Knowledge in Economics: An Evolutionary Viewpoint

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ABSTRACT: Since Sidney Winter published his paper on "Knowledge and competence as Strategic assets", the number of publications on the role of knowledge in economics has immensely grown. Here we shall analyze that role from an evolutionary point of view, and try to show that the discussion about concepts like "evolution" is not closed, and that the Darwinian framework of evolutionary economics is in debate.

Keywords: knowledge, evolutionary economics, tautological objection, Darwinian framework, random selection.

Since, in 1987, Sidney Winter published his paper on knowledge and management strategy ("Knowledge and competence as Strategic assets"), the number of relevant publications on this matter has immensely grown. Winter concluded that there was a serious dearth of appropriate terminology as well as of conceptual schemes to understand and analyze the role of knowledge in economics. Questions about the meaning of knowledge and knowledge production, separations and distinctions between different kinds of knowledge and the interaction between learning, knowledge and economic development have been formulated. But little agreement has been reached on those questions.

Mainly, knowledge and information appear in economic models in two different contexts. Standard microeconomics makes the fundamental assumption that the economic system in based on rational choices made by individual agents. From this point of view it is important to establish how much information agents have about the world or the environment in which they operate, and what kind of ability they have to process that information. This perspective on knowledge focuses on a transformation process through which data describing the actual state of the world are transformed into information as indicators that are accessible to the agents representing the state of the world, and then into knowledge conceived as the result of processing the information in analytical models. The other major perspective is that in which knowledge is regarded as an asset, and appears both as an input and as an output (*i.e.*, as competencies and innovations) in the production process. Then, innovation theory and competence-based theories of the firm are built to analyze how knowledge is produced and used in a market economy.

Rational choice theory and evolutionary arguments

The perspective of standard microeconomics supports that the observed configuration of economic variables is the result of rational actors that make choices to maximize their utility. Richard Nelson ("Evolutionary Theorizing about Economic Change") observes that the question about how that optimal decisions have been made is not a basic part of the theory: in any case the optimal response can be understood "as if" the actor had actually calculated it (Nelson 1994, p. 111). Then, the actor can be thought as being in possession of some kind of implicit knowledge about the context in which is involved. The theory can handle actor's errors, but only under the assumption that the actor has limited information about certain key parameters that determine some outcomes of making a decision. Nevertheless, systematic mistakes associated with ignorance or misunderstanding of the basic features of the situation are not admitted, *i.e.*, the theory presumes the actor has basically correct understanding of the actual choices and the consequences of them as the theorist modeling individual behavior has. This is called the "perfect knowledge" assumption. And associated notion is that of equilibrium: each actor is assumed to optimize, and the optimization decisions are presumed to be consistent with each other actor's optimizing action. This basic mode of explaining behavior has proved itself to be a satisfying way of exploring the way individuals and organizations make decisions. But evolutionary theorists studying long-run economic change have adopted a quite different alternative for many reasons. First, because rational choice theory, as Nelson points out, provides only limited light on context where actors cannot be presumed to have applicable experience and where trial-and-error learning is going on. Second, because in many cases rational choice analysis provides multiple equilibria: in each it is possible to specify the optimizing choice, but behavior differs greatly from one to another. To answer the question about why a particular equilibrium has turned out we have to appeal to evolutionary arguments. Third, rational choice theory provides a kind of explanation of behavior that takes the actor's objectives and constraints as given, while an explanation that considers how cultural and social institutions have evolved and affect the choices available to actors seems to provide a deeper understanding of behavior than rational choice explanation alone. Then, rational choice theory would seem applicable to contexts with which the actors are familiar, and evolutionary theory can be understood as an attempt to deal with situations where the presumption of familiarity does not seem applicable. In fact, evolutionary theory might be of great help in the analysis of behavior in contexts that involve novelty, *i.e.*, evolutionary theory can be understood as a theory about how society learns and acquires knowledge about the world. This perspective characterizes economists who have thought economic growth as a process driven by technological advance: almost all researchers on technological advance point out the uncertainties that are common in the process which seems to be outside the domain of rational choice theory.

Evolutionary theory in economics

There are two main analytic questions about evolutionary theory in economics: (1) a first question about what is the meaning of "evolutionary" as contrasted with a theory of another class, like neoclassical theory that employs "mechanical" analogies; and (2) a second question about the biological analogies invoked, *i.e.*, about the key differences as well as the potentially useful analogies between evolution in biology and in economics. As Nelson points out, one way to try to define evolutionary theory would be to start from biology and explore if one can find close analogies to the variables and concepts of that theory in other areas of inquiry, like in economics. But it would be more fruitful to start with the general and then examine applications in specific areas, like biology and economics as special cases (Nelson 1994, p. 113).

