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and ambiguity

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Fundamental uncertainty and ambiguity[1]

David Dequech

Abstract

This paper is an attempt to go beyond dichotomic taxonomies of the concept of uncertainty. It argues for the need to distinguish between at least two types of situation that have been opposed to what mainstream economics deals with under the rubric of uncertainty or risk. These situations are associated with the concepts of, respectively, ambiguity and fundamental uncertainty. It is also argued that Keynes refers both to situations of ambiguity and of fundamental uncertainty in his several writings, without explicitly distinguishing between them. Finally, the paper also discusses whether ambiguity and fundamental uncertainty come in (ordinal) degrees.

Key words: Fundamental uncertainty; Ambiguity; Keynes, John Maynard, 1883-1946; Degrees of uncertainty; Institutions.

Resumo

Esse texto é uma tentativa de ir além de taxonomias dicotômicas do conceito de incerteza. Ele defende a necessidade de distinguir entre pelo menos dois tipos de situação que têm sido opostos ao que a economia do *mainstream* trata sob a rubrica de incerteza ou risco. Essas situações são associadas com os conceitos de ambigüidade e incerteza fundamental, respectivamente. É argumentado também que Keynes se refere a situações tanto de ambigüidade quanto de incerteza fundamental em seus vários escritos, sem distinguí-las explicitamente. Finalmente, o artigo também discute se a ambigüidade e a incerteza fundamental vêm em graus (ordinais).

Palavras-chave: Incerteza fundamental; Ambigüidade; Keynes, John Maynard, 1883-1946; Graus de incerteza; Instituições.

Introduction

In recent years, some lines of research close to mainstream economics have started to deal with "Keynesian" or "Knightian uncertainty" (for surveys, see Camerer & Weber, 1992 and Kelsey & Quiggin, 1992). Some of these works include positive references to Keynes's *A treatise on probability*. At approximately the same time, in heterodox (particularly Post Keynesian) circles, a still-growing literature has appeared on the connection between *A treatise on probability* and

Keynes's mature economic writings, especially *The general theory* and related articles. Particularly important in this literature is the controversy around Keynes's notion of uncertainty, as well as the possible contribution of this literature to the interpretation of Keynes's views on liquidity preference and investment decision-making.

Also recently, scholars close to the mainstream, often applying options theory, have emphasized the irreversibility of investment decisions (e.g., Pindyck, 1991; Dixit & Pindyck, 1994) and/or have linked liquidity preference to a desire for flexibility (e.g., Makowski, 1989), sometimes using a non-standard conception of uncertainty (e.g., Jones & Ostroy, 1984). This has led to a revision, within the mainstream, of previously accepted "Keynesian" theories of liquidity preference and investment.

These are interesting developments, which raise questions such as: Has mainstream economics begun to incorporate the more heterodox ideas of Keynes and (particularly regarding uncertainty) Knight? Are some of the gaps between mainstream and heterodox economics being reduced?

The present paper attempts to contribute to a better understanding of these developments and questions by clarifying some of the concepts involved. This paper distinguishes between fundamental uncertainty and ambiguity, two notions pertaining to situations different from what mainstream economics deals with under the rubric of uncertainty or risk. An important aspect of the proposed distinction is that ambiguity refers to missing information that could be known, while fundamental uncertainty implies that some information does not exist at the decision time because the future is yet to be created. The distinction between fundamental uncertainty and ambiguity is important in theoretical terms and hopefully facilitates the communication between economists of different schools of thought, or different lines of research, allowing the identification of similarities and differences in their approaches to uncertainty and, consequently, to liquidity preference and investment.

A general issue involved here is whether the future is already predetermined, even if people cannot reliably forecast it. This issue may at first seem too philosophical, but it may have important consequences for policy discussions, if policy is understood as an attempt to construct a new future. A related, more specific issue involved here is whether uncertainty may disappear *ex ante* in a dynamic setting. This is important for, among other things, understanding

some reasons for liquidity preference and the possible (non-)neutrality of money in the long run. This paper argues that ambiguity, unlike fundamental uncertainty, may disappear *ex ante* with the passage of time. One possible consequence of this, which the paper cannot explore for lack of space, is that the way would be open for new mainstream models to accommodate ambiguity while still maintaining that money is neutral in the long run. From a post Keynesian perspective, these hypothetical models could then be criticized for accepting the long-run neutrality of money, in much the same way that Davidson (1991), for example, criticizes some analyses that, while keeping a standard notion of uncertainty (risk), improve the mainstream treatment of money by putting it in an intertemporal context but allow a "Keynesian" type of money demand to exist only in the short run. Fundamental uncertainty, in contrast, would be the type of uncertainty supporting the claim, made by Keynes and his more heterodox followers, that money is not neutral, either in the short or in the long run. In other words, discussing the concepts of ambiguity and fundamental uncertainty may have important applications in the debate about whether Keynes's critique of neoclassical economics is valid only for the short run, if at all.

The distinction between ambiguity and uncertainty also contributes to the achievement of another objective of the present paper, which is to show that Keynes referred both to ambiguity and to fundamental uncertainty (especially if one contrasts his earlier writings with the later ones). If we understand ambiguity and fundamental uncertainty as different types of uncertainty and define Keynesian uncertainty as the type of uncertainty Keynes wrote about, then the expression "Keynesian uncertainty" may be somewhat vague (the same applies to Knight). It is suggested here that communication may be improved if people adopt the distinction between fundamental uncertainty and ambiguity, instead of using the expression "Keynesian uncertainty". While some (especially post Keynesians) may interpret Keynesian uncertainty as synonymous with what is called here fundamental uncertainty, others may interpret the same expression as meaning ambiguity – indeed, as shown below, references to Keynes have appeared in the ambiguity literature. The discussion of Keynes's concept of uncertainty in this paper may also help others to assess the similarities and differences between the more mainstream and the more heterodox works which, as mentioned above, have in common the positive references to Keynes's work on probability and uncertainty.

