



Via Po, 53 – 10124 Torino (Italy)
Tel. (+39) 011 6704917 - Fax (+39) 011 6703895
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J. M. Keynes, thinker of economic complexity

Roberto Marchionatti

Dipartimento di Economia "S. Cagnetti de Martiis"
Centro di Studi sulla Storia e i Metodi dell'Economia Politica
"Claudio Napoleoni"
(CESMEP)

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J. M. KEYNES, THINKER OF ECONOMIC COMPLEXITY¹

ROBERTO MARCHIONATTI
(University of Torino)

Professor Planck, of Berlin, the famous originator of the Quantum Theory, once remarked to me that in early life he had thought of studying economics, but had found it too difficult! Professor Planck could easily master the whole corpus of mathematical economics in a few days. He did not mean that! But the amalgam of logic and intuition and the wide knowledge of facts, most of which are not precise, which is required for economic interpretation in its highest form is, quite truly, overwhelmingly difficult for those whose gift mainly consists in the power to imagine and pursue to their furthest points the implications and prior conditions of comparatively simple facts which are known with a high degree of precision.
(Keynes [1924], *Collected Writings*, X, 1972, 158n)

1. INTRODUCTION

In the late 1930s Keynes expressed his unease for the turn taken by an impressive number of contemporary economists in accepting a conception of economics different from what he considered correct while, at the same time, accepting the ‘constructive part’ of his work. This happened in particular when he was involved in the controversy with Jan Tinbergen on econometric method. Most of these economists were sympathetic with the econometric programme and conceived economic theory as a field where exact logic can be applied. They adopted the methods of natural science, which they thought would guarantee the clarity and rigour necessary for theory and empirical research in economics: this is the conception at the basis of the construction of post-war mainstream economics. On the other hand, Keynes’s conception was rooted in Marshall and Marshall’s profound sense of the complexity of the economic subject: this was something that the new wave of economists could not quite grasp. On the whole, Keynes was considered old-fashioned and "pretty uncertain as to the meaning he wanted to attach to economic theory" (Coddington 1976, 57). Consequently, Keynes’s willingness to expose his own perplexity towards methodological issues was considered of scarce interest in the economic literature before the 1980s, in the era of undisputed domination of the Samuelsonian mainstream. In the changing intellectual climate of the last part of 20th-century – an exciting period for economics -, new studies on Keynes have been

¹ The paper goes over and develops some previous papers (Marchionatti 1999 and 2002, Garrone and Marchionatti 2007 and 2009).

published and have enabled people to make a different interpretation of the relevance of his thought. What gradually emerges was the idea that Keynes's conception of economics strongly contrasts with the prevailing post-1945 conception and that it is not out-of-date for 21st-century economists. What I am trying to point out in this paper is that Keynes's work as an economist was essentially an attempt to cope with the complexity of economic world and the organic interdependence of the variables, founded on a conception of economics as science of social complexity. In an epistemological perspective, Keynes's work is homogeneous to some approaches to complexity that have recently emerged. The purpose of this paper is to show this fundamental characteristics of Keynes's thought by reconstructing how his conception of the nature and method of economics developed. I will focus on two fundamental *loci* of Keynes work - *The Theory of Probability* and *The General Theory*.²

2. ATOMISM AND ORGANICISM IN THE *TREATISE ON PROBABILITY*: THE FOUNDATION OF KEYNES' EPISTEMOLOGY

The *Treatise on Probability* (1921) is at the roots of Keynes's epistemological reflections. It is the result of a long intellectual tour that originates in Keynes's critical reaction to G. E. Moore's *Principia Ethica* (1902) at the beginning of the century. Moore's book was fundamental in Keynes's early intellectual formation, when he was a member of the Bloomsbury group and the Apostles, an elite intellectual club at Cambridge University. The influence of *Principia Ethica* on the young members of these groups is defined by Keynes in his 1938 autobiographical account *My early beliefs* "overwhelming", "exciting, exhilarating, the beginning of a renaissance, the opening of a new heaven on a new earth" (Keynes *Collected Writings* [hereafter *C.W.*], X, 435). However, Keynes specifies that what they got from Moore was "by no means entirely what he offered us". In fact Moore "had one foot on the threshold of the new heaven, but the other foot in Sidgwick and the Benthamite calculus and the general rules of correct behaviour" (ibid., p. 436): Keynes and his friends were excited by the former and rejected the latter.³ "There was one chapter in the *Principia*", Keynes continues, "of which we took not the slightest notice. We accepted Moore's religion, so to speak, and discarded his moral" (ibid.). *Religion* here was understood as one's attitude towards oneself and *moral* one's attitude towards the outside world. Here Keynes refers to

² In connection with *The General Theory* I will also have to deal with the published and unpublished writings from the years when he was formulating his theory to the after its publication when he was involved in controversies on method.

³ Mini (1991) explains the role of anti-Benthamism in Keynes' work. He maintains that the criticism of the Benthamite tradition, i.e. the overvaluation of the economic criterion, is the moral-political paradigm on which the *General Theory* is erected.

Moore's conception of ethical human conduct presented in Chapter V of his book, on "Ethics in relation to conduct". Moore deems the best course of action to be the one with the highest expected (or most probable) goodness. However, we do not have the knowledge needed in order to calculate the goodness and so we cannot know all the future effects of an action. Therefore we should follow the general rules adhered to in society. Since these rules represent accumulated knowledge, they would result in the greatest frequency of good outcomes. This Moore's conception of practical ethics was at odds with that professed at that time by Keynes and his friends, who opposed general rules of conduct and, instead, relied on personal judgement. Reflecting on his intellectual history in the years before the war, Keynes writes:

We entirely repudiated a personal liability on us to obey general rules. We claimed the right to judge every individual case on its merits, and the wisdom, experience, and self-control to do so successfully

(Keynes, *C.W.*, X, 446)

Considerations of probability played a large part in Moore's theory of the justification of general rules of conduct. This was indeed, Keynes writes, "an important contributory cause to my spending all the leisure of many years on the study of that subject" (*ibid.*, 445). Keynes considered the argument in the following quotation from *Principia Ethica* very questionable:

the first difficulty in the way of establishing a probability that one course of action will give a better total result than another, lies in the fact that we have to take account of the effects of both throughout an infinite future ... We can certainly only pretend to calculate the effects of actions within what may be called an immediate future .. We must, therefore, certainly have some reason to believe that no consequences of our action in a further future will generally be such as to reverse the balance of good that is probable in the future which we can foresee. This large postulate must be made, if we are ever to assert that the results of one action will be even probably better than those of another. Our utter ignorance of the far future gives us no justification for saying that it is even probably right to chose the greater good within the region over which a probable forecast may extend

(Moore 1902, 152)

According to Keynes Moore's argument contained an incorrect conception of probability. Keynes rebuts this passage in chapter 26 of the *Treatise of Probability*:

This argument seems to be to be invalid and to depend on a wrong philosophical interpretation of probability. Mr. Moore's reasoning endeavours to show that there is not even a probability by showing that there is not a certainty. We must not, of course, have reason to believe that remote consequences will generally be such as to reverse the balance of immediate good. But we need not be certain that opposite is the case .. The results of our endeavours are very uncertain, but we have a genuine probability, even when the evidence upon which it is founded is slight

Keynes countered Moore's theory with a theory of behaviour under uncertainty that he intended to be able to support the superiority of individual judgement on general rules. In constructing such a theory he was influenced by the work of another leading figure of Cambridge's intellectual élite - the philosopher and mathematician Bertrand Russell⁴. Actually, Keynes's *Treatise* is in the English analytical tradition. He extended Russell's analysis of logical relation between intuitive and derivative knowledge to the field of probable knowledge. Russell's aim was to give a logical basis to mathematics and determine the logic of deduction. Analogously, Keynes's aim was to establish and evaluate the logic of induction. In this perspective, probability is defined as "the degree of belief which is rational to entertain in given conditions" (*ibid.*, 4), i.e. the degree of rational belief in a proposition on the basis of the evidence available. Keynes presents his fundamental ideas in part I and his symbolic treatment of the subject in part II. In part III he investigates the validity of the inductive logic.

