically the future) does not render past knowledge effectually obsolete. Even if such a system recognizes uncertainty ‘*time and knowledge belong together*’ (Lachmann, 1959) because ‘*expectation is time itself*’ (Shackle, 1972), it does not recognise the functional difference between the past, present and the future, especially as it pertains to what can be known. There is no epistemological counterpart to ontological uncertainty in the manner suggested by varying theories of this nature (for example, see Dequech (1999a ; 1999b)). Suffice it here to say that the past, present and future are asymmetrically valid because they are asymmetrically mutable.

Convergence implies that this self-referential system may shrink to its definitive composition by some process of distillation of knowledge assuming that the system can actually be evolutionary. Divergence implies that by the same token the system can essentially explode. Both are consistent. Intersections of moments in time do not imply that the system is in any way contained. These are not systems of fundamental uncertainty because time is not unidirectional and the system does not and cannot exist “in the present, interposed between an uncertain future and a given and immutable past” (p.1, Setterfield, 1995), where the emphasis is on the immutability of the past. Examples include Critical Realism, Organicism, Schumpeterians as well as neo-Schumpeterian New Institutionalists.

²¹ This is not implicit in radical uncertainty because its existence is a separate process from that of varying and variable knowledge.

²² Granted Loasby’s account is to explain the processes of knowledge given that ‘we cannot know’.

²³ A possible representation would suggest linear arrows signifying a progression in time cumulatively overcome those signifying a backward move (so that moments in time do not overlap), but the implied discontinuity in time would merely compound the existing problems.

In spite of the apparent discrepancies, there are obvious parallels between the process of evolution brought about by the Schumpeterian entrepreneur and Critical Realist representations of change. The emphasis on evolution as “lopsided, discontinuous, disharmonious by nature” (p.102, Schumpeter, 1939) premised on “the disharmony...inherent in the very *modus operandi* of the factors of progress” (ibid) is analogous to the recognition that “there is no ontological asymmetry between relative continuity and relative change” (p.171, Lawson, 1997) and “there is equally no epistemic or logical asymmetry between the explanation of relative continuity and relative change” (ibid). Further, in as far as the Schumpeterian entrepreneur “has the capacity of seeing things in a way which afterwards prove true” (Schumpeter, 1934 cited on p.143, Loasby, 1992; Casson, 1982; Kirzner, 1982), or, to the extent that agents possess (differentiated or otherwise) foreknowledge of the future, theories fall into this category.

2.3 Linear or historical systems of time

The objective property of time is unidirectional and the impression of time *ex ante*. All moments in time are never to be re-lived as the same experience. Moments in time can only occur once and only once in any spatial plane; time can only pass once through any spatial plane; and critically, time can only move in a single direction in a linear progressive sequence. As time moves linearly forward, it continuously passes through an infinite number of such planes. So in essence, any occurrence in a time sequence can only occupy one and only one specific space-time locale. As such any event, decision, etc. has a unique position (as a coordinate) at which it occurred irrespective of whether it is repetitive or not. Note however that any given coordinate represents all occurrences which transpired at a single time (any given moment) rather than every single occurrence is its own singular occasion as distinct from all else at exactly the same moment in time. Alternatively, the content of any single moving solitary moment in its entirety is a single, unique, spatially and temporally removed incidence.

Here again time is continuous (and again the solitary moment isolated for exposition). The significant property of time here infers something very specific about the future, and which does not follow from other representations. The motion of time can only be in a single direction, never to be re-experienced. Each solitary moment in its origin or creation invalidates the last. The associated impression of time is now *ex ante*. Agents know what they

know, but that knowledge pertains to the *past* (also refer to Robinson, 1980). They can only entertain varying expectant notions of the future. Agents have knowledge of the past but consciousness is premised on a future that has no actualized content.

Agency is of the nature that any action or decision in the present is either the result of blind habit and convention or is directed towards its future consequences which cannot yet be known because the future is yet to be created. So in this sense the future is unknowable least of which to the extent that action today is alchemic and may have unintended consequences. It is also truly uncertain because there is nothing to know about a future that does not yet exist. As Rotheim (1995) suggests this does not indicate that future outcomes are independent of individuals' (collective) actions, but rather that agents cannot know what they know until they have entered into commitments, acted and interacted with others subject to those same conditions and circumstances. 'Unknowledge' (Shackle, 1972) however does not imply complete ignorance, nor that uncertainty is unbounded, and neither does it preclude typicality, just that these cannot be directly inferred with reference to existing knowledge.