In addition, the paper examines the issue of whether uncertainty comes in degrees. It is argued here that both ambiguity and fundamental uncertainty do admit

of degrees. While this is fairly clear in the case of ambiguity, accepting that fundamental uncertainty also comes in degrees depends on the ontological characterization of social reality and particularly on the role of institutions. The paper argues that fundamental uncertainty is not synonymous with complete ignorance and that its degree varies depending on the existence and range of institutions such as contracts, market-makers and informal conventions.

The issue of degrees of uncertainty is important, again, for discussions of reasons for liquidity preference. On the one hand, as already hinted at, the impossibility of completely eliminating fundamental uncertainty before the time of making some important economic decisions opens the way for a permanent reason for liquidity preference which may not exist under ambiguity and which is strictly precautionary. On the other hand, if, as also argued here, fundamental uncertainty can be *reduced*, then both under ambiguity and under fundamental uncertainty one of the reasons for people to prefer liquidity is that they may wait until obtaining more information and forming more reliable estimates about the future.[2] Therefore, both the differences and the similarities between some mainstream and some heterodox approaches to liquidity preference can be more easily understood in the light of the conceptual discussion proposed in this paper. The same applies to the various approaches to irreversibility and investment decisions, which is the other side of the liquidity preference coin.

Whether fundamental uncertainty comes in degrees or implies complete ignorance is also an important part of the discussions regarding the possibility of theorizing about behavior under this type of uncertainty. Some economists neglect fundamental uncertainty, at least in part because of a fear that it is not possible to deal with the phenomena concerned in a rigorous manner. Related to this is the belief that "anything goes" in a theory of behavior under fundamental uncertainty and the argument (by Coddington, 1982, for example) that consistently emphasizing fundamental uncertainty leads to theoretical nihilism. Those who implicitly or explicitly equate fundamental uncertainty with complete ignorance put more relative emphasis on factors such as animal spirits and may have more difficulty in debunking the charge of nihilism. Those who see fundamental uncertainty as a matter of degrees can more easily highlight the role of institutions

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(2) Thus, this paper provides the basis for an alternative approach (developed in Dequech, 2000) both to that which emphasizes the association between liquidity preference and waiting (Jones & Ostroy, 1984 and Makowski, 1989) and that which rejects the waiting argument and emphasizes the long-run non-neutrality of money (Davidson, 1991). In this alternative approach, waiting is possible, but money is not neutral in the long run (nor in the short).

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in an alternative economic theory. Moreover, the issue of degrees of uncertainty is also important for determining how difficult or easy it is to establish links between those (strands of) schools of economic thought which emphasize fundamental uncertainty, such as Post Keynesian, Austrian and neo-Schumpeterian economics, on the one hand, and those schools which stress the cognitive function of institutions, such as old and (strands of) new institutional economics, on the other. After all, institutions cannot perform a cognitive function under fundamental uncertainty if the latter implies complete ignorance and therefore does not admit of degrees.

Last but not least, the issue of degrees of uncertainty may also have important policy implications. For example, if fundamental uncertainty implies complete ignorance, policy-makers may have no basis on which to form expectations about the reaction of the public to their policies and to expect some policies to be better than others.

The remainder of this paper is organized as follows. The first section distinguishes fundamental uncertainty from ambiguity. The second section discusses the notion of Keynesian uncertainty. The third section is concerned with whether uncertainty comes in degrees. Concluding remarks are made in the last section.

Ambiguity is not the same as fundamental uncertainty

Several decades ago, Knight and Keynes, each in his own way, discussed uncertainty as a notion distinct from something else which Knight called risk. This distinction has been rejected by several mainstream subjective probability theorists (since de Finetti and Savage), who have then also adopted the term "uncertainty". Other scholars have insisted on the relevance of the distinction – some of them (e.g., Lucas, 1981: 224) are mainstream economists who nevertheless neglect uncertainty because of a belief that economic reasoning is impossible when it is introduced.

Many authors associate uncertainty with the absence of numerical probabilities. However, subjective probability theory, typically represented by the Bayesian approach, claims that it is possible to assign numerical probabilities to virtually any proposition or event. Betting rates are the mechanism through which subjective probabilities can be measured, allegedly also in situations that would be

otherwise characterized as ones of Knightian or Keynesian uncertainty. A person's subjective probability regarding the truth of a proposition (or the occurrence of an event) is revealed by the odds at which that person is exactly indifferent between betting for and against the proposition (or event). For example, if a person is willing to accept to pay P* for a gamble that pays S if proposition h is true and nothing if h is false, for P*/S to express the person's subjective probability it is necessary that the person be also willing to receive P* for a gamble that involves a loss of S if h is true and nothing if h is false (Runde, 1995: 338). This requires very precise beliefs, but presumably allows subjective probabilities to be assigned even to unique events. Thus, if this be so, the often-made association between uncertainty and the absence of measurable probabilities would not make sense. The same would apply to a distinction between risk (or weak uncertainty) and (strong) uncertainty on these grounds.[3]

In the mainstream subjectivist conception, uncertainty is characterized by the presence of a unique, additive and fully reliable probability distribution. Defined in opposition to this, strong uncertainty is essentially characterized by the absence of such a distribution, due to the paucity of evidence. Although this definition of strong uncertainty may be useful for some purposes, it is insufficient for us to distinguish between the types of situation that have been opposed to what mainstream economics deals with under the rubric of uncertainty or risk. In particular, the limitation of this general definition lies in the fact that there is a notion of uncertainty that goes beyond the standard treatment but still falls short of stronger notions, the latter being very relevant in economics. This less strong type of strong uncertainty is often called ambiguity.

Any dichotomic taxonomy – including the one that distinguishes between weak and strong uncertainty – is insufficient to clarify the different approaches to uncertainty in economics.