Most researchers interested in these issues would agree that "evolutionary" is a term that has to be reserved for theories about dynamic time paths which try to explain how things change over time, or why things are what they are by showing "how they got there", Nelson says. From this point of view, theories that are wholly deterministic should not be called "evolutionary": there is no point in saying that Kepler's laws of planetary motion and Newton's gravitational theory which explains them define an evolutionary system. So, a theory of economic change that analyzes that process as moving to a competitive equilibrium, like in neoclassical growth theory, should not be considered as an evolutionary theory. There are many deterministic models employing complex nonlinear dynamic equations that the authors have called "evolutionary", like the examples that can be found in *The Economy as an Evolving Complex System*, written by P. Anderson, K. Arrow and D. Pines (1988), but they are not to be considered as evolutionary because this term should be limited to theories or models where there is an essential stochastic element. Thus, the term "evolutionary" is reserved for models that contain both systematic and random elements: in biological evolutionary theory the random elements are associated with the generation or preservation of species, and the systematic elements are related to selection pressures, and it could be thought that a useful extension of the term "evolutionary" to other areas require something analogous (Nelson 1994, p. 114).

The question here is if one can regard technology (or science itself) as evolving. There is a set of complex models of economic growth in which technical advance is the driving force and in which technology and industry structure coevolve. The outcome of this process is growth of per worker productivity and per capita income, which are the standard measures of growth for economists.

Traditionally, economists have used biological analyses in writings about long-run economic growth, but with the publication of Solow's famous article "A contribution to the Theory of Economic Growth" (1956), the analysis of economic growth was brought under the neoclassical framework: the general equilibrium framework was dynamized to view economic growth as the moving equilibrium of a market economy in which technical advance is continuously increasing the productivity of inputs, and the capital stock is continuously growing with relation to labor inputs. In this way, an explanation for the increase in labor productivity and per capita income is provided as a standard measure of growth.

Technological change and economic growth

Technological advance is an essential element of neoclassical account of growth, but it is virtually accepted by all researchers that technical advance has an important component of uncertainty, differences of opinion among experts, and surprises in the process, so mechanical analogies involving moving competitive equilibrium seem to be inappropriate: the process must be understood as an evolutionary one (Nelson 1994, p. 123). The problem is to devise a theory of growth capable of explaining the observed macroeconomic phenomena on the basis of an evolutionary theory of technical change. In such theory firms would be key actors, both in making investments to develop new technologies and in the use of technologies to produce goods and services.

Economic growth in viewed as based on firms, which compete with each other through the technologies that they introduce and employ.

Firms are, from this point of view, the entities that are "fit", *i.e.*, that are more or less profitable. But firms can also be regarded as merely the carriers of technologies, *i.e.,* of particular practices and capabilities that determine what (and how) they do in particular circumstances. Nelson and Winter used the term "routines" to denote these practices and capabilities article "A contribution to the Theory of Economic Growth". The concept of routines is analytically equivalent to the genes in biological theory. And there are thee different kinds of routines: (1) those that might be called "standard operating procedures", which determine how and how much can be produced under various circumstances; these routines can be identified as "technologies"; (2) those routines that determine the investment behavior of the firm*, i.e.*, the equations that govern its growth or decline as a function of its profits; and (3) the deliberative processes of the firm that involve searching for better ways of doing things, which are called R & D (research and development) processes.

Firms whose R & D turns up more profitable products will grow more then their competitors, but R & D also tends to bind firms together as a community since profitable innovations are imitated by other firms in the industry. The collection of firms in the industry is viewed as operating within an environment which is exogenously determined, and can be interpreted as a "market" or a set of markets. In this theory, in the same way as routines are analogous to genes, firms are analogous to phenotypes or particular organisms in biological evolutionary theory, but there are important differences: firms do not have a natural life and do not die, neither can be viewed as having a natural size; and living organisms are stuck with their genes, but firms are not stuck with their routines; on the contrary, they have built-in mechanisms for changing them. Also, attention has to be paid to the fact that the model applies only to economic sectors where the market provides the selection mechanism, *i.e.*, the model is not suited for dealing with sectors like defense or medical care, where political process determine what is "fit" and what is not. Nevertheless, the central purpose of the model is to explain economic growth at a macroeconomic level, and it does it. So, it can be said that this "Schumpeterian" model of economic growth is rich and has a lot of potential. But as Nelson says, it remains to be seen how many economists using the neoclassical theory will be attracted to it (Nelson 1994, p. 124).

