TEXTO PARA DISCUSSÃO N° 147

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Novembro de 2000

Ficha catalográfica

330.834 C938c 2000	Crocco, Marco The concept od degrees of uncertainty in Keynes, Shackle and Davidson / por Marco Crocco. Belo Horizonte: UFMG/Cedeplar, 2000. p. (Texto para discussão ; 147) 1. Incerteza (Economia). 2. Economia Keynesiana. 3. Keynes, John Maynard, 1883-1946. 4. Shackle, George Lennox Sharman, 1903- 5. Davidson, Paul, 1930- I. Universidade Federal de Minas Gerais. Centro de Desenvolvimento e Planejamento Regional. II. Título. III. Série.

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THE CONCEPT OF DEGREES OF UNCERTAINTY IN KEYNES, SHACKLE AND DAVIDSON

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CEDEPLAR/FACE/UFMG
BELO HORIZONTE
2000

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SUMÁRIO

Abstract: The aim of the paper is to discuss and define a concept of Keynesian uncertainty capable of both to comprehend the concept of probable knowledge and admit the existence of degrees of uncertainty. Although the economic literature have been discussed this concept based on the discussion of the weight of argument that comes from Keynes's theory of probability, we claim that this discussion must include the analysis of the relevance of the evidence. Moreover, we claim that this concept of uncertainty is not incompatible with Shackle's concept of crucial decision and the understanding of the social reality as a nonergodic process.

INTRODUCTION

The aim of this piece is to discuss and define a concept of uncertainty capable of both comprehend the concept of probable knowledge and admit the existence of degrees of 'true uncertainty'. Sharing the opinion of other scholars (Runde 1990; Dow 1995 e Dequech 1997), we think that it is possible to find this definition of uncertainty in Keynes's works, and so, make a point to the understanding of uncertainty as a concept feasible to be graded. However, we go far on the discussion of the elements that justify the understanding of the existence of degrees of uncertainty. These authors centre their analyses on the role of the concept of weight of argument. Although we do not deny its important, we claim that it is necessary to incorporate the discussion about what define the *relevance* of the evidence to have a fully understanding of the concept of degrees of uncertainty.

Moreover, we claim that this concept is not incompatible with the understanding of the social reality as a nonergodic process. To sustain this claim, we will discuss Davidson's and Shackle's views and show that in their writings there are some elements that support our main point.

I. KEYNESIAN UNCERTAINTY

The concept of uncertainty in Keynes has been a subject of debate since the publication of the *General Theory*. Initially, the main feature of this discussion was the distinction between 'risk' and 'uncertainty'[1]. While the Neoclassical approach argued that only situations of risk were analytically tractable in economic analysis, e.g. Lucas, heterodox schools - specially the Post Keynesians - maintained that economic analysis should not neglect 'true' uncertainty. However, since the early years of the 1980's the debate has changed. Despite the fact that the previous distinction still remains, within the heterodox field a discussion about the existence or not of Keynes's concept of uncertainty in the *Treatise on Probability* and its link to the *General Theory* has emerged (Carabelli, 1985, 1988, 1992 and

[1] This distinction first arises in Knight's works:

1995; O'Donnell, 1989, 1990, 1991; Lawson, 1985, 1988; Runde 1990, 1991, among others). Thus, we think that it is important to look at the *Treatise on Probability* before we define what is understood here as Keynesian uncertainty[2].

I. 1. Keynes's Probability

For Keynes, probability is about logical relations between sets of propositions, premisses and conclusions. Let the conclusions be the set of propositions a, and the set of premisses, h. If a knowledge of h justifies a rational belief in a of some degree, one can say that there is a probability relation between a and h. This relation can be written as: a/h.

As one can see from the definition above Keynes's "probability was embodied in arguments and judgements which had no direct relationship with empirical and physical entities and which referred to the process of reasoning, rather than to the happening of events" (Carabelli, 1988, p. 15). The probability relation or the degree α of rational belief that it entails ranges from a situation of certainty ($a/h = 1$), meaning that the relationship between a and h is one of complete entailment, to a situation of impossibility ($a/h = 0$), where a and h are contradictory. A situation where $0 < a/h < 1$, means that the probability relation warrants a degree belief intermediate between 0 and 1.

However, it is important to note that what is described here as certainty does not mean truth. Truth is a property of a proposition while certainty is a logical relation between propositions. When the situation of $a/h = 1$ occurs, this means that a logical relation between two propositions allows us to believe that a follows from h with certainty. So, the probability relation is defined solely in terms of the relation between the conclusion and the premisses. If, after establishing a probability relation of type a/h, new evidence h_1 appears, this does not invalidate the previous probability relation, but gives rise to a new one a/hh_1.

An important feature of Keynes's theory of probability is that not all probability relations can be numerically measurable. On the contrary, in Keynes's view, a probability relation is, in general, a non numerically measurable quantity:

> Only probability relations which are of the *same kind* and in the *same unit* of quantity are numerically measurable and therefore numerically comparable. ... Moreover, this impossibility of numerical measurement is not a product of mental incapacity or lack of

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> It will appear that a *measurable* uncertainty, or 'risk' proper, as we shall use the term, is so far different from an *unmeasurable* one that it is not in effect an uncertainty at all. We shall accordingly restrict the term 'uncertainty' to the cases of the non-quantitative type (1921, p. 20).

[2] We will not discuss Keynes's theory of probability in its details as this discussion have already been done by other scholars (Carabelli, 1988; O'Donnell, 1989). For the present we will only make a brief presentation of the general ideas.

knowledge, but it arises from the nature of the case itself (Carabelli, 1992, p. 8; see also, Carabelli, 1995, p. 138).[3]

Despite the fact that probabilities are usually not measurable in a cardinal way, there are situations in which non-numerical probabilities can be compared in a ordinal way. To do so, they have to conform to either of two standard forms:

a) They have identical premisses but the conclusions are different but overlapping (a/h and ab/h). In this case $a/h > ab/h$, as the same set of premisses has to support a greater set of conclusions. "For example, given black clouds in the sky [h] the probability of rain alone [a] is higher than the probability of rain and hail combined [ab]" (O'Donnell 1989, p. 58).

b) The inverse case: they have identical conclusions and different but overlapping premisses (a/h and a/hh_1). In this case, h_1 must have only one independent piece of knowledge. Whether a/h is greater or less than a/hh_1, will depend on whether h_1 is favourable or not. For example, take the case where h = black clouds in the sky and a = today will rain. Suppose that h_1 = it is the rainy season. As h_1 is favourable premisses then $a/hh_1 > a/h$. If h_1 = the weather report says that today there will be no rain, then $a/h > a/hh_1$.