This paper is not particularly concerned with whether we should reserve the term "uncertainty" for one type of situation or distinguish between types of uncertainty, using adjectives such as strong, fundamental, Keynesian etc. This question is at least in part a strategic one, because there may be a communication problem between economists of different schools of thought. As the term "uncertainty" is widely used in mainstream economics, it is in principle helpful to

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(3) Note that mainstream subjectivist theorists may accept another distinction between risk and uncertainty, based on the existence or not of objective probabilities known to the decision-maker (e.g., Harsanyi, 1977: 9), while still claiming that they can deal with uncertainty.

use adjectives that suggest that one is referring to something different from that which many mainstream economists call uncertainty.

Ambiguity

Ambiguity usually refers to a situation in which there is uncertainty about probabilities and this uncertainty is due to lack of information. In this case, therefore, uncertainty does not refer to a situation in which known probabilities fall short of 1. It refers to lack of certainty about probabilities themselves, be they 0, 1, or something in the between. A situation in which a person does not know which event will happen but unambiguously assigns a definite probability to each and every event involves risk but not ambiguity. The same applies to the case where the ambiguity over probability can be expressed as a second-order probability. In this case, a person will conceive of a set of probability distributions rather than of only one, and will be able to unambiguously assign probabilities to each of these distributions (Camerer & Weber, 1992: 331). Uncertainty, as it is interpreted in standard subjective probability theory, can be measured by probability: the lower is the probability, the bigger is the uncertainty. This is not so under ambiguity.

There is in particular one definition of ambiguity that makes the term suitable for distinguishing between different types of strong uncertainty. This definition, which is adopted here, is due to Frisch & Baron (1988) and has been more explicitly proposed by Camerer & Weber (1992: 330): "Ambiguity is uncertainty about probability, created by missing information that is relevant and could be known".[4]

The reference to missing information that could be known is particularly useful in applying the term "ambiguity" to Ellsberg-type problems, by which I mean Ellsberg's (1961) urn problems, although Ellsberg considers other types of situation. The Ellsberg paradox is a most important reference in the ambiguity literature.

In one of Ellsberg's problems, there are two urns containing balls which are identical in everything except for their color (and perhaps not even their color, in one of the urns). The first urn contains 100 balls, each one of which is either red or black and the proportion of red and black balls is unknown. The second urn

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(4) Camerer and Weber are more explicit than Frisch & Baron (1988) about the fact that the missing information *could be known*.

contains 50 red balls and 50 black balls. People offered gambles regarding the color of a ball drawn at random from urn one are indifferent between betting on red and betting on black. The same applies for urn two. However, when asked whether they prefer to bet on a red ball being drawn from urn one or from urn two, many people prefer urn two, instead of showing indifference. The same applies if it is a black ball that is involved in the choice between urns. If one tries to infer probabilities from these choices in the usual way, the probabilities revealed in the choice among urns are incompatible with the ones revealed in the choice within urns, and contradict standard subjective expected utility (SEU) theory.

In another Ellsberg problem, an urn contains 90 balls. 30 balls are known to be red. The remaining 60 are black and yellow, but the ratio of black to yellow is unknown. One ball is to be drawn at random. People are offered two pairs of bets. In the first pair, they have to choose between "a bet on red" and "a bet on black". In the second pair, they have to choose between "a bet on red or yellow" and "a bet on black or yellow". Very often people choose "red" in the first pair and "black or yellow" in the second. This implies that they prefer to bet on "red" in the first pair while also preferring to bet on "not-red" in the second. Again, these choices are incompatible with strict SEU theory. These decision-makers cannot be said to be acting "as if" they were maximizing standard SEU.

Ellsberg (1961: 657) suggests that something else than the desirability of the payoffs and the relative likelihood of the events is involved, namely the nature of information about the relative likelihood, or its ambiguity.

It should be highlighted that, in the urn problems conceived by Ellsberg, the information about the contents of the urns in principle exists; it is just not made available to the decision-maker. It is *hidden information*, rather than *nonexistent* at the moment of decision.

Another important characteristic of Ellsberg-type problems is that, even though the decision-maker does not know with full reliability the probability that each event (or state of the world) will obtain, he/she knows *all the possible events* – so, even if none of the possible probability distributions is ruled out, this situation is not really one of "complete ignorance", despite some people's use of this expression (e.g., Ellsberg, 1961: 657). For example, in any of Ellsberg's urn problems, as the number of balls of a certain color in an urn ranges from 0 to n,

there are $n+1$ predetermined possible states of nature defined according to the number of balls of that color in the urn.[5]

A serious limitation of the notion of ambiguity is that it does not allow one to properly deal with creativity or with structural change in the decision-making environment, particularly a change due either to creativity itself or to the unintended consequences of people's actions.

In Ellsberg-type problems, it is relatively straightforward to discuss the evidence's degree of completeness. One can conceive of the complete information in possession of which there would be no ambiguity. For example, in the urn problems mentioned above, information would be complete if one knew the color of each ball in each urn. One can then assess how far short from complete information the actual information falls. Similarly, one can envisage what a fully reliable probability distribution would be in this case, and this provides the standard with which to gauge the reliability of another distribution.

Ellsberg himself may have meant to apply the term "ambiguity" to situations of stronger uncertainty than that involved in his urn problems. For example, Ellsberg (1961: 661) states that "the results of Research and Development, or the performance of a new President, or the tactics of an unfamiliar opponent are all likely to appear ambiguous". He also maintains that "the ambiguities surrounding the outcome of a proposed *innovation*, a departure from current strategy, may be much more noticeable" than in the case of a familiar, ongoing pattern of activity (p. 666). As Ellsberg does not elaborate on this, it is not clear that he has in mind an uncertainty as strong as that emphasized by economists in the Post Keynesian, Neo-Schumpeterian and Austrian traditions, for example, in connection with innovation and Schumpeterian entrepreneurship (see references below). At any rate, Ellsberg's references to innovation and the like, even if insufficiently clear, have apparently been lost in the ambiguity literature. As far as