Some critics concerning the evolutionary perspective in economics

1. *Random variation and selection*: As E. E. Harris points out, the current neo-Darwinian doctrine is that variation occurs by chance and is completely random, and that natural selection eliminates unfavorable mutations allowing the favorable ones to proliferate: natural selection is a purely negative influence which simply eliminates the unfit. But reproduction is just one of the ways in which the process of self-maintaining of living organisms occurs: as a self-maintaining system, an organism must modify its internal process and external behavior so as to adapt to changes in its environment, and if it fails to do this, it dies. As it reproduces itself, modifications of its structure and functioning which favor its survival will persist, while those that pro-

ve to be unfavorable will succumb to hostile conditions. Then, the progeny of the original phenotype will evolve and the mechanism of evolution will be variation and natural selection (Harris 1988). But Harris thinks that there are few but sufficient examples that persuade us that pure chance mutation is an inadequate explanation and that something more is needed. It is not an argument against the theory that mutation and natural selection are the means to evolution: the evidence in favor of that is impressive. But evolution cannot be the result of pure chance as it should be according to the current neo-Darwinism. In fact, there is no conclusive evidence that all mutations are entirely random, and there is good evidence that another factor of major significance is operating: biologist have discovered that genes do not act independently in determining isolated characters but they cooperate, and the results of this cooperation depend on their position in the chromosome. Then, the genome, *i.e.*, the entire body of genetic material, acts as a whole and changes within it can occur spontaneously. When those changes occur, whether by crossing over of chromosomes or by random mutation, they are mutually adjusted: some of them, which are disadvantageous, may remain recessive but may later become dominant and, if having survival, they will persist. Harris says that this is not a surprising theory, because the organism is adaptive and self-maintaining or would not be alive. Evolution should be nothing less than the extended process of the intrinsic adaptive character of living things, constantly maintaining and increasing their integrative coherence to become progressively more self-dependent and self-determining in changing circumstances (Harris, 1988:67). If so, the model of economic growth in which firms compete whith each other within the market is to be questioned.

2. *Stability of markets*: In his "Pluralism and Heuristic Identification" [*Theory & Psychology* (2001), vol. 11 (6), 796-807], M. Schouten and H. L. de Jong observe that genetic explanation, like other causal explanations, is to be considered as context-dependent and observer-relative. Then, they have explanatory primacy only for certain questions: those for which they provide ways to trace out a trait's causal ancestry, but not for others. Further, a genetic factor is only relevant inasmuch as it refers to some stable ecological background, which is not the case in market processes. It is truth that, by picking out genes and connecting them to phenotypic traits, masses of other causal factors are ignored, which may be important in other contexts. This implies that by offering these identifications the theory is deliberately simplifying matters, but these context-bound identifications must be considered legitimate simplifications. What is difficult to be sustained is that they can be applied in a non-stable ecological background.

3. *Biological and physical assumptions*: B. O. Küppers has pointed out that the field of biology is today undergoing a development as rapid and as exciting as the development of physics at the beginning of the XXth century. However there is a significant difference: while modern physics brought with it a profound conceptual change through quantum theory and relativity theory, in contrast, modern biology has not included such revolutionary changes. In fact, the Darwinian theory of evolution and its physico-chemical counterpart, the theory of biological self-organization, provide a stable and self-consistent foundation for the live sciences. Nevertheless, there has

been violent controversies within evolutionary biology concerning the "tautological objection", *i.e.*, the question of whether the Darwinian principle of the survival of the fittest, which is the basis of the entire evolutionary doctrine, could be formulated without involving a circular argument in which the greatest fitness is defined as the property of having survived. The physical justification of the selection principle in the framework of the molecular theory of evolution has ultimately decided the controversy in favor of the orthodox Darwinian position (Küppers 1999, p. 275).

In Niels Bohr's famous essay of 1933 ("Light and life"), it is predicted that the theoretical basis of biology would undergo the same changes as the physics of microscopic systems had done. Bohr believed that the revolutionary idea of complementarity in microphysics could be transferred to biology, arguing that a complete physical description of a living organism would never be possible because the required molecular or atomic analysis would lead to the destruction and death of the organism. As one can see, in biology as in quantum physics there would never be a clear distinction between what is observed and the observer, and consequently a description of the living phenomenon independent of the observer is impossible. This is why Bohr considered the existence of life to be an elementary fact which could not be explained and must be accepted as an irreducible axiom of biology, just as classical mechanics viewed the quantum of physics as an irreducible quantity which existence could not be deduced (Küppers 1999, p. 276).