For Keynes, however, the cases where cardinal comparisons are possible are not the general rule. Usually, the probability relations are not comparable on either ordinal or cardinal terms, i. e. neither if $a/h >^* b/h$ nor $b/h >^* a/h$.

An interesting way to represent Keynes's theory of probability is suggested by Koopman (1940). In this article he defines the axioms and the algebra of intuitive probability, and he identifies Keynes's theory of probability as an example of this type of probability. The intuitive thesis in probability asserts that probability derives directly from the intuition, both in its meaning and in the majority of laws which it obeys. Contrary to the common use of probability, the intuitive approach claims that experience should be interpreted in terms of probability and not the inverse. Thus, intuition comes prior to objective experience. The main aphorism of this thesis is that "**knowledge is possible, while certainty is not**" (Koopman 1940, p. 269).

The importance of the intuitive probability to our discussion is that it simplifies the conditions for the comparability between probabilities, without discrediting the main aspects of Keynes's interpretation. According to Koopman (1940, p. 270), "the fundamental view point of the [intuitive probability] is the primal intuition of probability expresses itself in a (partial) ordering of eventualities." Let a_1, h_1, a_2, and h_2 be propositions, where the meaning is perceived by an individual that does not know whether this apprehension is true or false.

> Then the phrase '[a_1] on the presumption that [h_1] is true is equally or less probable than [a_2] on the presumption that [h_2] is true', conveys a precise meaning to his intuition. …

[3] For a comprehensive discussion of the non-measurability of some types of probabilities relations see Runde 1994.

That is … a first essential in the thesis of intuitive probability, and contains the ultimate answer to the question of the meaning of the notion of probability.

(Koopman 1940, p. 270)

This could be represented in symbolic forms of comparison in probability as:

$$a_1 / h_1 \geq^* a_2 / h_2 \text{ [4]} \qquad (3.3)$$

Another important element on the Keynes approach is the concept of weight of argument. Keynes's main concern in discussing probability is to show that one can act rationally in situations where complete certainty about the future is absent. In these situations one should look not only at the probability relation but also at the size of the evidence - evidential spread - that support this probability. Here Keynes brings into discussion the concept of weight of argument.

Weight will be defined as the *degree of completeness of the information set on which a probability is based*.[5] This is expressed, according to Runde (1991, p. 281), as

$$V(a/h) = K_r/(K_r + I_r)$$

Notwithstanding this similarity, two aspects deserve more attention. The first one is related to the meaning of 'relevant ignorance'. As insightfully pointed out by Runde (1991), it is always possible to know, or at least identify, the factors that affect our probability relation, and about which one is ignorant. Secondly, due to the role of the relevant ignorance, an increase on the amount of evidence does not necessary implies an increase an increase on the weight. New evidence could decrease the weight if it implies the increase of relevant ignorance. A new piece of evidence can show that our previous relevant knowledge was wrong - decreasing the weight - albeit, simultaneously, the knowledge of the relevant ignorance is increasing.

Finally, it is well known that Keynes assumes a direct relationship between weight and *confidence* in using the probability estimate as a guide to conduct. From the discussion above it is possible to see that the definition of weight as a *degree of completeness of information* is much more appropriate to the understanding of this relationship. Confidence can either decrease or increase, for the reason that new evidence can increase the relevant ignorance or knowledge.

Summing up, Keynes is concerned with situations where frequency probability cannot be used. In this case, the use of *intuitive* probabilities can help understand the rationality in this kind of situation, and Keynes's probability has the main aspects of the *intuitive* approach. It is more about logical relations than events experience, and despite this fact, allows the comparison of the form of $a_1 / h_1 \geq^* a_2 / h_2$. Moreover, in order to act, one has to take into consideration not only the probability itself but also the set of evidences that bears on this probability. To make an assessment of these evidences, Keynes provides the concept of weight of argument, which, in its most comprehensive form, is defined as degree

[4] Where "$\geq^*$ is the qualitative probability relation 'at least as probable as' " (Runde 1997, p. 223).

[5] Runde (1991) argues that three definitions of weight can be found in the *Treatise*. In this paper we have adopted that one that, according to the authors views, is more comprehensive. For a discussion of the three concepts, see Runde (1991)

of the completeness of the information set. This definition allows the incorporation into the framework of analysis both the relevant knowledge and relevant ignorance.

I. 2. Degrees of Keynesian Uncertainty

These two main aspects of the *Treatise* - probability relation and weight of argument - have been used by some scholars (Runde 1990; Dow 1996; Dequech 1997) to define uncertainty in a Keynesian sense and, in addition, to demonstrate that Keynesian uncertainty admit of degrees. In this discussion, the weight of argument is viewed as measure of the degree of uncertainty. We do not disagree with this understanding. However, we believe that the claim of the existence of degrees of Keynesian uncertainty must also encompass the discussion about what constitute **relevance** when discussing weight of argument. In what comes next, we will discuss the concept of uncertainty in Keynes's view and elucidate the arguments based on it.

I.2.1. Weight of argument and degrees of uncertainty

Two notions of uncertainty emerge from the *Treatise* [6], both of them related to the absence of knowledge of the probability relation. In the first one, uncertainty can be described as a situation where the probability relation (*a/h*) is *unknown*. It "is *unknown* to us through our lack of skill in arguing from given evidence. The evidence justifies a certain degree of knowledge, but the weakness of our reasoning power prevents our knowing what the degree is" (*C.W.* VIII, p. 32). It is not a case of one having too little evidence, but of our inability to identify the probability relation, although this probability exists, at least in principle. It is worth noting that this notion of uncertainty is similar to Simon's (1976) concept of bounded rationality. However, it is not necessary to appeal to bounded rationality to describe the incapacity of the agent to identify the probability relation. As pointed out by Dow (1995, pp. 118-9), one key aspect of the world that makes it impossible to ascertain the probability relation is that, as Keynes himself acknowledges (C.W. X, p. 262), the economic system is organic and open. According to Dow,

> An open system is one where not all the constituent variables and structural relationships are known or knowable, and thus the boundaries of the system are not known or knowable.
>
> (Dow 1996, p. 14)

It is clear that there are some ontological features of the world that makes impossible for the agent to identify the probability relation. In others words, there are ontological features that are fundamental for the existence of the uncertainty.