The inductive hypothesis is logically founded on the principle of limited independent variety -- i.e. it depends on the assumption that only a finite number of characteristics are relevant to the proposition under examination. This principle states: the greater the number of independent constituents of a system, the less applicable the inductive argument becomes (*ibid.*, 279-80). In other words, an object of inductive inference should not be 'complex'. The reason for this requirement is that strictly positive prior probabilities are assessed by analogy - the importance of analogy in inductive reasoning is strongly emphasised by Keynes along the lines of Hume's conception.^{5 6} Keynes concludes that "probable knowledge can be validly obtained by means of an

⁴ Keynes says: "I was writing under the joint influence of Moore's *Principia Ethica* and Russell's *Principia Mathematica*" (*C.W.*, X, 445). In the preface to the *Treatise of Probability* he writes: "It may be perceived that I have been much influenced by W.E. Johnson, G.E. Moore, and Bertrand Russell, that is to say by Cambridge". Russell's book "furnished a method for handling the material provided by [Moore's book]" (*ibid.*, 438-9).

⁵ At the beginning of Chapter XIX ("The nature of argument by analogy"), Keynes writes that "Hume rightly maintains that some degree of resemblance must always exist between the various instances upon which a generalisation is based. For they must have this, at least, in common, that they are instances of the proposition which generalizes them. Some element of analogy must, therefore, lie at the base of every inductive argument" (*ibid.*, 247).

⁶ Inductive arguments are arguments which depend on the method of analogy and pure induction, where pure induction means mere quantitative empirical induction. Analogy is a process of reasoning which took into account qualitative likeness and unlikeness of events. Referring to Hume's famous example of eggs' similarity from the *Philosophical Essays Concerning Human Understanding* - nothing so like as eggs, and after a long course of uniform experiments we can expect with "a firm reliance and security" the same taste and relish in all of them, that is, "This only after a long course of uniform experiments in any kind, that we attain a firm reliance and security with regard to a particular event" - Keynes considers Hume's argument incomplete, only based on positive analogy, which measures the resemblances - and wants to improve it by introducing the principle of "negative analogy", which measures the differences. It is called negative analogy the principle "of varying those of the characteristics of the instances, which we regard in the conditions of our generalisation as non-essential" (p. 243). In the case of Hume's example the answer to the question 'are all eggs alike?' depends not only on tasting eggs under similar conditions: "his experiments should not have been to uniform, and ought to have differed from one another as much as possible in all respects save that of the likeness of the eggs. He should have tried eggs in the town and in the country, in January and in June" (p. 243). An increase in the

inductive argument” only in relation to finite independent variety systems (ibid., 280). Otherwise, the method of reasoning by means of analogy breaks down, and induction becomes impossible.

If we accept the hypothesis that the character of the system of nature is finite, we must accept the hypothesis about the atomic character of natural law. It “amounts to very much the same thing”, Keynes emphasises (ibid., 290). This implies to assume the hypothesis of atomism -- that the system under examination consists of atoms whose effects are distinct, independent and invariable. This is an assumption about the character of material laws upon which “scientists appear commonly to act” (ibid., 276). However, a system may have a different “degree of complexity” and thus be organic. If so, the inductive method is invalid. Here Keynes basically has used Moore’s definition of organic as “a whole has an intrinsic value different in amount from the sum of the values of its part” (Moore 1902, 36).⁷

Keynes stressed that this theory has other limits and difficulties from the standpoint of the student of probability, two in particular: how can we measure the degree of probability numerically ? (Keynes, *C.W.*, 344); and can we always know the probability of an event ?. To speak of probability as a degree of rational belief, as Keynes actually did, may have seemed to imply that probabilities are quantitative and measurable. On the contrary, “so far from our being able to measure them, it is not even clear that we are always able to place them in an order of magnitude” (ibid., 29). Moreover, even though probability exists, it may remain unknown because our knowledge can be vague. *Vagueness* is defined as knowledge not susceptible of “strict logical treatment” (ibid., 17). Keynes does not attempt to analyze the meaning of this important concept:

number of experiments “is only valuable in so far as, by increasing .. the variety found amongst the non-essential characteristics of the instances, it strengthens the negative analogy” (p. 243). Negative analogy is the fundamental element in determining the strength of an inductive argument: an increase in the “variety of the characteristics of the instances” led to an increase in the strength of argument.

The validity of every induction depends not on a matter of fact (the empirical confirmation) “but on the existence of a relation of probability”: “An inductive argument affirms, not that a certain matter of fact is so, but that relative to certain evidence there is a probability in its favour” (p. 245). It was a “question of logic and not of experience” (ibid). It is about its reasonableness not its truthfulness. “The validity and reasonable nature of inductive generalisation is .. a question of logic and not of experience, of formal and not of material laws. The actual constitution of the phenomenal universe determines the character of our evidence; but it cannot determine what conclusions given evidence rationally supports” (p. 246).

⁷ At the turn of the century the most important writers in United Kingdom supporting an organicist view were the British Hegelians F. H. Bradley and J. M. McTaggart (a lecturer of philosophy at Trinity College, Cambridge, and member of the Apostles). See Phillips (1970) for an exposition of their theories. According to Moore, these philosophers believed that organic wholes have three properties: 1) the parts are related to one another and to the whole as means to ends, 2) the parts have no significance apart from the whole, 3) the whole has a value which is greater than the value of the sum of the parts. Moore accepts the third of these properties and limits his own use of the term organic to this sense. Hence, Moore’s position was that of mediation between idealism and mechanicism. On the debate between Moore and these idealist philosophers see Leddy (1991). According to Phillips (1970) there was another idea in the organicist position - that the parts are dynamically interrelated or interdependent.

It is certainly not the same thing as knowledge proper, whether certain or probable, and it does not seem likely that it is susceptible of strict logical treatment. *At any rate I do not know how to deal with it*, and in spite of its importance I will not complicate a difficult subject by endeavouring to treat adequately the theory of vague knowledge

(ibid., 17-8, my italics)

Keynes also comments on the language of the enquiry in a note at the end of Chapter 2 of the *Treatise*. He criticises the symbolism of *Principia Mathematica* and brings up the issue of whether symbolic analysis is more precise and less ambiguous than everyday language. He answers:

There are occasions for very exact methods of statement, such as are employed in Mr. Russell's *Principia Mathematica*. But there are advantages also in writing the English of Hume. Mr. Moore has developed in *Principia Ethica* an intermediate style which in his hands has force and beauty .. Confusion of thought is not always best avoided by technical and unaccustomed expressions, to which the mind has not immediate reaction of understanding; it is possible, under cover of a careful formalism, to make statements, which, if expressed in plain language, the mind would immediately repudiate. There is much to be said, therefore, in favour of understanding the substance of what you are saying all the time, and of never reducing the substantives of your argument to the mental status of an x or y

(ibid., 20n. 1)

Keynes reconsiders the range of validity of the inductive method in Part V of *Treatise*. Here he discusses statistical inference, that part of the theory of statistics closely bound in with the theory of probability. Statistical inference “seeks to extend [the] description of certain characteristics of observed events to the corresponding characteristics of other events which have not been observed”. The analysis of statistical induction, Keynes writes, “is not fundamentally different from that of universal induction attempted in Part III” (ibid., 446). Keynes starts off his analysis with a historical discussion of Bernoulli's theorem, that permits us to derive a numerical measure of probability from a numerical statistical frequency of previously observed similar events -- that is to infer an exact measure of probability from observed frequency. He claims that such a theorem “is only valid subject to stricter qualifications ... and in conditions which are the exception, not the rule” (ibid., 369).⁸ Moreover, “it cannot possibly be inferred from a statement of the number of trials and the frequency of occurrence merely, that [these conditions] have been satisfied” (ibid., 404-5). In fact, “we must know, for instance, that the examined instances are similar in the main relevant particulars, both to one another and to the unexamined instances to which we intend our conclusion to be applicable. An unanalysed statement of frequency cannot tell us this” (ibid., 405). Keynes's

⁸ They include such assumptions: 1) that the knowledge of what has occurred at some of the trials would not affect the probability of what may occur at any of the others; and 2) that probabilities are all equal *a priori*. This implies that the typical example for the valid application of the Bernoulli's theorem is that of balls drawn from a single urn, containing black and white balls in a known proportion and replaced after each drawing.

conclusion was that “the application of the mathematical methods .. to the general problem of statistical inference is invalid” (ibid., 419). He writes:

Our state of knowledge about our material must be positive, not negative, before we can proceed to such definite conclusions as they purport to justify. To apply these [mathematical] methods to material, unanalysed in respect of the circumstances of its origin, and without reference to our general body of knowledge, merely on the basis of arithmetic ... can only lead to error and to delusion

(ibid., 419)

Here Keynes echoes Leibniz’s critique of Bernoulli:

In dealing with the correspondence of Leibniz and Bernoulli, I have not been mainly influenced by the historical interest of it. The view of Leibniz, dwelling mainly on considerations of analogy, and demanding ‘not so much mathematical subtlety as a precise statement of all circumstances’, is, substantially, the view which will be supported in the following chapters. The desire of Bernoulli for an exact formula, which would derive from the numerical frequency of the experimental results a numerical measure of their probability, precludes the exact formulas of later and less cautious mathematicians

(ibid., 403)

There has been a wide debate among scholars trying to identify Keynes’s position in the *Treatise* as atomistic or as organicist. According to some authors -- e.g. O’Donnell (1989), Davis (1989a and 1989b), Bateman (1988) -- Keynes was an atomist. Other scholars maintain that he was an organicist -- e.g. Carabelli (1995) who writes that “Keynes was always an organicist” (Carabelli 1995, 141). As for myself, I think that Keynes takes a sort of middle ground. He has recognized that the atomistic hypothesis is one that is commonly adopted by scientists and one that yields good results in many fields. In this sense he says that the atomistic hypothesis is acceptable on the basis of experience, as is the inductive method. However, the atomistic hypothesis is not acceptable in a conclusive way, because it is not justified on a purely logical basis. All in all, Keynes adopts an atomistic position as a theorician of probability. He investigates the logic of induction and he shows that it requires an atomistic hypothesis for it to be validated. At the same time, he strongly emphasises that inductive logic is invalidated outside that atomistic hypothesis.⁹ Keynes acknowledges the practical usefulness of universal and statistical inference, “on the validity of which the boasted knowledge of modern science depends” (Keynes, *C.W.* VII, 468). He concludes

⁹In *My early beliefs* Keynes wrote that he “was always an advocate of a principle of organic unity through time” (*C.W.* X, p. 436), but his reference to the years of the *Treatise* should be read through Moore and should be applied to question of psychological value. When recalling Moore’s religion, Keynes refers to the states of mind: “These states of mind ... consisted in timeless, passionate states of contemplation and communion ... Their value depended, in accordance with the principle of organic unity, on the state of affairs as a whole which could not be usefully analysed into parts” (ibid.).

that all this can only exist “if the universe of phenomena does in fact present those peculiar characteristics of atomism and limited variety which appear more and more clearly as the ultimate result to which material science is tending” (ibid.).

Keynes’s position changes some years later in the mid-1920s. In his biographical essay of Edgeworth, Keynes criticises the use of the atomistic hypothesis in mathematical psychics (Keynes *C.W.* X, [1926]). He wrote that “the atomic hypothesis ... has worked so splendidly in physics”, but it “breaks down in psychics”.¹⁰ In fact:

We are faced at every turn with the problems of organic unity, of discreteness, of discontinuity – the whole is not equal to the sum of the parts, comparisons of quantity fail us, small changes produce large effects, the assumptions of a uniform and homogeneous continuum are not satisfied

(ibid., 262)

There is a set of reasons that can explain why Keynes switched. At that time, Keynes changed tack and became an economist, not only that, but one trained in Marshall. Tackling the problems of the economic conditions of his time, Keynes went on to consider that the characteristics of the universe of social phenomena were not reducible to the hypotheses of atomism and limited variety. He raised the methodological issue of dealing with a complex phenomenon – i.e. a phenomenon characterized by “problems of organic unity, of discreteness, of discontinuity”. This is strictly tied in his new reflections on the theory of probability.

3. BETWEEN THE *TREATISE ON PROBABILITY* AND THE *GENERAL THEORY*: THE MAKING OF KEYNES’S APPROACH TO THE ECONOMIC COMPLEXITY

3.1. The requirements of economic interpretation: Marshall’s methodological lesson

Economics is a difficult subject, Keynes says, because the economic interpretation requires an “amalgam of logic and intuition and the wide knowledge of facts, most of which are not precise” (Keynes, *C.W.*, X, 1972, 158n). This idea comes from Marshall. Keynes had already been introduced in economics and Marshall’s thought in the first period of his intellectual formation, when he attended Marshall’s lectures to prepare for the Civil Service examination (Raffaelli 1996, O'Donnell 1997, Marchionatti 2002). However, it was only some years later - mainly the 1920s – that economics became Keynes's main interest. In dealing with the economic problems of his times,

¹⁰ Keynes uses the term *psychics* to mean *social sciences*. He uses the term *mathematical psychics* to mean the *application of mathematics to social sciences*. Davis (1989) interpreted Keynes’s passage in a different way: according to him Keynes psychics simply to mean individual state of mind; and uses mathematical psychics to mean the frequency approach to expected utility. Rotheim (1989) has convincingly argued against this interpretation.

he inevitably again had to come to terms with Marshall's conception of economics and hence with Marshall's idea that the economic subject is fundamentally complex.

Marshall maintained that the economic interpretation of the "complex and incompletely known facts of experience" requires to go beyond the "bare bones of economic theory" (Keynes *C.W.*, vol. X, 186). Keynes emphasized this in his memoir on Marshall published in the September 1924 *Economic Journal* immediately after the death of the master. According to Marshall these "bare bones" are inadequate for dealing with the subject-matter of economics - the "living and ever-changing economic organism" (Marshall 1961 [1890], 769). Marshall's crucial issue is how to deal with it.

Marshall's reasoning runs like this.¹¹ The economist must start off with the analysis of facts. However, "facts by themselves teach nothing". Therefore he must use reason – i.e. abstract reasoning. This is not enough, however: "The work to be done is so various that much of it must be left to be dealt with by *trained common sense*, which is the ultimate arbiter in every practical problem" (ibid., p. 38).¹² In fact common sense gives flexibility to reason and contextualizes theoretical models, so avoiding the risks of abstract reasoning. Therefore:

Economic science is but the working of common sense aided by appliances of organised analysis and general reasoning, which facilitate the task of collecting, arranging, and drawing inferences from particular facts

(ibid., 38)

This conception has an important implication for the language of economics. Marshall writes that "[economics'] .. *must* endeavour to conform itself to the familiar terms of everyday life, and so far as possible must use them as they are commonly used" (ibid., 51). In fact everyday language makes it possible to maintain the *shades of meaning* that in common use every word has, shades of meaning which can be interpreted "by the context". This approach to the economic problem requires that the good economist uses not only reason but also perception and imagination in his enquiry. The possession of these faculties enables the economist to study concrete cases in depth – i.e. to use what Marshall calls the intensive method of research, the detailed study of cases which requires a combination of judgement in the selection of cases and insight in their interpretation.¹³

¹¹ For a wider exposition of Marshall position see Marchionatti 2001, 2002 and 2004.

¹² Marshall emphasises that common sense must be 'trained' to carry out its task. In fact, he distinguishes between "untutored common sense or public opinion" and trained common sense (Marshall 1885). The first is knowledge based on surface phenomena unconcerned with the complexity of reality. The second is a sort of conscious common sense.