Bohr's thesis of the irreductibility of life has been present in the philosophical and theoretical debate in biology for several decades, until the successes of molecular biology in the nineteen-fifties and early sixties pointed out that Bohr's argument did not hold. Bohr had seen a physically inexplicable property of life in the ability of an organism to reproduce itself, but now is known that this is just the macroscopic expression of a microscopic property of molecules, *i.e.*, the inherent capability of DNA-molecules to reproduce themselves. Today, Bohr's thesis is only of historical interest, but it contains an idea that reflects an important step in the development of modern science, *i.e.*, the fundamental idea of microscopic physics that an object can only be understood in relation to the subject that observes it, even if this has not practical importance for macroscopic objects. With the abandonment of the idea of an absolute object, microscopic physics introduced a conceptual change that had already been proposed by relativistic physics. But, even when Bohr's approach ultimately failed, the doubts that he expressed about the theoretical bases of biology pointed in the right direction: theoretical biology will have to depart from the idea of absolute information the same way physics had to abandon the ideas of absolute space, absolute time and absolute objects (Küppers 1999, p. 277).

The complexity of living matter is dynamically ordered and functionally effective, and is expressed in the organism's purposeful construction and activity. This is the aspect that is related to information in biology when the complexity of living matter is interpreted as being completely "controlled" by information. The working hypothesis according to which all the processes of life, from metabolism to heredity, are instructed by genetic information receives strong support from molecular biology, and has been so successful that the ideas of storage, transfer and generation of information are today fundamentals of theoretical biology. The fusion of the information theory and the Darwinian evolution theory has given a unified theory for the generation of biological information and has determined the direction of the theoretical debate on biological self-organization.

However, the concept of information is derived not from natural sciences but from the communication theory, which represents a completely different conceptual framework. We usually speak of a purposefully constructed machine or a purposeful plan of action, and in the same way biologists speak of a purposeful, *i.e.*, information directed, functional context in living organisms, which lead us to the problem of the introduction of the semantic aspect of the information into biology. This problem is of considerable importance for the intertheoretical relation between biology and physics. The fact that the concept of information is extra-biological, and the amazing parallel between genetic and human language (certain molecular components of the biological information carrier, the nucleotides, function as letters in a genetic alphabet, and these letters are grouped in defined code-words), raise the question of whether genetic information really is an inherent property of living matter, or whether it is merely an arbitrary way of describing things. The central question is whether information is a natural entity, in the same way as gravity or electricity in physics, or not. (Küppers 1999, p. 279). The majority of biologists appear to accept that biological information is a natural entity which expresses itself in the specific structures of biological macromolecules. However, this point of view has been strongly criticized by constructivistic philosophers of science as P. Janich (1992). The main attack has been directed against the application of the concept of information in non-human areas. From this viewpoint, the transfer, storage and production of information can only be understood as metaphors, the object of which takes shape only when related to communication between two human beings.

As it can be seen, the discussion about the concept of evolution and natural selection is not to be closed easily. Then, the Darwinian framework of evolutionary economics is in debate, and will have to prove through empirical confrontation that it is a convenient theoretical approach to economic phaenomena.

BIBLIOGRAPHY

Harris, E. E. (1988). *The Reality of Time.* Albany: State University of New York Press.

Janich, P. (1992). *Grenzen der Naturwissenschaft.* München: Beck.

Kuppers, B.O. (1999). "The Context - Dependence of Biological Information", in R. Gutiérrez Lombardo *et alia* (eds.): *Estudios en historia y filosofía de la biología.* México, D.F: Centro de Estudios Filosóficos, Políticos y Sociales "Vicente Lombardo Toledano", 275-289.

Nelson, R. (1994). "Evolutionary Theorizing about Economic Change", in Smelser, N.J, Swedeberg, R. (eds.): *The Handbook of Economic Sociology.* New York: Princeton University Press, 108-136.

Nelson, R,.Winter, S. (1974). "A contribution to the Theory of Economic Growth", *Quarterly Journal of Economics* 70, 65-94.

Schouten, M., de Jong, H. (2001). "Pluralism and Heuristic Identification", *Theory & Psychology* 11 (6), 796-807.

Solow, R. (1956). "A contribution to the Theory of Economic Growth", *Quarterly Journal of Economics* 70, 65-94.

Winter, S. (1987), "Knowledge and Competence as Strategic Assets", in Teece, D. (ed.): *The Competitive Challenge*: Cambridge, Mass: Ballinger Publishing Company.

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