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[6] Keynes himself does not explicitly define uncertainty. However, the interpretation suggested here shares the understanding of many scholars (see, Lawson, 1985, 1987; Runde 1990, 1991; O'Donnell 1989, among others).

The second notion is stronger than the first one, as it claims that the absence of probability relation is due to the fact that "there is no probability at all".

It is possible to identify these notions of uncertainty in the 1937 *QJE* article:

> By 'uncertain' knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is merely probable. The game of roulette is no subject, in this sense, to uncertainty; nor is the prospect of a Victory bond being drawn. Or, again, the expectation of life is only slightly uncertain. Even the weather is only moderately uncertain. The sense in which I am using the term is that in which the prospect of an European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention, or the position of private wealthowners in the social system in 1970. *About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know* (*C.W*. XIV, pp. 113-114, italics added)[7].

From what has been said before, one can conclude that Keynes's notions of uncertainty have both epistemological and ontological aspects. Uncertainty is epistemic when its cause is a lack of skill in identifying the probability relation. But, also, uncertainty is ontological, when the probability relation does not exist due the organicity and openness of the world. However, it should be noticed that these concepts are not mutually exclusive. [8]

Runde (1991, 1990) argues that this two notions of uncertainty do not exhaust the ways that Keynes uses the concept of uncertainty. He claims that uncertainty could be related to the size, in some sense, of the information set upon which the probability relation is based. In other words, uncertainty can be related to the weight of argument if the latter is defined as a *degree of completeness of*

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[7] O'Donnell (1989, p. 260) gives a very interesting interpretation of this passage based on Keynes philosophical framework:

> The first key word is 'scientific' which, …, may be translated as 'rational'. The second key word is 'calculable', for which two options are open. If taken in the narrow cardinal sense, the contention is that only numerical probabilities are unavailable. This option leaves open the possibility of knowledge of non-numerical probability. But these, too, Keynes apparently wants to exclude, for his intention is to go *beyond* the distinction between certainty and probability. The sense of uncertainty he is seeking to identify is more that that implied by a knowledge of probabilities. Not only are the numerical probability of roulette excluded, but so are those weather forecasts for which a probability (whether cardinal or ordinal) could conceivably be established. This leads to interpreting 'calculable' in the wider ordinal sense, in which case we have full-blown irreducible uncertainty with no known probability whatsoever, numerical or non-numerical. We are landed in the realm of *unknown probabilities* which arise from a weakness of reasoning power in relation to given data. It is in this sense that agents 'simply do not know' - they are deprived, by a deficiency of logical insight, of knowledge of *a/h*. There is simply insufficient data relative to logical ability to from a probability of any kind; expressed in related terms, the weight of argument is extremely low for events in distant future.

[8] In Dequech's words,

> The notion of uncertainty is always epistemological in the sense that it is associated with the lack of some kind of knowledge (…), and knowledge is the subject of epistemology; at the same time, the notion of uncertainty always has an associated view of reality, and has an ontological counterpart, given that ontology refers to the study of the nature of reality.
>
> (Dequech 1997, p. 24)

information on which a probability is based. Despite the fact that this notion is not fully explored in the *Treatise*, Runde gives two quotations from *The General Theory* that support his claim that uncertainty can be related to the weight of argument:

> The state of long-term expectations, upon which our decisions are based, does not solely depend, therefore, on the most probable forecast we can make. It also depends on the *confidence* with which we make this forecast - on how highly we rate the likelihood of our forecast turning out quite wrong (*C.W*. VII, p. 148).

And:

> The liquidity-premium, it will be observed, is partly similar to the risk-premium, but partly different; - the difference corresponding to the difference between the best estimates we can make of probabilities and the confidence with which we make them (*C.W*. VII, p. 240).

It is clear from the previous quotations that *confidence* is the key factor in this interpretation of uncertainty. As it was shown above, the concept of weight, as a *degree of completeness of information,* appears to be the best one to capture the role of *ignorance* on the assessment of the *confidence* on the probability relation. As a consequence of this approach, the *complete* absence of probable knowledge should be interpreted as the extreme case of uncertainty. If it is impossible to establish the probability relation, whatever the reason - no existence of probability or lack of skill to determine or identify it -, it is also impossible the existence of any *confidence*. Thus, this situation could be interpreted as an extreme case not only for uncertainty, but also for *confidence*[9].

From this extreme position, one can move to situations where uncertainty prevails due to low weight of argument, which implies low *confidence*. Thus, there is a *qualitative* change in the uncertainty, from a situation of which a probability relation does not exist to another one in which probability relation exists but the weight is low. Moreover, as the weight of argument is increasing, the confidence follows in the same direction and the uncertainty decreases. In this approach, probable knowledge is taken into account as a guide to conduct, and the degree of reliability of this probable knowledge - the *confidence* it merits - determines the *degree of uncertainty* that exists in a specific situation. So the concept of weight allows the understanding of uncertainty as a relative concept.

[9] Some authors, like O'Donnell in the end of the last footnote (13) interpret *unknown probability* as low weight of argument (in its relative concept). We think that this interpretation is contradictory to the understanding of uncertainty as the logical impossibility of established the probability relation. Weight is not a property that exist in isolation. It is related to the probability relation and only in relation to it, that weight can be measured. If it is *impossible* to assert a probability relation it is also *impossible* to measure the weight. Moreover, to know the relevant ignorance must imply an understanding of what the ignorance is about. If it is impossible to assert the logical relation between *a* and *h*, so it is impossible to know what is relevant (knowledge or ignorance) about it.

I.2.2. The relevance do the evidence and degrees of uncertainty

Dow (1995) goes further in the development of the concept of degrees of uncertainty. She argues that to estimate uncertainty in terms of weight, one must bring into consideration the knowledge of what constitutes relevance. Therefore, it is required to have "some degree of belief in a hypothesised structure on which to base an estimate of weight" (Dow 1995, p. 124).