¹³ In *Principles* (Part III, chapter 4) there is a note on the difficulties of the statistical study of consumption. Marshall distinguishes between two methods of research, intensive and extensive. He cites the mathematician and engineer Frédéric Le Play's *Les ouvriers européens* as a good example of intensive method:

"The method of Le Play's monumental *Les Ouvriers Européennes* is the *intensive* study of all the details of the domestic life of a few carefully chosen families. To work it well requires a rare combination of judgement in selecting

Hence, the role of abstract reasoning, which uses the “bare bones of economic theory”, is limited when dealing with a complex subject. “Abstract, or general, or theoretical economics” seems to him “an essential but a very small part of economic proper”. This is how Marshall put it in a letter to Edgeworth (August 28, 1902). Abstract economics is effective for the earlier stages of economic reasoning, where the hypothesis of *ceteris paribus* is used, the influence of time is excluded (by adopting the statical method which assumes static or stationary conditions) and the successive approximation approach is used. So, Marshall (1898) can write that “there is a fairly close analogy between the earlier stages of economic reasoning and the devices of physical statics”. This analogy falls down when the complexity of the subject increases:

I think that in the later stages of economics better analogies are to be got from biology than from physics; and consequently, that economic reasoning should start on methods analogous to those of physical statics, and should gradually become more biological in tone ... The method will become ever more remote from the physical and more akin to the biological

(Marshall 1898, 39)

He specifies that in mechanics “the catastrophes ... are caused by changes in the quantity and not in character of the forces at work” (Marshall 1961, p. 42), whereas “in life their character changes also”:

‘Progress’ or ‘evolution’, industrial and social, is not mere increase and decrease. It is organic growth, chastened and confined and occasionally reversed by decay of innumerable factors, each of which influences and is influenced by those around it; and every such mutual influence varies with the stages which the respective factors have already reached in their growth

(ibid., 42-3)

Consequently, the mathematical engines used in classical physics, which “work out large volumes full of mathematical formulae and figures” can be only partially applied to economics:

The most helpful applications of mathematics to economics are those which are short and simple, which employ few symbols; and which aim at throwing a bright light on some small part of the great economic movement rather than at representing its *endless complexities*.

(ibid., 39)

cases, and of insight and sympathy in interpreting them. At its best, it is the best of all: but in ordinary hands it is likely to suggest more untrustworthy general conclusions, than those obtained by the *extensive* method of collecting more rapidly very numerous observations, reducing them as far as possible to statistical form, and obtaining broad averages in which inaccuracies and idiosyncrasies may be trusted to counteract one another to some extent” (Marshall 1961, 116).

The function of abstract reasoning is “not to forge a *few long chains of reasoning*, but to forge rightly *many short chains* and single connecting links” (ibid., 773). It is illusory to think that there is room for long trains of deductive reasoning in economics since economic material is often inadequate to bear the strains of the mathematician’s machinery:

It is obvious that there is no room in economics for long trains of deductive reasoning ... It may indeed appear at first sight that the contrary is suggested by the frequent use of mathematical formulae in economic studies. But on investigation it will be found that this suggestion is illusory ... [The mathematician] takes no technical responsibility for the material, and is often unaware how *inadequate* the material is to bear the strains of his powerful machinery

(ibid., 781)

Hence, Marshall maintains that the nature of economic material is what limits the use of mathematics -- i.e. the use of the mathematical approach in economics based on linearity and system of differential equations. The reason that long trains of deductive reasoning cannot be made is that, as we move out from a determined situation, the variables at stake increase in number and intensity in relation to external circumstances. The problem does not consist in manipulating a greater number of givens. Rather, it consists in broadening the connections among them. In other words, it is impossible to characterise a few causes as predominant in an effort to render the hypothesis of *ceteris paribus* practicable. The attempt to translate a complex problem into a system of equations is bound to fail for considerations “connected with the manifold influences of the element of time”:

While a mathematical illustration of the mode of action of a definite set of causes may be complete in itself, and strictly accurate within its clearly definite limits, it is otherwise with any attempt to grasp the whole of a *complex problem of real life*, or even any considerable part of it, in a series of equations. For many important considerations, especially those connected with *the manifold influences of the element of time*, do not lend themselves easily to mathematical expression: they must either be omitted altogether, or clipped and pruned till they resemble the conventional birds and animal of decorative art

(ibid., 850, my italics)

This was the methodological lesson that Keynes learned by Marshall. Keynes’s considerations on economic theorising are fundamentally based on it. They were enriched by his philosophical reflections on the theory of probability and what he went on to consider the weak points in his *Treatise of Probability*.

3.2. *Vague knowledge, human logic and conventions: new concepts and extension of the field of study in Keynes's philosophical reflections*

The evolution of Keynes's philosophical thought between the *Treatise* and the *General Theory* is difficult to follow, essentially because in that period Keynes did not write papers specifically dedicated to philosophical issues in that period.¹⁴ However, we can reconstruct his evolution through some of his writings from the mid-1920s to the late 1930s. In 1926 the first evidence of change emerges, exemplified in a letter to F. M. Urban, translator of the German edition of the *Treatise*.¹⁵ Keynes expressed disappointment in the conceptual structure of the *Treatise* and maintained that it could be improved by the development of the concept of vague knowledge, introduced in the *Treatise* but, as we could see, scarcely analysed there:

As time goes on I myself feel that there is a great deal in the book which is unsatisfactory, and, indeed I felt this even when I was writing it. I was published as it stood because it seemed to me that it would help on the subject that I should do so more effectively that if I was to try to make further refinements and revisions which might quite likely prove beyond my capacity. I believe that the ultimate theory of the subject may differ very considerably from mine. But I still think that the problems as I have posed them may be the right starting point for further research.

Amongst those students in England for whose opinion I feel most respect I find a marked reluctance against finally abandoning some variant of the frequency theory. They admit my criticisms hold good on existing versions, and they are not yet ready to prepare a version which can resist them. But they maintain all the same that they have a strong instinct that some kind of frequency theory will be found in the end to be more fundamental to the whole conception of Probability than I have yet allowed. I shall not be surprised if they prove right. I suspect, however, that the first step forward will have to come through progress being made with the partly subject of vague knowledge, and that further developments in a strictly logical field must wait for a clear distinction between logical probability proper and the theory of what I have called vague knowledge

(Keynes to F. M. Urban, 15 May 1926, in *Keynes Papers*, file TP/1₂)

Keynes's 1931 review of Frank Ramsey's *Foundations of Mathematics* is an important milestone in the development of Keynes's philosophical thought. Ramsey developed a subjective approach to probability based on individual psychology, thereby rejecting the notion that probability consists in objective relations between propositions. Keynes accepted the distinction between formal and human logic introduced by Ramsey. Formal logic is concerned with the rules of consistent thought, human logic is concerned with useful mental habits. According to Keynes, the calculus of probabilities amounts to a set of rules for ensuring that the systems of degree of belief that we hold

¹⁴This difficulty has raised a debate on continuity and change in Keynes philosophical thought. See O'Donnell (1989 and 1991), Carabelli (1988), Bateman (1987 e 1996), Davis (1989), Gerrard (1992).

¹⁵ Gerrard (1992) first drew the attention of the scholars to this important letter.

is consistent. However, the basis of our degree of beliefs is part of human logic, as Ramsey argued. Keynes writes:

Formal logic is concerned with nothing but the rules of consistent thought. But in addition to this we have certain 'useful mental habits' for handling the material with which we are supplied by our perceptions and by our memory and perhaps in other ways, and so arriving at or towards truth; and the analysis of such habits is also a sort of logic. The application of these ideas to the logic of probability is very fruitful. Ramsey argues, as against the view which I had put forward, that probability is concerned not with objective relations between propositions but (in some sense) with degree of belief, and he succeeds in showing that the calculus of probabilities simply amounts to a set of rules for ensuring that the system of degree of belief which we hold shall be a consistent system. Thus the calculus of probabilities belongs to formal logic. But the basis of our degrees of belief – or the a priori probabilities, as they used to be called – is part of human outfit, perhaps given us merely by natural selection, analogous to our perceptions and our memories rather than to formal logic. So far I yield to Ramsey – I think he is right

(Keynes, *C.W.* X, 338-9)

However Keynes thought that Ramsey's theory of induction was not adequate:

But in attempting to distinguish rational degrees of belief from belief in general he was not yet, I think, quite successful. It is not getting to the bottom of the principle of induction merely to say that it is a useful mental habit. Yet in attempting to distinguish a 'human' logic from formal logic on the one hand and descriptive psychology on the other, Ramsey may have been pointing the way to the next field of study when formal logic has been put into good order and its highly limited scope properly defined

(*ibid.*, 339)

Although some scholars have maintained this, there is no textual evidence in these passages that Keynes accepted the two central propositions that Ramsey put forward -- i.e. that probabilities are subjective and that they are numerical. Keynes just thought that Ramsey contributed to defining the limits of formal logic and that he pointed out the way to the next field of study – i.e. the inquiry into the practical and psychological aspects of human behaviour under uncertainty and vague knowledge¹⁶.