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(5) It is in relation to Ellsberg's urn problems that Einhorn & Hogarth (1986) define ambiguity. In the case of an urn with an unknown proportion of balls of different colors, several probability distributions over the proportion of the different types of balls are admissible and equally likely. For Einhorn & Hogarth (1986: S229), "ambiguity results from the uncertainty associated with specifying which of a set of distributions is appropriate in a given situation. Moreover, the amount of ambiguity is an increasing function of the number of distributions that are not ruled out by one's knowledge of the situation". At one extreme, no distribution is ruled out. This corresponds to what Einhorn and Hogarth call ignorance. If people were gradually given information about the contents of the urn, ambiguity would decrease until all distributions were ruled out but one, which constitutes a situation of risk (Ellsberg, 1961: 657-58) must be their source of inspiration). New types of probability distributions, defined over new states of the world, cannot be added to the set of probability distributions to which Einhorn and Hogarth refer.

terminology is concerned, what matters most is the usual sense in which ambiguity has been discussed, and this seems to be well reflected in Camerer & Weber's (1992) reference to information that could be known.

The acceptance of this more restrictive conception of ambiguity among economists tends to be reinforced by its implicit or explicit prevalence in the formal literature on ambiguity (sometimes called uncertainty) and on Ellsberg (1961). This prevalence can be seen in the case of two of the major formal approaches that generalize expected utility (EU) theory beyond weak uncertainty: the multiple-priors approach and the nonadditive prior approach (for a detailed discussion of these and other alternatives to standard EU and particularly SEU theory, see Kelsey & Quiggin, 1992 and Camerer & Weber, 1992).

The multiple-priors approach abandons the standard idea that decision-makers have a unique probability distribution. Ellsberg (1961: 661) himself introduces a set of probability distributions and also refers to the confidence that the decision-maker has in his/her estimates. Thus, the idea of full reliability is also abandoned, which explains the paradox, since in Ellsberg's experiments people prefer more reliable information. A similar approach, in an otherwise Bayesian framework, is pursued by Gärdenfors & Sahlin (1982). An axiomatization of the multiple prior approach is provided by Gilboa & Schmeidler (1989).

Within this approach, Bewley (1989) deserves a special mention for dealing not only with the Ellsberg paradox but also with innovation and entrepreneurship. In this sense, he goes beyond the ambiguity literature and recovers Ellsberg's references to innovation. Bewley drops the assumption of complete preferences but keeps the assumption of an exhaustive list of states. Thus, his view of innovations is quite limited. Innovations are treated as new alternatives that change the available choice set but do not create new "states". States are thus still conceived of as independent of what people do. People form multiple subjective probability distributions and there is a "true distribution" or a "true stochastic mechanism governing the environment" (Bewley, 1989: 4-5).

The non-additive prior approach, again axiomatically developed by Schmeidler (1989) and Gilboa (1987), retains the commitment to point probabilities (and for this is criticized by Runde, 1995: 349n), but replaces the Bayesian prior with a non-additive measure or capacity. This results from the introduction of weaker axioms than Savage's sure thing principle and allows for an

explanation of the Ellsberg paradox.[6] A non-additive measure may exhibit uncertainty [ambiguity] aversion (Schmeidler, 1989, 574). The degree of sub-additivity may be taken to represent one's faith in probability assessments (Karni & Schmeidler, 1991: 1803 and Camerer & Weber, 1992: 348).

In terms of standard Subjective Expected Utility (SEU) theory, as represented by Savage (1954), situations of ambiguity may violate not only the sure thing principle but also the complete ordering axiom. This axiom requires people to have a complete preference ordering over acts (the relation among events is to be inferred from people's choices). People choose between acts the consequences of which depend on which state of the world prevails.[7] Their propensity to act (to bet on the occurrence of some events, as seen above) is the instrument through which subjective probabilities can be estimated. Under ambiguity, people may refuse bets that would allow the elicitation of their subjective probabilities, because they prefer to wait for the missing information and/or because of fear of asymmetric information, that is, fear that someone else may have the missing information (Frisch & Baron, 1988; Camerer & Weber, 1992).

Fundamental uncertainty

Going beyond situations of ambiguity, members of different schools of heterodox economic thought have emphasized situations of uncertainty of a more radical type. These situations are essentially characterized by the possibility of creativity and structural change and therefore by significant indeterminacy of the future. Uncertainty appears here in a dynamic context, in which the passage of time is crucial. The future cannot be anticipated by a fully reliable probabilistic estimate because *the future is yet to be created*. In socioeconomic contexts, the future is to a

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(6) This principle is the analogue in Savage's theory to the independence axiom in Von Neumann-Morgenstern's (actually, in a theory named after Von Neumann and Morgenstern, who did not state the independence axiom explicitly). It can be stated as follows: if the lottery L^* is preferred to the lottery L, then the mixture $\alpha L^* + (1-\alpha)L^{**}$ will be preferred to the mixture $\alpha L + (1-\alpha)L^{**}$ for all $\alpha > 0$ and L^{**} (Machina, 1987: 127). Mixing each of two lotteries with a third one – in the same proportion in the two cases – does not change the ranking. Ellsberg examples show that the comparison between these alternatives depends also on the reliability of the available information. The preferences revealed in Ellsberg's experiments are inconsistent with the existence of additive probabilities, and in Savage's theory the sure thing principle is mainly responsible for the additivity of probabilities (Karni & Schmeidler, 1991: 1803).

(7) In alternative presentations of the standard theory, probabilities are directly attached to consequences, which is equivalent to attaching them to states because there is a one-to-one correspondence from states to consequences.

considerable extent unknowable, because surprises may occur, both as intended and as unintended consequences of human action. The very decisions that would require a fully reliable probabilistic guide may change the socioeconomic future in an unpredictable way, and this possibility of change prevents such a fully reliable guide from existing.

The problem is not merely that we do not have enough information to reliably attach probabilities to a given number of events. An event which we cannot yet imagine may occur in the future. As we cannot imagine it in the present, we cannot attribute to it any probability. This means that some relevant information *cannot be known, not even in principle*, at the time of making many important decisions. Associated with this is the fact that in many cases, as something that we cannot imagine may happen, we cannot conceive what the complete information would be.