Although we agree with this general statement, we think that to define what is relevant or not it is necessary to go further in the analysis. First, the relation between weight and probability should be clearly understood. Despite possessing different attributes, they cannot exist without each other. Weight is not a property that exists in isolation. It is related to the evidence that bears an hypothesis and, so, it is related to a specific probability relation. A same amount of evidence can bear different degrees of belief in different conclusions. The relevance of a given set of evidence will differ for different kinds of conclusions.

The main point here is to note that there is a difference between to define to what extent the amount and quality of *h* gives confidence on the probability relation (which is related to the discussion about the weight) and to acknowledge that it is possible to establish a logical relation between *a* and *h* (which implies a discussion about what gives rise to a probability relation). Our claim here is that the understanding of the latter is essential to answer the question about what constitutes relevance.

Keynes answers the question about how a probability relation arises, by bringing into discussion the concept of secondary proposition (q). It is a proposition that describes a particular characteristic of a primary proposition. It is the knowledge of the secondary proposition (q) that supports the degree of rational belief in *a/h*. In Keynes's words,

> The proposition (say, q) that we know … is not the same as the proposition (say, $[a]$[10]) in which we have a probable degree (say, α) of rational belief. If the evidence upon which we base our belief is h, then what we know, namely q, is that the proposition $[a]$ bears the probability relation of degree α to the set of propositions h; and this knowledge of ours justifies us in a rational belief of degree α in the proposition $[a]$.
>
> (Keynes C.W. VIII, p. 11)

In our view, Keynes's secondary proposition and Dow's (1995) "hypothesised structure on which to base an estimate of weight" are very much alike. For we can only evaluate whether a set of evidence is relevant or not, and so estimate the weight of argument, if we refer to the factors that allow us to have a degree of belief that there exists a logical relation between the hypothesis (a) and the evidence that bears it (h). This factor is the secondary proposition.

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[10] Keynes uses *a* and *p* interchangeably to represent the set of conclusions. To avoid confusion to the reader we substitute *p* for *a* in Keynes's quotation.

Now the discussion turns to whether the secondary proposition can be treated as uncertain. This is not a consensual matter. Keynes, himself, was ambiguous about this point (Runde 1994, p. 103).[11] To clarify the matter, one should enquire into the nature of the direct knowledge, which is the essence of the secondary proposition: Is this direct knowledge true and certain or a priori thought? Lawson (1987, pp. 960-62) provides an answer to this question. He argues that direct knowledge has both a relative and an absolute nature. He starts by asserting that

> … knowledge can be understood, not as the building of a superstructure upon an unchanging foundation, but as proceeding in stages where the foundations at each new stage is the previous one. The course of acquiring and developing knowledge, provisional starting points come to be questioned and criticised and existing views are rethought and reinterpreted.
>
> (Lawson 1987, p. 960)

Knowledge in this account is provisional as it is delimited by the circumstances in which it is used and it is subject to rethinking and reinterpretation. In this sense it has a relative nature: "The directness of knowledge is relative to the background of the knower" (Lawson 1987, p. 961). However, at the same time, it is absolute in relation to this background. The claim here is that, as relative and susceptible to change, direct knowledge can be subject to uncertainty.

One has now two orders of uncertainty that work together. First, there is uncertainty about the secondary proposition, or in other words, uncertainty about the "hypothesised structure" that gives rise to a probability relation. This structure should be used to evaluate the relevance of the evidence. Uncertainty, in this sense, is inversely related to a lower order of knowledge regarding this structure. Second, there is uncertainty about the degree of completeness of information on which a probability is based. From this perspective, the limit situation is one where knowledge about the probability relation is absent and ignorance is complete.[12]

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[11] This ambiguity can be seen through the following quotations:

> A probable degree of rational belief in a proposition …arises out of knowledge of some corresponding secondary proposition. A man may rationally believe a proposition to be probable when it is in fact false, if the secondary proposition on which he depends is true and certain.
>
> (Keynes *C.W.* VIII, p. 11)

> While it is important, in establishing a control of direct judgment by general principles, not to conceal its presence, yet the fact that we ultimately depend upon an intuition need not lead us to suppose that our conclusions have, therefore, no basis in reason, or that they are subjective in validity as they are in origin. It is reasonable to maintain with the logicians of the Port Royal that we may draw a conclusion which is truly probable by paying attention to all the circumstances which accompany the case, and we must admit with as little concern as possible Hume's taunt that 'when we give the preference to one set of arguments above another, we do nothing but decide from our feeling concerning the superiority of their influence'.
>
> (Keynes *C.W.* VIII, p. 76)

[12] However, this situation is admitted as not feasible:

> As uncertainty is compounded at higher recursive levels, our necessary conceptual structures become complex, counterintuitive and involuted to the point that they collapse under their own weight. Put in another way, absolute ignorance is incompatible with knowledge of absolute uncertainty.
>
> (Dow 1995, p. 124)

We think that an example can help to understand the argument. Suppose the following four situations, in which different persons are asked to assess the likelihood of rain the next day. In situation one, an alien has just arrived at earth, coming from a planet with a completely different atmosphere. The situation can be described as follows: the conclusion is the proposition (*a*) 'it will rain tomorrow'; the evidence (*h*) is 'annual series of atmospheric pressure, temperature and rain in the last fifty years, and the present atmospheric pressure and temperature, and he is asked to assess the probability *a/h*. As he is an alien, he does not know the relation between atmospheric pressure and rain, in other words, he does not know the structure that should be used to assess the uncertainty. In this case, the probability relation will be unknown and there will be no weight to be assessed. It is an extreme case of uncertainty.

In the second situation, an ordinary person, who knows the relation between atmospheric pressure and rain by personal experience and by reading newspapers (i.e. has a degree of belief in the structure[13]), receives as evidence the series of pressures, temperatures and rain in the last fifty years but not the all the actual measures (only the temperature). He is faced with the same question: 'will there be rain tomorrow?' In this case, he can establish the probability relation *a/h* and so, he can evaluate the relevance of the evidence he has. As important pieces of information are missing, one can say that he is facing a high degree of uncertainty due to low degree of belief in the structure and low weight of argument.