Keynes's writings clearly testify to the change in his thought. In the letter to Urban and in the review of Ramsey's book he confirmed that a purely logical-formal approach to probability was limited and stressed the need to inquire into the field of human logic: in effect, probability cannot be known merely in terms of logical relations but should be approached psychologically. This opened the door to Keynes's recognition of the importance of vague knowledge. In other words, formal

¹⁶As Runde (1994) writes, this does not modify the formal structure of Keynes's theory of probability.

logic studies the question of the consistency of the degrees of beliefs, but it is not able to explain the bases of degree of beliefs.

Hence, Keynes's acknowledgement of the limits of formal logic goes well beyond the *Treatise*. He turns his theory of human conduct into a more 'general' theory of human behaviour, something that is able to take in the organic nature of social relations and human complex logic. A central topic in Keynes's writings emerges in this context - conventions. Davis (1997) writes that "the concept of convention is the primarily philosophical concept of Keynes's later philosophical thinking" (ibid., 204). This came to the fore as a result of Keynes's relationship with Wittgenstein, beginning with Wittgenstein's return to Cambridge in 1929 (see Davis 1994 and 1997, and Coates 1996 and 1997). The memoir *My Early Beliefs* (1938) also illustrates the point. There Keynes asserts his personal adherence to what he still considers the positive aspects of the credo of his youth – especially, his philosophical individualism, his anti-utilitarianism and his personal immoralism¹⁷ -, while at the same time illustrating the serious limits of that credo:

We were not aware that civilisation was a thin and precarious crust erected by the personality and the will of a very few, and only maintained by rules and conventions skilfully put across and guilefully preserved. We had no respect for traditional wisdom or the restraints of custom .. As cause and consequence of our general state of mind we completely misunderstood human nature, including our own. The rationality which we attributed to it led to a superficiality, not only of judgement, but also of feeling.

(Keynes C. W., X, 447-8)

Above all Keynes emphasises their mistake in attributing "an unreal rationality to other people's feelings and behaviour" and in having "an *a priori* view of what human nature is like" as well as "a pseudo-rational view of human nature". The attribution of full rationality to human nature, "instead of enriching it, now seems to me to have impoverished it" (ibid.), because "it ignored certain powerful and valuable springs of feeling", "some of the spontaneous outbursts of human nature" (ibid.) and many of "deeper and blinder passions" of the human heart (ibid., 449). Keynes sees himself and his friends "as water-spiders, gracefully skimming, as light and reasonable as air, the surface of the stream without any contact at all with the eddies and currents underneath" (ibid., 450). Keynes here criticized their negation that general rules and convention had a significant role in judgement: "We repudiated entirely customary morals, conventions and traditional wisdom" (ibid., 446). On the contrary, he later thought that we had to take these hitherto neglected factors in account in order to fully understand individuals's behaviour.

¹⁷ The term *immoralism* does not mean that Keynes and his friends were immoral. *Immoralism* means freedom from rules and conventions, reliance on intuition as something sufficient for determining moral judgements.

There are two fundamental implications of this new vision aimed at incorporating the organic nature of social relation and human complex behaviour. First, there is a critique of the concept of rationality that had been elaborated at the beginning of the century and formalized in the *Treatise*, and there is the adoption of the concept of reasonableness.¹⁸ The issue is discussed mainly in relation to the entrepreneurial expectations on investments in the *General Theory*, in an article in the *Quarterly Journal of Economics* (1937) and in several letters. Second, there is the critique of the reductionist formalism *à la Russell*. This had already been mentioned in a note of the *Treatise*: we cannot apply mathematical methods to a subject too vague in itself to be suitable to such a treatment. This issue is developed in the years 1932-1939 – i.e. from the years of preparation of the *General Theory* to the years of the reflections inspired by the debates over the book. In this context Marshall's lesson is used for defining the method and the language in Keynes's economics. In fact, his methodological program falls in line with his Marshallian beliefs on the characteristics and requirements of economic interpretation. He tended to accept Marshall's conception of the economics as an amalgam of "logic and intuition and wide knowledge of facts", but to deepen it philosophically along the post-*Treatise* lines. In the early 1930s, this program was translated at an analytical level and rid of the schemes of the 'classical economists'. This process led to the construction of the *General Theory*. The organicist approach is implicitly declared in the title itself of this book, as explained in the preface to the French edition (1939):

I have called my theory a general theory. I mean by this that I am chiefly concerned with the behaviour of the economic system as a whole ... And I argue that important mistakes have been made through extending to the system as a whole conclusions which have been correctly arrived at in respect of it taken in isolation

(Keynes, *C.W.*, VIII, xxxii)

4. IN THE YEARS OF *GENERAL THEORY* AND AFTER: KEYNES'S ORGANICIST APPROACH TO ECONOMIC COMPLEXITY

4.1. *Issues on the nature, method and language of economics*

In 1938 Keynes exchanged letters with R. F. Harrod in connection with Harrod's «Scope and Method in Economics» (1938). This paper provoked "plenty of thought" in Keynes (letter of July 4, in Keynes *C.W.* 1973). This exchange gave him the chance to make his mature conception of

¹⁸ In Marchionatti (1999) I tried to show that in the analysis of human behaviour in *General Theory* Keynes stressed some points which are at the heart of contemporary microeconomics of bounded rationality.

economics fully explicit. Firstly, economics is defined as “a branch of logic, a way of thinking” (ibid., 296), “a science of thinking in terms of models joined to the art of choosing models which are relevant to the contemporary world” (ibid., 297). Secondly, economics is considered essentially a moral science and not a natural science. By *moral science* Keynes means that economics belongs to those disciplines that deal with human beings in their social environment -- i.e. the human sciences. It is not – Keynes emphasises - a natural science, as Robbins had recently argued in his influential *Essay on the nature and significance of economic science* (1935). Keynes’s reason is that “the material to which it is applied is, in too many respects, not homogeneous through time” (ibid.). In fact, economics deals with changing and unstable factors like “motives, expectations, psychological uncertainties” (ibid., 300). This non-homogeneity through time compels economics to make a limited use of deductive analysis and to take the particular characteristics of the historical world into account. In examining this material, economics uses introspection and value judgements in order to discover the relevant factors needed for building a model or a sample. The *General Theory* exemplifies what Keynes means:

Our present object is to discover what determines at any time the national income of a given economic system and (which is almost the same thing) the amount of its employment; which means in a study so complex as economics, in which *we cannot hope to make completely accurate generalisations*, the factors whose changes mainly determine our quaesitum.

(Keynes *C.W.*, VIII, 247, our italics)

Keynes takes on the issues of the precision of definitions and the level of generalization extensively in his *Cambridge lectures* of November 1933. Here Keynes dealt with the question, ‘What degree of precision is advisable in economics ?’ (Rymes 1989, 101). According to students’ notes, Keynes maintained that ‘on the matter of precise definition of terms, there is some questions as to the utility and propriety of the scholastic exercise in trying to define terms with great precision in a subject like economics’ (ibid., 102). The danger of doing so “is that you may ‘precise everything away’ and be left with only a comparative poverty of meaning’ (ibid.). In other words, “there is the danger of falling into scholasticism, the essence of which is treating what is vague as what is precise” (ibid.). Keynes maintains that “a generalisation to cover everything is impossible and impracticable”. He adds that “generalising in economics is thinking by sample, not by generalisation”. Coates (1996 and 1997) associates these reflections to Keynes’s involvement with Wittgenstein's criticism of analytical philosophy beginning in the late 1920s. According to Coates, Keynes pointed out the problems that ensue from defining concepts with artificial precision that are characterised by what Wittgenstein defined as combinatorial vagueness: “for the precise definition will leave out of account too much of what we intuitively intend when using the concept” (Coates 1997, 249). This

connection is certainly true, but Marshall's influence on Keynes' reflection is present too, in the 1933 lectures explicitly. Here Keynes referred to Marshall's method positively during his criticism of the scholasticism. When he asks what level of precision is useful in economics, he notes with approval that Marshall's definitions were very loose and that many terms were not defined, but that much was provided that would allow the reader to infer the required definitions. In contrast, many other economists, in making their definitions precise, make them too rigid. According to student's notes Keynes said:

Marshall, for example, does not make any effort to use his terms precisely, but you always get his meaning from the richness of his context. This is much better than that specious precision which some writers effect, because you are not misled by supposing the term to be precise, and you must supply the precision from the context and the whole of the thought