Decision appears as the source of history, creating essential novelty from moment to moment assuming a world where there is action and not merely the illusion of action; where history comes into being and is not merely revealed in successive stages to the human consciousness; where there are constraints on the precise sequence of events but where complete and perfect knowledge of these constraints would leave agents ignorant of what will happen next; where, in short, events are partly shaped by what has gone before. Agents then cannot know what will happen, as the sequel of this or that act; but are able to form judgements about the sorts of things that can happen, and can set bounds to the range and diversity of conceivable consequences for each available action choice. In face of this bounded uncertainty agents' choices of act are not empty and automatic, but require thought and something more implied and conducted through thoughts, namely decision. "I define *decision* as *choice in the face of bounded uncertainty*" (p.75, Shackle, 1966, emphasis in original).

Not only is this system unequivocally incompatible with equilibrium, it is fully causal. The epistemic asymmetry of past and future establishes the apparent flow of time, a new percept rearranges the moment-in-being by signalling that what may have been anticipated has now been observed. So, the cognitive flux of the mind's content forces realization of the passage of time; of duration. Further, if such epistemic adjustments regulate the experience of time

then each and every distinct moment in time necessarily carries different epistemic content (Bausor, 1982-3). As such each and every moment which passes may alter the course of the future (this is true even if it does not). The emphasis is on the potentiality that the passage of time embodies. This is invariant for as long as it can only be *ex post* determined that any particular moment that passed did not in fact change the course of the future. What is significant here is that theories that accept this represent varying complementary aspects, both of a transmutable future, but also of the very separate process entailing what can be said about individuals contemplating that future.

“When we elect to study a non-deterministic world, we elect to study one in which a man seems to need *laws* according to which this or that action will have knowable, deterministic consequences. He seems to need laws, in order that he may know what action will give him the consequences which, out of all within his reach, he most desires. Yet when we suppose that *everyone* has this same freedom to choose his actions, the possibility of such laws seems to dissolve. For the consequences of my act depend upon the character of the simultaneous acts of others, and those acts, by our explicit assumption are not determinate, are not unique inevitable consequences of past history, and therefore cannot, even in principle be known by me when I am deciding on my own action. This is the paradox...If laws of consequence are needed, they are not there. They are available only if they are perfectly otiose, in a world where all is pre-determined” (p.72-3, Shackle, 1966, emphasis in original).

We suggest that the future evolves into the present which evolves into the past if uncertainty is radical or fundamental. So time must not be viewed as progressive and originating from the past. Time is necessarily regressively projected from the future. It is the conscious appreciation of this that determines behaviour. So, a better defined complementary concept of agency, that implies that something meaningful can be said both about an uncertain future and the individuals poised on its realization, can thus be developed, consistent with the inextricability of time from uncertainty in post Keynesian approaches.

In short, all that is not risk is not fundamental uncertainty and all that is not fundamental uncertainty is not risk either. Theories can be categorized in terms of risk and uncertainty in the following manner. Risk situations are systems of circular time, that is, the system is completely closed. Quasi-risk situations are atrophic time systems because time is effectively closed off at one end. The problem though is that closure is at the end of time and not the

beginning. Quasi-uncertainty situations correspond to the remaining two self-referential systems where time is open at both ends; and chaotic time systems where time is everywhere open. Fundamental uncertainty situations are so because of the strictly linear progression of time that is effectively closed at the beginning. Aspects of the varying kinds of time systems are not complementary. In order to attach to them aspects of others would require that these properties not be violated. There is no violation in attaching aspects of varying analyses within the same ‘family’, after all relative emphasis varies in theories of fundamental uncertainty. Crucially, risk and quasi-risk systems are purely (partial) knowledge iterations. Quasi-uncertainty systems are those of knowledge indeterminacy. Uncertainty systems are temporal iterations.

1.5 Conclusion

The above classification illustrates that the distinction between risk and uncertainty is richer than the limited context to which it is usually constrained²⁴. More importantly, it is possible to draw the distinctions that Davidson (1996a) makes, but also be able to use the same criteria to evaluate ongoing contributions to the debate. While post Keynesianism is clearer about the nature of the world that agents inhabit, the manner in which ontological or aleatory elements, as distinct from epistemological, are applied is inconsistent within the literature, arising from the lack of clarity about the role that agents play in such an analysis.

This paper only considers one aspect of this, namely implicit accounts of how agents experience uncertainty and also the nature of that uncertainty. This in turn necessitates the further requirement that not merely knowledge, but so too agency, is a separate process from uncertainty. This remains under-explored but work has already begun to do so. At the very least, and in order to not lose the meaning and significance of the sense of uncertainty that post Keynesians seek to convey, cross-pollination should occur between theories of uncertainty of the same species. To the extent that a common language can be found so too can the net be cast wider²⁵.

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²⁴ For an example see Runde (1998b) in reference to Epstein and Wang’s (1994) formulation.

²⁵ Lewis and Runde (1999) differ in ascribing the problem to retaining a common (dualist) rhetorical strategy.

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