In situation three, the set of evidence is the same as in the previous case, but the person is a professor of climatology. As an expert he possesses a knowledge of the structure that allows him to have a higher degree of belief in the structure than the ordinary person at situation two. So, despite having the same set of evidence, the uncertainty faced by the professor is lower than the ordinary person. It is a case of high degree of belief in the structure and low weight.

Finally, we can have a situation in which the professor received the same set of evidence as the alien. In this case, the degree of uncertainty is low as there is a higher degree of belief in the structure and a high weight.

To sum up this section, we think that it is necessary to present a working definition of Keynesian uncertainty. As shown before, it is possible to find in Keynes's writings three different definitions of uncertainty. To avoid unnecessary confusion we think that a simple definition, sufficiently capable of incorporating all three notions, should be used. Uncertainty will be characterised by situations in which the evidential set upon which the decision-maker has to decide does not provide a completely reliable knowledge to guide conduct. This unreliability is due both to the amount and quality (relevance) of the evidence, and, to the provisional feature of the knowledge necessary to judge the evidential set.[14]

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[13] As this person does not has a formal education in climatology he cannot has a full certainty about the structure.

[14] This definition is similar, not identical, to Dequech (1997). He advocates a notion of uncertainty "in which knowledge, due to the paucity of evidence, is incomplete to an extent that makes it not completely reliable as a guide to conduct" (Dequech 1997, p. 21). My disagreement with this definition is that the use of "the paucity of evidence" as the origin of uncertainty

Under this definition of uncertainty it is possible to explain situations that are qualitatively different, that is to say, subject to different degrees of uncertainty. The extreme situation of uncertainty - complete absence of probable knowledge - and situations in which probable knowledge exists - where weight is interpreted as a measure of gradability of uncertainty - are captured in this definition, eluding any confusion. Qualitative degrees of uncertainty can be visualised in Table 1.

II . DEGREES OF UNCERTAINTY CRUCIAL DECISIONS AND NONERGODICITY

In the Keynesian literature about uncertainty, there are numerous references to the concept of 'nonergodicity' to justify an interpretation of uncertainty as a rigid concept that cannot be graded (Davidson 1982/1983, 1993, 1995). Shackle's discussion about crucial decisions or unique experiments has been widely used to justify the nonergodicity of the economic environment. In this section we will show that the existence of degrees of uncertainty does not contradict an understanding of the world as a nonergodic system. Indeed, we will show that even in Shackle's and Davidson's writings it is possible to find elements that support this argument.

TABLE 1

Scale of Qualitative of Degrees of Uncertainty

Uncertainty	absence of probable knowledge	no-existence of (*a/h*)	(A)
		lack of skill to recognise (*a/h*)	
	probable knowledge	low degree of belief in (*a/h*) and low weight	(B)
		high degree of belief in (*a/h*) and low weight	
		high degree of belief in (*a/h*) and high weight	

Uncertainty decreases as you move from (A) to (B)

captures only one dimension of the evidential set: its size. However, there is another dimension that it is important to take into account, that is its 'quality' or "relevance".

II.1. Shackle's Decision Process and Potential Surprise

The concept of knowledge for Shackle is fundamental to the understanding of his work. For Shackle, knowledge is directly related to certainty. Where there is knowledge there must be certainty. This position is expressed in many passages, for example:

> Knowledge would not deserve that name if it gave us several conflicting accounts and answered our question "What will follow if I do this?" in more than one way. [...] Knowledge must consist in a statement which is unique.
>
> (Shackle 1970, p. 106)

If knowledge means certainty, where there is uncertainty there is no knowledge. These situations will appear, according to Shackle, in circumstances where crucial, non-empty decisions apply. An empty decision is the mere account of a formal solution to a formal problem. It is that situation where a person has a complete and certain knowledge about all possible choices and all possible outcomes of each choice. It is a mechanical and inevitable action (Shackle 1959, p. 291).

When one looks at Shackle's definition of 'decision', one realises that empty decisions are not true 'decisions' in his account. He argues for an understanding of 'decision' as a commitment to the first step in an action of choosing among a plurality of rival and mutually exclusive hypotheses, about which it is impossible to know the relevant consequences (Shackle 1958, p. 35). Obviously, this is far from a situation of complete knowledge and deterministic actions as in the case of empty decisions.

By contrast, the crucial, non-empty decision implies the impossibility of repetition of the decision process "because its very performance destroys forever the conditions in which it was undertaken, which form an essential part of it" (Shackle 1970, p. 109). It is a unique decision that brings new information "which agents will need to take into account in the future courses of action" (Andrade 1997, p. 13). Some examples of crucial decisions are investment, accumulation of wealth, and finance. In Shackle's view, when crucial decisions such as these are made, there is no knowledge.

If a decision is a process of commitment by the decision-maker with an action-scheme whose outcome is unknown, the question that should be raised is about the process in which such a decision is made. Here, Shackle introduces his concept of expectation. According to him, the decision-maker is concerned with the consequences of his choice in the future. As the outcome is not known beforehand, he has to resort to imagination to figure what will be the possible outcomes. It is the enjoyment or satisfaction provided by these outcomes that will guide the choice of the decision-maker. However, Shackle argues that there is a distinction between free or pure imagination, and what he calls expectations. In Shackle's words:

> There are of course pleasures to be had from mere day-dreaming, but they are of a different sort from those of expectation. These latter we may call enjoyment by anticipation. When we speak of what the decision-maker can visualise, we mean what he can anticipate, that is what he can imagine without a sense of unrealism.

(Shackle 1958, p. 42) [15]

Nevertheless, based in this concept of expectations, how are decisions made? This question brings into account another important contribution of Shackle, that is, his concept of potential surprise. The latter can be explained as follows.

> Between a feeling of certainty that a given event will happen (or some particular answer to a given question turn out to be the truth), and a feeling of certainty that it will not, there seems to be a continuous range of different levels at which our *degree of belief* can stand.
>
> (Shackle 1943, p. 101)

This degree of belief is measured by an operation by which the decision-maker asks himself how much "intensity of shock or surprise" he "would feel if, without there having been any change in the knowledge available to him on which he based his belief in it, he were to learn that this belief is mistaken … The measure so obtained is what we may call the potential surprise associated … with a given hypothesis" (Shackle 1943, p. 101).