(Rymes 1989, 102)

These observations are truly representative of the mature phase of Keynes' thought. In a 1935 draft of *General Theory*, Keynes writes that "Much economic theorising to-day suffers ... because it attempts to apply highly precise and mathematical methods to material which is itself much too vague to support such treatment" (Keynes, *C.W.* vol. XIV, 379). In a 1932 passage from a Cambridge lecture, he notes that:

If an author tried to avoid all vagueness, and to be perfectly precise, he will become so prolix and pedantic, will find it necessary to split so many hairs, and will be so constantly diverted into an attempt to clear up some other part of the subject, that he himself may perhaps never reach the manner at hand and the reader certainly will not. I believe, therefore, that it is necessary in writing economic theory for one's language to be less generalised than one's thought

(*C.W.* vol. XXIX, 36)

Economics follows a quasi-formal method of exposition because it does not give us a complete statement but a sample statement. Keynes justifies in an early fragment of the preface of the *General Theory*, written around mid-1934, this point:

When we write economic theory we write in a quasi-formal style; and there can be no doubt, in spite of these disadvantages, that this is our best available means of conveying our thoughts to one another. But when an economist writes in a quasi-formal style, he is composing neither a document verbally complete and exact .. nor a logically complete proof. Whilst it is his duty to make his premises and his use of terms as clear as he can, he never states all his premises and his definitions are not perfectly clear-cut. He never mentions all the qualifications necessary to his conclusions. He has no means of stating, once and for all, the precise level of abstraction on which he is moving, and he does not move on the same level all the time. It is, I think, of the essential nature of economic exposition that it gives,

not a complete statement, which, even if it were possible, would be prolix and complicated, to the point of obscurity, but a sample statement, so to speak, out of all the things which could be said, intended to suggest to the reader the whole bundle of associated ideas, so that, if he catches the bundle, he will not in the least be confused or impeded by the technical incompleteness of the mere words which the author has written down, taken by themselves.

This means, on the one hand, that an economic writer requires from his reader much goodwill and intelligence and a large measure of co-operation; and, on the other hand, that there are a thousand futile, yet verbally legitimate, objections which an objector can raise

(Keynes 1973, 469-70)

If “we cannot hope to make completely accurate generalisations” (Keynes *C.W.*, vol. VIII, 247), the correct language for constructing a model must not be exclusively symbolic language but must also be ordinary language, as in Marshall. The reason is:

in ordinary discourse, where we are not blindly manipulating but know all the time what we are doing and what the words mean, we can keep 'at the back of our heads' the necessary reserves and qualifications and the adjustments which we shall have to make later on, in a way in which we cannot keep complicated partial differentials 'at the back' of several pages of algebra which assume that they all vanish

(*ibid.*, 296-8)

Keynes was not going to reject the use of mathematics in economics *per se*. He appreciated the contributions in the field when mathematics make it possible to shed light on economic problems – i.e. when the subject matter makes its use appropriate.¹⁹ However mathematical generalisations have a primarily instrumental role. They are especially useful to “disclose gaps and imperfections in your thought” (Keynes *C.W.*, vol. VIII, 305). Ordinary language seems to be more efficient in handling the complexity of the economy. The essential consequence of this argument is that economic thinking cannot be reduced simply to “blind manipulation”. Keynes writes:

The object of our analysis is, not to provide a machine, or method of blind manipulation, which will furnish an infallible answer, but to provide ourselves with *an organised and orderly method of thinking out particular problems*; and, after we have reached a provisional conclusion by isolating the complicating factors one by one, we then have to go back on ourselves and allow, as well as we can, for the probable interactions of the factors among themselves. This is the nature of economic thinking

(Keynes, *C.W.*, VIII, 297, *my italics*)

¹⁹ This is the case, for example, with Ramsey’s economic-mathematical works. Keynes wrote that “A Mathematical Theory of Saving” was “one of the most remarkable contributions to mathematical economics ever made, both in respect of the intrinsic importance and difficulty of its subject, the power and elegance of the technical methods employed, and the clear purity of illumination with which the writer’s mind is felt by the reader to play about its subject” (Keynes, 1973, 335-6).

The “method of blind manipulation” is that of the “recent mathematical economics”. It assumes “strict independence between the factors involved” (C.W. VIII, 298), - i.e. it assumes the atomistic hypothesis. It permits us “to lose sight of the complexities and interdependencies of the real world in a maze of pretentious and unhelpful symbols” (ibid.).

The construction of the ‘relevant’ model is the key problem. A ‘relevant’ model does not emerge automatically out of empirical study as a result of the blind manipulation of data. How adequate the model is depends on the ability to choose the relevant factors. We have to make a decision as to what part of concrete reality to incorporate into a model. Keynes terms this decision a ‘judgement of value’. This is what makes economics into art because we need to exercise the art of introspection in order to study psychic processes, and judgements of value, if we want to construct models that are relevant.²⁰

4.1.1. *Two examples of the ‘right’ method of thinking in the General Theory*

Chapter 18, the General Theory re-stated. In this chapter Keynes points out the elements in the economic system that he considers as given, what elements are independent variables and what are dependent variables. The independent variables, i.e. the basic relationships that underlie Keynes’ model, are the propensity to consume, the schedule of the marginal efficiency of capital and the liquidity preference. The dependent variables are the volume of employment and the national income. The given elements include the existing skill and quantity of labour and equipment, the existing techniques, the degree of competition, consumer tastes, and the social structure. Keynes comments:

The division of the determinants of the economic system into the two groups of given factors and independent variables is, of course, quite *arbitrary* from any absolute standpoint. This division must be made entirely *on the basis of experience* ... Our present object is to discover .. the factors whose changes mainly determine our quæsitum

(Keynes C.W., vol. VIII, 247, my italics)

Keynes then emphasises the repercussions of the process of income determination upon the position of equilibrium. All the determinants are subject to change, thus creating a highly complex situation. Nevertheless,

²⁰ An example of the right way of approaching economic problems in the history of economics is, according to Keynes, that of Malthus. He was able “to penetrate these events with understanding by a mixture of intuitive selection and formal principles”, “thus to interpret the problem and propose the remedy” (Keynes C.W. vol. X, 107).

These seem to be the factors which it is useful and convenient to isolate. If we examine any actual problem along the lines of the above schematism, we shall find it more manageable; and our practical intuition (which can take account of a more detailed complex of facts than can be treated on general principles) will be offered a less intractable material upon which to work

(ibid., 249)

Chapter 21, the relation between money and prices. Preliminarily, Keynes here suggests some assumptions in order to enunciate a quantity theory of money. They include (1) a perfectly elastic supply curve as long as there is unemployment and (2) output changes in proportion to aggregate demand and quantity of money. Then, he considers “the possible complications which will in fact influence events” (ibid., p. 296). Keynes lists five complicating factors:

(1) effective demand will not change in exact proportion to the quantity of money. (2) since resources are not homogeneous, there will be diminishing, and not constant, returns as employment generally increases. (3) Since resources are not interchangeable, some commodities will reach a condition of inelastic supply whilst there are still unemployed resources available for the production of other commodities. (4) The wage-unit will tend to rise, before full employment has been reached. (5) The remuneration of factors entering into marginal costs will not all change in the same proportions

(ibid., 296)

Keynes’s next step was to consider each factor in turn, even though “this procedure must not be allowed to lead us into supposing that they are, strictly speaking, independent” (ibid.). Keynes then considers the complexities encountered in a theory of money and prices in detail. The effect of changes in the quantity of money on prices can be derived from three schedules -- liquidity preference, investment-demand and propensity-to-consume. However, these functions are themselves partly dependent upon the elasticity of output and of factor costs (money wages and the remuneration of other factors) in respect to changes in aggregate demand. Moreover, monetary policy may change expectations with respect to the investment outlook. If we take all these functions and the influences exerted on them into account, we could say that a determinate increase in effective demand will correspond to an increase in the quantity of money. However, Keynes concludes that this is an interrelation that is highly complex and very far from the simplicity of the quantity theory of money.