This argument has clear antecedents in the work of Shackle (e.g., 1972: 399-400), who is against the use of probability distributions, even subjective ones, in situations of fundamental uncertainty. A similar point has been more recently raised against both the rational expectations hypothesis and Subjective Expected Utility (SEU) theory by Bausor (1983: 6-7; 1985: 69-73), Davidson (1991: 132, 136), Carvalho (1988: 75) and Vickers (1994), among others. It is not denied here that decision-makers may still construct subjective probability distributions in these situations, if they so wish, but they should acknowledge the unknowability of a list of all possible events and the consequent limited guidance provided by these probability distributions.[8]

The best example of human creativity and of unpredictable structural change in the economic sphere is the introduction of technological or managerial innovations, as in Schumpeter's process of creative destruction. This is a good example to show that what is at issue here is not whether a machine will be invented which can make more precise predictions about the future.[9] People can be creative in the sense of doing things that cannot be thought of in advance. No machine could have determined in advance if someone would invent the airplane,

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(8) Langlois & Cosgel (1993: 460) interpret Knight as saying that a decision-maker facing uncertainty "would have first to 'estimate' the possible outcomes to be able to 'estimate' the probabilities of occurrence of each". Also worth mentioning here is Carvalho's (1988: 76) interpretation of Keynes's logical probability theory. He argues that: in situations of uncertainty people have to use their imagination to create the premises on which they reason; "given these premises, a probable relation can be built"; and, in order to act, people have to have confidence in the premises.

(9) I am grateful to an anonymous referee for forcing me to clarify this point.

the television or the computer, just to use examples of this century. These examples are quite adequate to illustrate the argument that we can at least say that one particular machine will *not* be invented, namely a machine that reliably predicts the whole future of the social world.

Schumpeterian creative destruction plays an important role in the defense of a more radical notion of uncertainty by Post Keynesians such as Davidson (1991), Dow & Dow (1985: 55) and Lavoie (1992: 44). The connection between innovations and a more radical type of uncertainty also appears in the Neo-Schumpeterian literature (for example, Freeman, 1982: 149-150 and especially Dosi & Egidi, 1991: 148), as well as in some strands of Austrian and new institutional economics (Langlois, 1994).[10] Innovations are particularly important in this context because competition, in a capitalist system, stimulates decision-makers to innovate in search for extra profits, so that there is an endogenous pressure for something that causes uncertainty – see Kregel (1990: 90) on Shackle.

In all these schools or strands, a stronger type of uncertainty than ambiguity is connected with the possibility of unpredictable structural changes in general, and not only due to innovations – Lawson (1985: 921), Hamouda & Smithin (1988: 162-163), Davidson (1991: 133), Dosi & Egidi (1991: 148) and Langlois (1994: 121). Historical changes can be of a more typically political or cultural nature. They have a significant impact on preferences, work relations, the workers' bargaining power, government decisions etc.

We must question the very applicability of the notion of state of the world. In EU theory, a state of the world is defined as *independent of acts*. This means that, whatever the intended or unintended consequences of what people do, people's acts cannot create new "states of the world". This does not prevent one from using the notion of state of the world to deal with Ellsberg-type problems, for in these cases the list of all possible states of the worlds is already predetermined.

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(10) In Austrian and new institutional economics, the discussion of cognitive problems sometimes centers on the complexity of the world vis-à-vis people's limited capability. Going beyond this, Langlois (1994: 119-120) maintains that "one does not in fact know with certainty a listing of all possible states of the world. This uncertainty about the very structure of the world, not captured in neoclassical modeling and not well-suited to the probability calculus, is what I have called structural uncertainty". He also connects this uncertainty with innovative behavior: "Perhaps the clearest example of the characteristic Austrian focus on structural uncertainty ... is to be seen in the theory of entrepreneurship" (Langlois: 1994: 121). However, the Austrian emphasis on entrepreneurship is not sufficient in this context, as entrepreneurship is sometimes associated with the discovery of already existing opportunities rather than with the creation of new ones. Wubben (1995) provides a comprehensive survey of the Austrian treatment of uncertainty, with some references to fundamental types of uncertainty.

In other, fundamental cases of uncertainty, the notion of state of the world as it is usually constructed cannot be used.

This means that criticisms of EU theory in its own field are inevitably limited. For example, Camerer & Weber (1992: 339) argue that "preferring bets on unambiguous events is only a violation of SEU if equivalence between the likelihoods of the ambiguous and unambiguous events has been established". This is possible in Ellsberg-type problems, but SEU theory is not even applicable in more radical problems, because of limitations in its very conceptual apparatus, particularly regarding the notion of state of the world. A less restrictive notion of event, as something that can be endogenous to the decision process, is needed to allow for creativity. Technical change, for example, implies endogeneity of events (Dosi & Egidi, 1991: 148).

Ambiguity in a dynamic setting and fundamental uncertainty

It is conceivable, under ambiguity in a dynamic setting, that more information may become available to the decision-makers, changing their probability distributions and/or their assessment of the reliability of these distributions. If so, people may wish to wait until they obtain more information and thus temporarily refuse to bet under ambiguity, not revealing any subjective probabilities. In contrast, regardless of whether fundamental uncertainty implies complete ignorance or not, it does imply that some types of information will never be obtained *ex ante*, no matter how long people wait for. When creativity and unpredictable structural change are possible there is information that is not knowable at the moment of decision.