So, there is an direct relationship between the degree of belief in one possible outcome and its potential surprise value. The higher the degree of belief, the higher the potential surprise. It is clear that the concept of potential surprise is directly related to novelty. What makes the degree of potential surprise differ among different hypotheses is the possibility of the emergence of new and special factors, of which there is no evidence at the present for the decision-maker. Thus, surprise means that the individual's structure of expectations either contains a misjudgement or has been incomplete.

To conclude our discussion of Shackle's approach to the decision process, it is necessary to bring into the framework the concept of the attention-arresting power of the hypotheses. The impossibility of feeling certain about one future outcome - meaning the impossibility of feeling that a particular unique result will be attained in future - does not imply that the decision-maker does not desire a "unique focus for his imagination, that is to say, that he will not centre his hopes on one particular level of success" (Shackle 1943, p. 103). The real incentive for choosing an action is the enjoyment of anticipating a high level of success (attention-arresting power). [16] The intensity of enjoyment is a decreasing function of the degree of potential surprise and increasing function of the outcome.

The combination of the potential surprise and the attention-arresting power, produces what Shackle calls focus-values. These will be the best (focus-gain) and the worst (focus-loss) outcomes that concern the decision-maker. Comparing these focus-values, he will assess the attractiveness of his course of action in comparison with others. They provide a clear-cut and simple basis of comparison between different alternative and exclusive courses of action.

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[15] Elsewhere, Shackle uses this limitation to the imagination of the decision-maker to define 'decision' as a "choice in face of bounded uncertainty" (Shackle 1959, p. 293).

[16] The similarity between this concept and the concept of *animal spirits* in Keynes is clear.

II.2. Davidson's Nonergodicity Approach

The technical definition of ergodicity classifies a system as ergodic if the stochastic process is such that time and space averages will coincide for infinite realisations.[17] If the realisations of a stochastic process are infinite in number, the space and time averages tend to converge. As a consequence, if the process is ergodic the data obtained from past realisations can provide a useful (safe) guide to decisions about the future (Davidson 1982/83, p. 185). Thus, economic systems governed by an ergodic process show timeless (ahistoric) and immutable relationships. Accordingly, if the averages do not tend to converge, the system is classified as nonergodic.

The concept of ergodicity is used by Davidson (1995) to classify theories in economics. He argues that economic theories could be classified in two groups according to their understanding of the process that governs reality: (i) immutable reality, meaning the theories that assume that the world works as an ergodic system; and (ii) mutable reality, where a world is conceived as a nonergodic system. This taxonomy implies different ontologies.

Those theories classified in the first group admit, implicitly or explicitly, that reliable information can always be supplied by the present and the past. They differ regarding how much, if any, reliable information about the immutable reality can be obtained by agents in the short run. According to this criterion, ergodic theories can be sub-classified in two types: those that claim that in the short run, "the future is known or at least knowable"; and those which claim that "in the short run, the future is not completely known due to some limitation in human information processing and computing power" (Davidson 1995, p. 109). Thus, the main difference is epistemological. For the first sub-group there is no uncertainty, while for the second sub-group uncertainty is due to a failure in the acquisition of information. In both cases, uncertainty is epistemological, not ontological. [18]

Using the concept of ergodic systems, Davidson defines uncertainty, in both the short and long run, as the absence of governing ergodic processes. What the above theories claim as uncertainty is, in fact, risk. If the reality is immutable (ergodic), then the matter is to find a way to collect information from past events and make them available to the decision-maker. Moreover, if the environment is ergodic, all possible future outcomes are known in advance. However, he correctly claims that, in economic life, this kind of situation is very rare, and important economic events operate in a nonergodic reality.

One of the main factors that makes economic events nonergodic is Shackle's crucial, non-empty decision. As shown before, crucial, non-empty decisions are unique in that they cannot be repeated.

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[17] In Davidson's words: "Space averages refer to a fixed time point and are formed as averages over the universe of realisations … . Time averages … refer to a fixed realisation and are formed as averages over an indefinite time space" (Davidson 1982/83, p. 185).

[18] Davidson classifies the following theories as ergodic: Type 1 - Classical perfect certainty models; actuarial certainty equivalents, such as rational expectations model; New Classical models; and some New Keynesian theories. Type 2 - Simon's bounded rationality; Savage's expected utility theory; New Keynesian models such as asymmetric information and co-ordination failure theories; and Austrian theory.

Uncertainty applies to situations of nonergodicity, and in these cases, no data can be used as a reliable guide to the future. "Decision-makers in these situations believe that no relevant information exists today that can be used as a basis for scientifically predicting future events" (Davidson 1993, p. 430). Nonergodic theories are: Keynes's General Theory, Post-Keynesian monetary theory, the post-1974 writings of Sir John Hicks and G.L.S. Shackle's crucial experiment analysis.

Some authors who are important to the development of this approach strongly deny of any kind of degree of uncertainty. Knowledge, for Davidson, is defined as the inverse of uncertainty.[19] Nonergodic processes are, in Davidson's account, those situations where there is uncertainty; where these predominate, knowledge is completely absent and uncertainty is absolute. As there is no place for more or less knowledge in these cases, Davidson concludes that there is no case for more or less uncertainty.

The behaviour of the agent is described as follows: first, the decision-makers have to recognise what kind of environment they are dealing with. "The problem facing every economic decision maker is to guess whether (a) the phenomenon involved is currently being governed by distribution functions which are sufficiently time invariant as to be presumed ergodic - at least for the relevant future, or (b) nonergodic circumstances are involved" (Davidson 1987, p. 148). If the latter is the case, sensible economic agents "try to form sensible expectations which rely on the existence of social institutions that have evolved (e.g. contracts and money) to permit humans to cope with the unknowable" (Davidson 1993, p. 149).

Questions arising from the above view are: what exactly defines sensible agents? Is it proper to define knowledge in such dualist way?