A comment. These are examples of what Keynes meant by the effort “to provide ourselves with an organised and orderly method of thinking particular problems” and not simply a method of “blind manipulation”. This is the effort that he bases his criticism of the symbolic method on:

It is a great fault of symbolic pseudo-mathematical methods of formalising a system of economic analysis ...that they expressly assume strict independence between the factors involved and lose all their cogency and authority if this hypothesis is disallowed.

(ibid., 297)

4.2. *The central locus of economic complexity in the General Theory: the analysis of the long-term expectations and the business cycle*

In the *General Theory* Keynes analyzes a “monetary economy” -- “one in which changing view about the future are capable of influencing the quantity of employment and not merely its directions” (Keynes, CW, 7, xxii). Thus expectations play a *leading role* at the centre of the model. Marshall made a fundamental contribution when he recognized the importance of expectations in the behaviour of economic agents. Nevertheless Keynes is one who first closely examined expectations theoretically.

Keynes introduces expectations in Chapter 5 of the *General Theory*. Here entrepreneurial decisions depend on the expectations on “what the consumers will be prepared to pay when he [the entrepreneur] is ready to supply them after the elapse of what may be a lengthy period” (Keynes 1973b, 46). There are two types of expectations - short term and long term. Long term expectations concern investment and have a special nature because they “cannot be checked at short intervals in the light of realised results” , as opposed to short term expectations (ibid., 51). Consequently, Keynes analyzes them separately in Chapter 12.

Keynes maintains that long-term expectation depends on the most probable forecast that agents can make and upon the confidence with which they make that forecast. The state of confidence is the shape that the weight of argumentation – the concept in the *Treatise of Probability* -- took in the *General Theory*. It is defined in terms of “how highly we rate the likelihood of our best forecast turning out quite wrong” ((Keynes 1936, 148). Therefore confidence depends on the knowledge of the future that is “fluctuating, vague and uncertain” (Keynes 1937, 113). Uncertain, “very uncertain”, Keynes notes, does not mean improbable, because it refers to a situation where “there is no scientific basis on which to form any calculable probability whatever” (ibid.). In other words, we cannot use a probabilistic theory of expectations – such as a rational expectation hypothesis *à la Muth* - which assumes that expectations correctly identify the mean and variance of stochastic variables affecting future contingencies. On the contrary, rational calculation is scarcely useful in presence of such radical uncertainty and “it is reasonable .. to be guided to a considerable degree by the facts we feel somewhat confident about” (ibid., 148), because “it would be foolish, in forming our expectations, to attach great weight to matters which are very uncertain” (ibid., 148).

How do we get around this shortage of information and knowledge ? We can answer this question by observing market and business psychology, Keynes maintains. In fact, “there is ... not much to be said about the state of confidence *a priori*: this makes the digression “on a different level of abstraction” (ibid., 149) from that of most of the *General Theory*. In practice, agents have to fall back on conventional judgement and animal spirits, or, more precisely, on neither ‘rational’ nor ‘irrational’ motives, as Keynes wrote to his former student Hugh Townshend:

Generally speaking, in making a decision we have before us a large number of alternatives, none of which is demonstrably more “rational” than the others, in the sense that we can arrange in order of merit the sum aggregate of the benefits obtainable from the complete consequences of each. To avoid being in the position of the Buridan’s ass, we fall back, therefore, and necessarily do so, on motives of another kind, which are not “rational” in the sense of being concerned with the evaluation of consequences, but are decided by habit, instinct, preference, desire, will, etc.

(Keynes, *C. W.*, XV, 1979, 294)

If we pretend that we are acting as perfectly rational man under radical uncertainty we are, paradoxically, following “a pseudo-rationality”, using “a mythical system of probable knowledge” (Keynes 1937, p. 124). Human behaviour under conditions of structural uncertainty is so complex that of a formal probabilistic treatment of expectations is invalid.

The analysis of entrepreneurial behaviour in getting around the informative and cognitive shortage is split by Keynes in two parts, corresponding to the two phases of capitalism -- old-fashioned competitive capitalism and mature capitalism. Mature capitalism is characterized by the separation between the ownership and the management of the firm and by the development of organized investment markets. In old-fashioned competitive capitalism, the leading actor is the entrepreneur, the owner and manager of his own firm at the same time. Here the expectations depend on his “genuine expectations”. Keynes defines these entrepreneurs as “individuals of sanguine temperament and constructive impulses who embarked on business as a way of life, not really relying on a precise calculation of prospective profit” (ibid., 150). Entrepreneurial activity assumes a peculiar mixed character resembling a “a mixed game of skill and chance” (ibid.), where investment is the result not only of “cold calculation” but also of “temptation to take a chance” and “satisfaction (profit apart) in constructing a factory, a railway, a mine or a farm” (ibid.). Here the entrepreneur acts on the basis of *animal spirits* – “a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities” (ibid., 161). Actually, Keynes adds, individual initiative is adequate only if cold calculation is “supplemented and supported by animal spirits”, so that “the thought of ultimate loss which often overtakes pioneers is put aside as a healthy man puts aside the expectation of death”

(ibid., 162). In mature capitalism, on the other hand, the leading actor becomes the stock market investor, and investment depends on “the average expectation of those who deal on the Stock Exchange as revealed in the price of shares” (ibid., 151). In their decisions investors drawn from conventions. The essence of conventions lies “in assuming that the existent state of affairs will continue indefinitely, except in so far as we have specific reasons to expect a change” (ibid., 158). Keynes defines conventions more generally in his 1937 article, where he refers to three types of assumptions:

- (1) We assume that the present is much more serviceable guide to the future than a candid examination of past experience would show it to have been hitherto. In other words we largely ignore the prospects of future changes about the actual character of which we know nothing.
- (2) We assume that the existing state of opinion as expressed in prices and the character of existing output is based on a correct summing up of future prospects, so that we can accept it as such unless and until something new and relevant comes into the picture.
- (3) Knowing that our own individual judgement is worthless, we endeavour to fall back on the judgement of the rest of the world which is perhaps better informed. The psychology of a society of individuals each of whom is endeavouring to copy the others leads to what we may strictly term a conventional judgement

(Keynes, *CW*, XIV, 114)

In financial markets the evaluations in investment depend on the “judgement of the rest of the world”, or on the attempt “to conform with the behaviour of the majority or the average” (Keynes 1973 [1937], 114). This technique is compatible, according to Keynes, “with a considerable measure of continuity and stability in our affairs, so long as we can rely on the maintenance of convention” (p. 152). However, Keynes says, this type of conventions is fundamentally arbitrary – because of the ignorance about the future, which cannot be filled up by experience and rules – and consequently precarious. This precariousness increases in proportion to the number of people owning equities who are ignorant of the prospect of a particular investment. Professional speculators possess more knowledge and information than private investors, but they do not act in order to counteract those factors of market fragility and precariousness because they deal in *speculation* -- i.e. the activity of forecasting the psychology of the market and of anticipating the basis of conventional valuations a short while ahead.

The coexistence of these two types of property-management relationship and the existence of organised financial markets makes business activity a mix of enterprise, stock market evaluation and speculation. Enterprise is based on reasonable calculation, as far as it is possible, and is supplemented by a particular “way of life”, “spontaneous optimism” and animal spirits. Instead, investor activity is fundamentally guided by conventional judgement. In order not to end up like

Buridan's ass, business people must draw from motives which are, "not rational in the sense of being concerned with the evaluation of the consequences", but are rather "decided by habit, instinct, preference, desire, will, etc." (Keynes 1938, 249). These factors determine people's state of confidence and therefore the magnitude of investment. Conventional judgements and animal spirits act together to make up a fundamental determinant of the rate of confidence. They are a substitute for reasonable calculation when confidence is low or absent. They act as a mechanism of fulfilling expectations on the basis of successful rules and spontaneous optimism. Only a set of repeated failures may induce the rejection of a particular belief model.

Long-term expectations are very important in business cycle phenomena. According to Keynes, they are determined by fluctuations in investment. Investment itself depends upon the relationship between the rate of interest and the schedule of the marginal efficiency of capital. This, in turn, depends upon the relationship between the supply price of a capital-asset and its perspective yield. This is determined by the state of the psychological expectations or state of long term expectations. As we have seen, the state of long term expectations is a fundamental case in the *General Theory* where the non-homogeneity of the material is the key feature. This is what make the business cycle a "highly complex" phenomenon (p. 313). Since expectations and investment cannot be modelled by using probabilistic relationships, the business cycle is beyond the domain of probabilistic inference. This is the key reason why Keynes criticized the statistical testing of business cycle theories, like that of Tinbergen (1939).