If, as argued below, fundamental uncertainty does not imply complete ignorance, the ordinal degree of uncertainty regarding the results of a decision may vary over time. In this case, people may also wait to obtain more information; for example, they may wait until some phase of institutional turmoil is over. However, they should not wait for information that will never exist at the time of decision. Moreover, since some information does not exist at the time of decision, there is no asymmetry regarding such information: nobody has it (of course, asymmetry is possible regarding the information that does exist). Thus, a refusal to bet may also happen under fundamental uncertainty, but the reasons for this refusal need not be the same that operate in a context of ambiguity, namely, a wait for additional

information or fear of asymmetric information. If the decision-maker acknowledges the existence of fundamental uncertainty, he/she may prefer not to bet on the occurrence of any of the "states of the world" that he/she is able to imagine. The decision-maker may also wish to protect himself/herself against the occurrence of undesirable unpredictable events.[11]

The common definition of uncertainty as a situation in which objective probabilities are not known is not sufficiently clear. It may describe ambiguity, where the objective probabilities exist, but also fundamental uncertainty, where they do not. In the case of ambiguity, the passage of time may lead people's subjective probability distribution to converge towards an objective, fully reliable probability distribution that can be said to exist.[12] In the case of fundamental uncertainty, such an objective distribution does not exist at the time of decision and therefore nothing can converge to it. It should also be noted that, for a staunch subjectivist, an objective distribution does not exist, in any situation.

Keynesian uncertainty

Keynes, ambiguity and fundamental uncertainty

Keynes's name has often been mentioned in discussions of uncertainty, particularly when uncertainty is distinguished from risk. Sometimes people write of Keynesian uncertainty or of uncertainty in Keynes's sense. However, it is necessary to clarify which type of uncertainty one is writing about, because different conceptions of uncertainty exist whose proponents may claim a Keynesian lineage. Keynes in his several writings refers both to situations of ambiguity and of fundamental uncertainty, without explicitly distinguishing between them. Thus, the expression "Keynesian uncertainty", if interpreted as meaning the type of uncertainty Keynes wrote about, may be sufficient to indicate that one is not referring to risk in an objectivist approach or to uncertainty in standard SEU

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(11) Davidson (1991: 134) observes that Keynes's liquidity preference is associated with a violation of the complete ordering axiom. Davidson adopts a notion of fundamental uncertainty, but, as noted above, this violation may also occur under ambiguity. The lack of an exhaustive list of states may be sufficient but is not necessary for incompleteness of preferences.

(12) This possibility of convergence could also be envisaged by those who attribute the decision-makers' lack of knowledge to their limited mental capabilities. Convergence could occur as this capability increases and as people have more time to understand a complex but constant environment.

theory, but it leaves unanswered the question of whether one is referring to ambiguity or to fundamental uncertainty.

Situations of ambiguity appear in his *A treatise on probability* (TP hereafter). Indeed, Keynes discussed in the TP (p. 82) a case very similar to one of Ellsberg's (1961) urn problems. It is particularly in his later economic writings that Keynes refers to situations of fundamental uncertainty. Keynes (1937, 113-114) includes "the obsolescence of a new invention", "the prospect of an European war" and "the position of private wealth owners in the social system" thirty years hence as examples of uncertain matters about which "we simply do not know" – see also Keynes (1936: 141, 252) and his comments on Tinbergen (Keynes, 1973b: 287, 309).[13]

These situations are not the focus of attention in *A treatise on probability*, but Keynes refers to the TP in *The general theory* and related writings (see some references below). A whole line of research has emerged that interprets Keynes's mature economic writings in the light of his earlier work on probability.

Controversy surrounding "A treatise on probability"

Attempts to express Keynes's notion of uncertainty in terms of the TP have been the subject of much controversy. Some interpreters have argued that uncertainty corresponds to an absence of numerically determinate or even comparable probabilities – see Lawson (1988), Rotheim (1988: 88), Brown-Collier & Bausor (1988: 238-239), Hamouda & Smithin (1988: 160) and Dutt & Amadeo (1990: 105-106). However, there are also those for whom probability relates to just one dimension of Keynes's notion of uncertainty, with another dimension relating to the TP's notion of weight. In its second dimension, uncertainty is measured by weight – see Hoogduin (1987), Kregel (1987), O'Donnell (1991), Runde (1991), Anand (1991), Brady (1993) and Gerrard (1995). While probability in the TP is a relation between two propositions, weight has to do with the evidence on which the probability relation is based. Keynes is not always consistent in defining weight, and two basic concepts may be extracted from the TP (Keynes, 1973a: 77, 84, 345). According to the first definition, weight represents the amount of relevant evidence. According to the second one, weight represents the evidence's degree of

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(13) Following a conventional procedure, I refer to Keynes's collected writings by the notation CW followed by the respective volume number.

completeness (which is equivalent to the balance of relevant knowledge and relevant ignorance). The second concept is less accepted among Keynes's interpreters but is the one required to connect weight with the notion of confidence in *The general theory* (Runde, 1990).

Weak uncertainty (risk) would refer, in the TP terms, to the presence of numerical less-than-unity probabilities and maximum weight. The TP interpreters mentioned above are clearly discussing something else, but they have overlooked the difference between ambiguity and fundamental uncertainty.

Expressed in the TP terms, both ambiguity and fundamental uncertainty are cases in which there is no basis for establishing point, numerical probabilities. In the case of ambiguity, one may use interval probabilities. People may be uncertain about point probabilities or about interval probabilities, but the list of possible events is already predetermined, contrary to what happens under fundamental uncertainty. Moreover, in most ambiguity models, doubts about the list of possible events are not considered (one exception is Mukerji (1997)). Both ambiguity and fundamental uncertainty are marked by a paucity of evidence and, thus, in the TP terms, by low weight. Weight is *not synonymous* with ambiguity, nor fundamental uncertainty. Rather, it has been proposed as a *measure* of ambiguity and fundamental uncertainty. Both ambiguity and fundamental uncertainty represent the lack of knowledge, or lack of reliability of knowledge, resulting from the lack of evidence, and weight measures the amount or completeness of evidence. However, that does not mean that the notion of weight is equally applicable to both cases. This is the issue to which I now turn.