II.3. A Critique of Shackle's Unknowledge and Davidson's Approaches

As we have seen above, Davidson's approach is founded on Shackle's concept of crucial decisions to justify the existence of nonergodicity in economic life. What will be argued here does not deny the existence of crucial decisions as one of the determinants of nonergodicity, but rather claim that it is possible to find in Shackle's work elements to justify the existence of degrees of uncertainty and then to show that the latter is compatible with nonergodicity. To do this, it is necessary to scrutinise the concept of knowledge used by Shackle to demonstrate that it is in itself contradictory to the concept of potential surprise. By revising this concept of knowledge and, thus, by making it conform to the concept of potential surprise, it is possible to argue in favour of the existence of degrees of uncertainty. Finally, we return to Davidson's work to demonstrate that it is also possible to accept the concepts of crucial decision and nonergodicity together with the idea of degrees of uncertainty.

[19] He is very explicit about this matter: "Once technical definitions of the concept of *uncertainty* and its inverse, *knowledge*, …" and "knowledge's inverse, the concept of *uncertainty regarding real world future events*…" (Davidson 1987, p. 147).

An assessment of Shackle's view must start with the recognition of his most important contribution, which is the concept of the crucial decision. It is fundamental for the understanding of the effects of uncertainty on the decision process. As shown before, it implies that "the person concerned cannot exclude from his mind the possibility that the very act of performing the experiment may destroy forever the circumstances in which the choice is made" (Shackle 1990[1956], p. 6). It is a creative action.

However, two points in Shackle's framework deserve some further comments. First, as pointed out by Andrade (1997, p. 15), there is a "extreme form of methodological individualism underlying his subjectivism". The individual appears to behave and to reason as if he is alone in the world. The social relations that he is involved in do not affect his choices, and these are performed only taking into consideration what is in the mind of the economic agent.

Second, Shackle has a very restricted and contradictory concept of knowledge. He has a dualistic[20] approach: "Where there is knowledge there is not uncertainty", and accordingly where there is no knowledge there is uncertainty. Knowledge, thus, is only conceivable in situations of complete certainty.

However, when he defines expectations he imposes limits on the imagination process which the decision-maker goes through to anticipate some possible outcomes. He explicitly says that expectation is "what he [the decision-maker] can imagine without a sense of unrealism". Yet, to define what is possible or not in this sense implies the acknowledgement that the decision-maker must have some knowledge about what is unrealistic and what is not.

This definition of 'expectation' contradicts his definition of knowledge, as shown above. The main point here is that Shackle differentiates between what he calls imagination and knowledge. Despite the fact that he argues that an individual, when making his expectations, must constrain his images in two ways, "making them in the first place compatible with the individual's beliefs about the nature of things and about human nature, so that they represent something that seems to him possible in abstract" (Shackle 1959, p. 288), and second trying to anticipate what possible transformation could happen in future, [21] he does not accept an individual's belief as a kind of knowledge.

However, how can a decision-maker define what can be possible or not in a situation of complete lack of knowledge? As Shackle said in his article of 1959, one can only avoid a choice in the face of chaos and anarchy if one has some knowledge about what is possible or not. [22]

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[20] According to Dow,

> Dualism is the propensity to classify concepts, statements and events according to duals, belonging to only one of two all-encompassing mutually-exclusive categories with fixed meanings: true or false, logical or illogical, positive or normative, fact or opinion, and so on.
>
> (Dow 1996, p. 16)

[21] "…attaching then to named future dates and restricting them to such transformations of his existing situation as seem to him possible in the time-span between 'now' and 'then'" (Shackle 1959, p. 288).

[22] In Shackle's words:

> … for a man who thought that any act could have any sequel whatever, and that there was no possibility of excluding *anything* as incapable of following from any stated course of action, would believe any one act just as eligible, just as wise and efficient, as any other ….
>
> (Shackle 1959, p. 293)

Indeed, Shackle uses the expression 'bounded uncertainty' to define decision. Here, again, when he uses the adjective 'bounded' to qualify uncertainty, he contradicts his definition of uncertainty as unknowledge. If between a situation of certainty, which means knowledge, and a situation of uncertainty meaning unknowledge, there is a situation of 'bounded' uncertainty, then this latter must imply 'bounded' or partial knowledge.

Moreover, the discussion of potential surprise reveals this contradiction. To construct the potential surprise curve one has to measure the intensity of shock or surprise of an unexpected outcome. In doing so, one has to 'imagine' the hypothetical outcomes and compare them in terms of 'surprise'. This should be done, using Shackle's words "without there having been any change in the knowledge available to him on which he based his belief in it" (1943, p. 101, italics added). Nevertheless, if knowledge for Shackle means, as shown before, "a statement which is unique" - i.e. certainty - there is only one possible outcome and any other should be regarded as impossible. From this point of view, there is no basis to ascribe different degrees of surprise to impossible outcomes. Thus, the construction of the potential surprise curve must imply a concept of knowledge that does not denote certainty. This conclusion could be reinforced with the analysis of the concept of *attention-arresting power*. Remember that, according to Shackle, the real incentive for choosing an action is the *enjoyment of anticipating* a high level of success. Two factors are the determinants of the intensity of enjoyment: the degree of potential surprise (inverted related) and the expected outcome (positively related). As one can see this enjoyment is related to factors that necessarily involve some kind of knowledge. In the same sense as the discussion about the degree of potential surprise, the determination of expected outcome *must* imply the existence of degrees of uncertainty.

To conclude, the contradiction between Shackle's concept of knowledge and his potential surprise curve can be eliminated if one replaces the concept of knowledge as certainty with the concept of probable knowledge that appears in Keynes's Treatise. In doing so, one must admit that Shackle's work is compatible with the concept of degrees of uncertainty.

Very similar conclusions can be derived from an assessment of Davidson's contributions. As noted before, Davidson's approach is grounded in Shackle's works to sustain his concepts of nonergodicity and absence of knowledge, as defining features of uncertainty. Two aspects will be analysed here: the sources of ergodicity and their implication for the knowledge possessed by the decision-maker and the concept of knowledge used by Davidson. Let us look at the first aspect.