4.3. *A corollary of Keynes's method of analysis: the criticism of econometric method and the Keynes-Tinbergen debate*

Tinbergen's 1939 report for the League of Nations, *Statistical Testing of Business-Cycle Theories* is a fundamental contribution to contemporary statistical and econometric research on business cycles. In the first volume there is an explanation of the econometric method. Tinbergen outlined the technical method of multiple correlation analysis by applying it to an economic business cycle theory translated into a parametrized mathematical-economic model. Then, he tested for the plausibility of the parameter estimates. Finally, he checked out the outcomes generated by the system as a whole to see whether the theory provides a business cycle mechanism or not. In a review, Keynes (1939) raised the methodological question whether statistical methods are proper tools for testing business cycles theories: "the logic of applying the method of multiple correlation to unanalysed economic material, which we know to be non-homogeneous through time" (Keynes 1939, 285-6).

Here are the most important points of Keynes's criticism.²¹ First, the logical condition for using the method of multiple correlation is the existence of "numerically measurable, independent forces, adequately analysed" – i.e. "independent atomic factors and between them completely comprehensive, acting with fluctuating relative strength on material constant and homogeneous through time". However, "the economic material under investigation" (ibid., 285-6) rarely satisfies these conditions. This raises the question of the validity of the method. Unfortunately, Tinbergen's discussion appeared "grievously disappointing" because "it leaves unanswered many questions which the economist is bound to ask before he can feel comfortable as to the conditions which the economic material has to satisfy, if the proposed method is to be properly applicable" (ibid., 306). Keynes then raised a set of issues about the conditions under which Tinbergen's procedures would be valid. The first condition was that the significant causes must be completed. If all the factors at work are not included, the estimated coefficients suffer from omitted variable bias. Only if they are included can economists examine their quantitative importance -- i.e. how strongly each of them operates. The second condition is that all the significant factors must be measurable. Keynes wondered what room was left for expectations, for the state of confidence relating to the future and for non-numerical factors, such as inventions, politics, labour troubles, wars, financial crises. He suspected that the choice of factors can be influenced by what statistics are available. The third question was that the factors should be independent. Here Keynes raises the problem of spurious correlation and the problems of simultaneity and multicollinearity. Then, Keynes brings up two issues of technical importance - they concern the functional forms, the time lags and trends. First Keynes maintained that it is implausible to assume that there is linearity and he argued that alternative functional forms should be examined. Secondly, Keynes expressed some doubts about time-lags and trend and the general problem of dynamic specification. He accused Tinbergen of scarce rigour in treating time-lags and trends in an *ad hoc* manner by choosing them by a trial and error approach. This seems inaccurate and arbitrary. Keynes questioned the manipulation of data to "make possible to fit an explanation to any fact" (ibid., 311). In conclusion, Keynes emphasizes what he considered the critical condition -- the likely structural instability. Keynes put the constancy of the parameters into question. Tinbergen assumed that the parameters were constant for 10 years or longer. This is an issue that is directly tied in with the problem of the inductive generalisation – i.e. the inductive and predictive value of the estimates or the relevance of the estimated model to the future. It is "the slippery problem of passing from statistical description to inductive generalisation": it is the problem which, Keynes remembered, "thirty years ago [in his dissertation then published in a revised version as *A Treatise on Probability*] I used to be occupied

²¹ The criticism of Tinbergen and, more generally, the relation between Keynes and the econometricians in the period 1938-1941 are widely analyzed in Garrone and Marchionatti 2007 and 2009.

in examining in the case of simple correlation”. The problem is that Tinbergen “makes the least possible preparation for the inductive transition” (ibid., p. 316). According to Keynes, the correct procedure is to break up the period under examination into a series of sub-periods.²² However, Tinbergen did not follow this procedure. The chief dilemma Tinbergen was facing was “that the method requires not too short a series, whereas it is only in a short series, in most cases, that there is a reasonable expectation that the coefficients will be fairly constant” (ibid., 294). This is the key point of Keynes’s criticism. Actually,

the broad problem of the credit cycle is just about the worst case to select to which to apply the method, owing to *its complexity, its variability, and the fact [that] there are such important influences which cannot be reduced to statistical form.*

(ibid., my italics)

This does not mean that “there may not be problems within the general field of the trade cycle which would provide suitable material”. According to Keynes “the method will prove valuable when applied to certain types of problems, [more elementary cases (ibid., 317)] where adequate statistics exist” (ibid.).²³

In his reply Tinbergen (1940) addressed the technical aspects of Keynes’ critique avoiding the logical question and “the slippery problem”. He stressed the flexibility of his empirical technique. Thus he left Keynes’s central objection unanswered and concluding that “the proof of the pudding is in the eating”. In his comment, Keynes (1940) Keynes recognised that Tinbergen’s reply was “very valuable” on the technical side, but not enough to answer his methodological question

²² This procedure originates in *A Treatise on Probability*. There the criticism of the application of mathematical methods to the statistical inference leads Keynes to propose other methods ‘more consonant with the principle of sound induction’. In fact to argue from the mere fact that a given event has occurred invariably in a great number of instances that it is likely to occur invariably in future instances ‘is a feeble inductive argument, because it takes no account of the analogy’ (Keynes 1921, p. 445). To strengthen the argument we need to increase the analogy between the instances. This ‘chiefly consists, Keynes argues, in determining whether the alleged association is stable, where the accompanying conditions are varied’ (ibid., p. 427). A technical method that supplies the qualified procedure is, according to Keynes, the one proposed by the German statistician and economist William Lexis. It consists in breaking up a statistical series into a number of sub-series, ‘with a view to analysing and measuring, not merely the frequency of a given character over the aggregate series, but the *stability* of this frequency amongst the sub-series’ (ibid., 428, italics added).

²³ In his correspondence Keynes cites some examples of the types of problems in which the specific features of the object of analysis justify the use of multiple correlation analysis. One of these, particularly emphasised, is the case of the demand for investment in new rolling stock, cited in the letter to Tyler of 23 August 1938. At that time Keynes was publishing an article in the *Economic Journal* by English statistician E. J. Broster that studied the relation between the volume of traffic and operating costs on the British Railways in the years 1928-1937. He introduced multiple linear regression equations expressing total operating costs as a function of passenger-miles, ton-miles and coaching train-miles, and freight-train-miles: “That is the sort of case – Keynes remarked – where one has at any rate a modest expectation of useful results”. He continued: “On the other hand, the question of what determines the volume of investment itself I should regard *prima facie* extremely unpromising material for the method” (Keynes 1973, 295).

persuasively. What he opposed were the attempts at statistical inference without any prior effort to ascertain the suitability of the economic material for making such inferences. Keynes thought that:

The successful application of this method to so enormously complex a problem as the business cycle does strike me as singularly unpromising project in the present state of our knowledge.

5. CONCLUDING REMARKS

This reconstruction shows that Keynes's theoretical work can be interpreted as the progressive development of a conception of economics as well as a theoretical framework that deals with the complexity of the social world. The economists of his time were unable to accept the extremely ambitious challenge represented by Keynes's program. The mainstream of economic science in the second part of twentieth century was rooted in the anti-Marshallian change that occurred in the theoretical and methodological approach in economics in the 1930s. Mainstream economists appropriated some parts of Keynes's macroeconomic work but rejected Keynes's (as well Marshall's) reflections on nature, method and style of economics, and considered Keynes, from this point of view, an old-fashioned economist.

In recent years, mainstream economics has been successfully challenged in many sub-fields and as the dominant paradigm. In the light of these recent changes in economics Keynes's analysis appears surprisingly fresh and modern. On the methodological level, Keynes's reflections on the nature, method and style of economic reasoning, along Marshallian lines, seem to be able to help us in defining the characteristics of a new paradigm for economics. On the analytical level, Keynes offers a theoretical framework -- e.g. in relation to the formation of expectations -- where the outcome of the model is the result of the interaction of heterogeneous, bounded rational agents that revise their behaviour as they accumulate information. We can now interpret their interaction as the generation of an adaptive complex system, as the contemporary economics of complexity would term it.

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