Weight: a difficulty

The concept of weight, in general and not only in Keynes's work, still awaits proper clarification (Hamouda & Rowley, 1996: 121) and involves rather complicated issues (Cohen, 1985). In the ambiguity literature, the connection between this notion and ambiguity has been noted by Gärdenfors & Sahlin (1982), Frisch & Baron (1988), Camerer & Weber (1992), Kelsey (1994) and Fox & Tversky (1995). In most cases, people interpret weight as the amount of evidence, but, as argued above, it is *relatively* straightforward to discuss the evidence's degree of completeness in Ellsberg-type problems. This degree of completeness is

one of the senses in which Keynes defines weight. Here, therefore, Keynes's notion of weight in this latter sense can also be used in a relatively straightforward way.

Regarding fundamental uncertainty, the notion of weight is more problematic. For those who think that fundamental uncertainty implies complete ignorance and does not come in degrees, weight as a measure of uncertainty would have no place in this context. If, in contrast, fundamental uncertainty is not seen as implying complete ignorance, this does not mean that all the necessary conditions for using weight would be satisfied, for there is still one difficulty in this case. Situations of fundamental uncertainty are such that we cannot precisely establish how complete our information about the future is. This is due to the fact the future is *yet to be created* by our very actions. There is no predetermined full amount of information to provide a standard to which the completeness of actual information can be compared. Keynes, in *The general theory* (Keynes, 1936: 148n, 240n) and in a 1938 letter to Townshend (Keynes, 1979: 293), seems to have suggested we use the notion of weight when dealing with fundamental uncertainty. If we are to do so, and in particular if are to we use weight in the sense of the evidence's degree of completeness (so that we can relate weight to confidence), we cannot imply that complete information exists at the time of decision under fundamental uncertainty.

The difficulty in applying weight to these situations has been neglected by those who suggest that we use weight as a measure of uncertainty, with the possible exception of Runde (1990: 283), who admits that "we can never say how complete our information is at any point". This difficulty implies either that Keynes's notion of weight cannot be used in situations of fundamental uncertainty or that is has to be used in a different way.[14]

Does uncertainty come in degrees?

Can we speak of degrees of uncertainty, at least in *ordinal* even if not in cardinal terms? It is important, again, to distinguish between ambiguity and fundamental uncertainty.

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(14) It should be noted that the expression "Knightian uncertainty" has also been associated with both ambiguity and fundamental uncertainty. Ellsberg (1961: 653) observed that Knight (1921) had discussed something similar to one of his urn problems. On the association between Knight and fundamental uncertainty, see, for example, Langlois & Cosgel (1993). Like Keynes's, Knight's notion of uncertainty has been the subject of much controversy.

It is relatively easy to defend the idea that ambiguity comes in degrees. In the first section, some possible measures of ambiguity were mentioned. One of them is weight, in Keynes's TP framework.[15] In the generalizations of EU theory, measures of ambiguity are clearly admitted, such as the degree of sub-additivity of a single probability distribution, in the non-additive prior approach, or Gärdenfors & Sahlin's (1982) degree of epistemic reliability of multiple probability distributions, in the multiple prior approach.

Whether fundamental uncertainty comes in degrees depends, first of all, on whether or not fundamental uncertainty implies complete ignorance. If it does, as on some occasions Shackle (1967: 228) and Vickers (1994: 12) seem to argue, it cannot be a matter of degrees.

The characterization of fundamental uncertainty by the possibility of creativity and structural change is basically an ontological one. This ontological criterion has been adopted by Davidson (1996) to distinguish uncertainty from other situations, based on the difference between what he calls a transmutable and an immutable reality. The ontological side of the discussion about uncertainty inevitably has a counterpart in terms of the type of knowledge that people can or cannot have under fundamental uncertainty. It is necessary to examine in more depth both the ontological conception of economic reality and its counterpart in terms of knowledge.

The counterpart, in terms of knowledge, of the ontological conception of economic reality as subject to unpredictable structural changes is fundamental uncertainty. But does this uncertainty imply complete absence of knowledge, that is, complete ignorance (or unknowledge, to use Shackle's expression)? First of all, people are or at least may be aware of uncertainty itself. In Hicks's (1977: vii) aphorism, people [may] know they don't know. Can people know more than that? As the type of knowledge of reality that is possible for us to have depends on the characteristics of reality, the question then becomes: is there an ontological basis for some knowledge in a transmutable reality? That depends on whether there is more to be said of the ontology of such a changeable reality.

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(15) There is no implication here that weight could be measured non-arbitrarily in situations of ambiguity. For a suggestion that the measurement of weight is somewhat arbitrary in this case, see Cohen (1985: 274-275). See also Georgescu-Roegen (1954: 24-25) on the difficulty of measuring what he calls the "credibility" of a probability (or betting quotient). "Credibility" is very similar to ambiguity, according to Ellsberg (1961: 659). The quality and not only the quantity of the information may be important (Kelsey, 1994: 435), which complicates measurement.

This is the question examined next. Having elaborated on ontology, the paper then turns to the issue of whether fundamental uncertainty comes in degrees.

Social practices and knowledge under fundamental uncertainty

There is more to be said of ontology, particularly regarding the existence of social practices that lend stability to economic reality. For the purposes of this paper, perhaps the least controversial of these practices are those related to the existence of some legal institutions, so let us begin with them. Later on, reference is made to other, more informal social practices.

Legal institutions: contracts. Legal contracts reduce uncertainty about the future values of nominal variables. This is particularly so in the case of costs such as wages and inputs. Contracts do not, in general, make real outcomes more knowable, but some contracts are linked to a price index. In any case, nominal outcomes are of great importance in a monetary economy.

Ontologically, the existence of legal contracts has to be associated with the existence of another institution, the State, which is supposed to enforce contracts. In terms of knowledge, the existence of the state and its power to enforce contracts, resorting to physical force if necessary, creates an ontological basis for the belief that contracts will be enforced in case one of the parties decides not to fulfil its obligations or finds itself unable to do so, due to unforeseen circumstances (it is these two possibilities that lead some creditors to require a collateral before engaging in debt contracts). Consequently, there is an ontological basis for a decision-maker's belief in his/her estimates of future values of nominal variables specified in contracts. The existence of contracts and the State rules out at least some events or outcomes which would be possible or more likely otherwise.[16]

It should be noted, however, that the role of contracts varies according to how people understand them and to how the state enforces them. This varies from country to country and from time to time, and depends on informal social practices (which are commented on below).