Davidson claims that an important element that makes the economic world nonergodic is the role played by technical change. In his words,

> To restrict entrepreneurship to robot decision-making via Bayes' theorem, …, is to provide a descriptive analogy of modern real world economies which ignores the role of the Schumpeterian entrepreneur - the creator of technological revolutions and change. (Davidson 1982/1983, p. 193)

However, as we have shown elsewhere (Crocco 1999, 2000), while innovation guarantees the nonergodicity of the world, it does not necessarily imply complete ignorance about patterns of technical change. The concepts of technological paradigms and technological trajectories developed by the EI approach to technical change (Dosi 1982) can be used to show that at any moment in time, there is always a technological paradigm that determines the features of innovative activity for every sector of the economy, *imposing a selective, precise and ordered pattern of technological change*. The pattern of technical change will be disorderly only in situations characterised by a shift in the technological paradigm.

It must be made clear that what has been claimed here is not that the outcome of the innovative process can be perfectly forecast, but rather that there is an ordered pattern of change originating from the introduction of an innovation. This feature of innovative activity allows the emergence of a kind of knowledge that is not complete or certain, but that can be used to guide the decision-maker. In other words, there is a probable knowledge in the innovative activity that is not contradictory with the nonergodicity feature of this activity.

The second aspect to be analysed is Davidson's definition of knowledge. We think that the above discussion shows that in order to restrict uncertainty to unknowledge it is necessary to use a narrow definition of knowledge. If one understands imagination as a process in which previous knowledge is employed, one must be open to conceive that uncertainty and knowledge can exist in gradations.

It is interesting to take a look at the debate between Davidson and Runde (1993), as it reveals a contradiction in Davidson's approach which is similar to the contradiction in Shackle's approach. Runde (1993) argues that Davidson has two positions when he discusses uncertainty: official and unofficial. The main point of the official position is the relationship between knowledge and ergodicity. Ergodicity is a precondition for the existence of knowledge, and as ergodicity is a feature of some aspects of the world, it is an ontological precondition. In Runde's words:

> Davidson's official position thus consists of an epistemological dichotomy between knowledge and uncertainty and a corresponding ontological opposition between ergodic and nonergodic processes.
>
> (Runde 1993, p. 384)

The consequence of this concept of knowledge is that the dualist approach, knowledge on the one side and uncertainty on the other, does not give space for 'sensible expectations'. This dichotomy implies that either expectations exist because one has knowledge (ergodic systems), or no expectations can be asserted as no knowledge exists. 'Sensible expectations', as claimed by Runde, must imply a third category, which is (fallible) probable knowledge. [23]

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[23] According to Runde:

> by treating knowledge as one pole of a simple opposition it becomes impossible to distinguish between the epistemological status of different kinds of knowledge. I would go along with Davidson on the kind of truth and certainty guaranteed by sound a *priori* reasoning, for example, and ignore the question of whether or not the standard axioms of logic and rules of inference are themselves not to some extent arbitrary. But our knowledge of the 'facts' of science or history is a different thing entirely, resting as it does on a shaky base of observation, perception, and inference. By adopting a conception of relative or probable knowledge,

Davidson's reply is not sufficient to invalidate Runde's point. Davidson denies that he accepts empirical regularities as criteria for science. His denial of the prevalence of ergodic processes is used to justify his non-acceptance of this approach. Indeed, he argues that empirical realism

> is neither a necessary or a sufficient condition for 'science'. The primary goal of science is to explain. If one can also predict on the basis of 'empirical regularities', then that is icing on the scientific cake. Scientists, however, should 'know' in what areas they cannot search for past empirical regularities to predict the future. In these nonergodic areas of economic science, human beings can and should develop 'certain important [institutional] factors which somewhat mitigate in practice the effect of our ignorance of the future'.
>
> (Davidson 1993, p. 431)

However, from the quotation above, it is possible to see that Davidson stopped halfway. The logical consequence of the acceptance that economic science and human beings can and do develop institutions, is that some kind of knowledge must be derived from the development of institutions. Likewise, as institutions exist to deal with nonergodic situations, some kind of knowledge could exist in nonergodic processes.

Davidson's account of the process of sensible expectations formation is also problematic. Davidson argues that the decision-maker makes two sequential steps to form expectations. The first one is to guess whether a specific event is ergodic. After that, if the guess (belief) is that the event is nonergodic, the agent looks for the existence of social institutions on which to base his sensible expectations. It is as if the decision-maker and the social structure were independent. However, as pointed out by Lawson (1997a, p. 83) the "social structure is the, typically unacknowledged, condition of all our actions as well as the, usually unintended, consequence". There is no two-step sequence in the decision process. The decision-maker is interacting with the social structure before asking whether some event is ergodic or not. In Runde's (1993, p. 390) words: "Social structures thus not only permit and facilitate human agency, but presuppose it".

The main point here is that the acknowledgement of the nonergodic process is not a distinctive process separated from the acknowledgement of the institutions that exist to deal with it. Institutions exist before the decision maker forms his expectations and they are reproduced through the engagement of the decision-maker with them. They are an antecedent element in the process of forming expectations and, in some degree, they shape those expectations. The important question is about the stability and endurability of these institutions. If, in the eyes of the agent, they are stable and endurable, he can, despite the nonergodicity, have a probable knowledge about the future course of events and feel himself less uncertain about the future. As Andrade has pointed out,

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> Davidson could accommodate this difference, namely, that knowledge based on experience is fallible, whereas the knowledge arrived at by sound reasoning (and assuming the truth of the premisses or axioms) is not.
>
> (Runde 1993, p. 395, n.14)

> Complexity and the passage of time make us ignorant or uncertain about many relevant current and future events that take place in our environment. However, there is a form of (incomplete) knowledge in the existing system of rules and conventions.
>
> (Andrade 1998, p. 132)

Summing up, crucial decisions and nonergodicity should not be considered as features of the economic process that make it impossible to discern degrees of uncertainty. The prevalence of crucial decisions and nonergodic processes not only do not vitiate the existence of a concept of probable knowledge, but also supply the basis for claiming that there is a continuum of degree of uncertainty inherent in these processes.

III. CONCLUSION

We have tried in this paper to show that to understanding uncertainty as an concept feasible to be market it is necessary to take into account not only the discussion about the weight of argument, but also the analysis about what constitute relevance. Moreover, we tried to show that the concept of degree of uncertainty is an intrinsic element of both Shackle and Davidson works. They themselves do not recognise it but, as we have tried to show before, it is necessary to understand the concept of *potential surprise* in Shackle and *sensible agents* in Davidson.

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