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(16) Under fundamental uncertainty, as unimaginable events may occur, contracts are necessarily incomplete. This is not so under ambiguity, but see Mukerji (1998) for the argument that ambiguity aversion justifies the existence of incomplete contracts.

Legal institutions: market-makers. Another type of institution that provides stability to a transmutable reality is a market-maker. In a market for a durable asset, the market-maker is responsible for providing orderliness, significantly reducing the magnitude of possible changes in the asset spot price. Prices are more stable, even if not rigid, than they would be in the absence of a market-maker.

A very important market-maker is the central bank in its role of lender of last resort (Minsky, 1986; Davidson, 1988). In this role, the central bank provides a more concrete basis for people's expectations not only about prices, but also other nominal variables, such as deposits in bank accounts and shares of bank funds. Bank insolvency would be a much more serious threat without commercial banks having the central bank to fall back on. The same applies to generalized bankruptcy, which would affect the value of all sorts of economic variables. In addition, the central bank is important in the control of international transactions. At an international level, there may exist institutional arrangements that work in a similar way that an international central bank would, to reduce the volatility of exchange rates and international reserves.

More generally, public institutions like the central bank and others, through their influence on prices and on the level of economic activity, contribute to reduce fundamental uncertainty, if they act so as to promote stability both in terms of prices and growth. Public announcements of their long-term policies may play an important part in this.

Informal institutions. One can also speak of the stabilizing role of institutions, including conventions, in the sense of socially shared and/or prescribed standards of thought and behavior. Although people can be creative and idiosyncratic, we do not expect (all of) them to behave in a completely erratic manner, because people have been socialized.

In the institutionalist literature, the historical and therefore changeable character of the social reality has been emphasized, but, at the same time, both old and new institutionalists argue that institutions perform an important 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

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perception that people have of reality, that is, on the way people select, organize and interpret information. I call this their deeper cognitive function.

Much of our knowledge of these informal social practices is tacit or practical, that is, held subconsciously. This kind of knowledge tends to be neglected in discussions of uncertainty, but it is possible to think of practical knowledge as providing a basis for beliefs regarding events.

Through their cognitive function, institutions provide and influence knowledge in an environment marked by fundamental uncertainty. At the same time, this cognitive function may prevent people with different institutional backgrounds from understanding each other. These people may attribute different meanings not only to informal institutions, but also to formal ones, like contracts. The mere presence of these informal and formal institutions is not sufficient, therefore, to reduce uncertainty in social interactions.

Does fundamental uncertainty come in degrees?

People do have some kind of knowledge even in a transmutable reality, that is, even in situations of fundamental uncertainty. This opens the way for us to speak of different degrees of fundamental uncertainty. I have in mind ordinal rather than cardinal degrees: we can speak of some situations involving less uncertainty than others (in contrast, we could not say this if fundamental uncertainty implied complete ignorance). For example, in social environments where the institution of contracts is more widespread than in others and where more market-makers exist, there is less uncertainty about the possible future nominal values of important variables and there are less nominal variables about whose future values people do not know anything. There are less outcomes and events that can be considered as possible or likely. Inversely, uncertainty increases when institutional arrangements that have promoted stability break down.

Admittedly, we cannot know exactly how ignorant we are, as the future is yet to be created. No standard of complete knowledge or complete ignorance exists to provide a reference against which to measure our actual ignorance. However, we can say that people are more ignorant at least about some things – such as possible future values of nominal variables – in some situations than in others, the difference between these situations depending on the existence and prevalence of

stabilizing institutional practices. It is in this specific sense that we can say that the degree of uncertainty is bigger in some cases than in others.

Our knowledge of the stabilizing effect of these social practices provides us with a concrete basis on which to assess the degree of uncertainty. The assessment can never be completely objective in situations of fundamental uncertainty, given that complete information does not exist *ex ante*; however, the basis provided by these social practices means that the assessment of uncertainty is not completely a question of animal spirits or the like.

Concluding remarks

Fundamental uncertainty has to be distinguished from uncertainty as defined in mainstream economics and from ambiguity. As emphasized by members of different schools of heterodox economic thought, fundamental uncertainty reflects the limitations of knowledge in an environment marked by the possibility of creativity and structural change. Ambiguity has been accommodated in some generalizations of expected utility theory, but not fundamental uncertainty.

Keynesian uncertainty, interpreted as the type of uncertainty Keynes wrote about, includes both ambiguity and fundamental uncertainty. Keynes's later economic writings convey a notion of fundamental uncertainty, sometimes with references to his earlier book on probability. However, not everyone using *A treatise on probability* to conceptualize uncertainty has fundamental uncertainty in mind, for that book can also be used in connection with ambiguity.

The distinction between ambiguity and fundamental uncertainty is also useful when discussing if one can speak of (at least ordinal) degrees of uncertainty. It is relatively easier – or less difficult – to argue that ambiguity comes in degrees. Finding some standard with which to gauge the available evidence's degree of completeness or reliability is relatively less complicated in this case, although difficulties exist when it is necessary, for example, to assess the quality of the available evidence in different situations.

At least one major complicating factor must be added when examining if fundamental uncertainty comes in degrees: some information simply does not exist at the time of making decisions, because the future is yet to be created. There is no predetermined full amount of information to provide a standard to which the

completeness of actual information can be compared. However, in some cases it is possible to maintain that decision-makers are at least more ignorant about some relevant issues than in others. In order to accept this, one has to go beyond the ontological characterization of economic reality as subject to creativity and unpredictable structural change. The expanded ontological characterization suggested here is one that includes stabilizing social practices, which provide a basis for some kind of knowledge together with fundamental uncertainty.

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