# FROM BIOECONOMICS TO BIOECONOPHYSICS

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**Abstract.** *This interdisciplinary approach of the economy changes its classical concept for reasons connected with the need to extend the biology laws in the economic reality, but also to replace the outdated view of the classical and unsystematic economic theory, in the view of the external environment, limited resources and the coexistence of man with other species, in a limited habitation. Econophysics is another interdisciplinary approach to economics and physics, yet focused on improving the model of investigation by capitalizing on the realism of physics models in the subject of study of the economy and by improving it from the instrumental and experimental point of view. Bioeconophysics seems to be not a compromise but a first real attempt of the economic reality by valorizing the laws of biology and the models of econophysics.*

**Keywords:** *bioeconomics, bioeconophysics, bioeconomy, trans-, inter-, and multidisciplinarity.*

## 1. INTRODUCTION

Among the most important economic school of the 20th century one can find Bioeconomics, a transdisciplinary science placed alphabethically between Austrian school and the Chicago school, in a long list together with constitutional economics, evolutionary economics, econophysics school, Freiburg school, Freiwirtschaft, Georgism school, institutional economics, Keynesian economics, Marxian (Marxist) and neo-Marxian economics, Neo-Ricardianism, New classical macroeconomics, New Keynesian and Post-Keynesian economics, public choice school, Lausanne school, sociophysics school, Stockholm school, etc.

As a new concept, *Bioeconomics* was used for the first time by British biologist Hermann Reinheimer, in 1913, in his paper entitled *Evolution by Co-operation: A Study in Bioeconomics*, and today we can find four usual significations [1]:

A. Studying the dynamics of living resources using economic models (Fisheries)

B. Economic systems based on the laws of thermodynamics (Biophysical)

C. Study of the relationship between human biology and economics (Biological economics)

D. Social theory of Nicholas Georgescu – Roegen (Bioeconomics) [2].

One of the most important and recognized mathematician, statistician, demographer and biologists in USA, during the first half of the 20th century, Alfred James Lotka (1880-1949) was the first theoretician of the new science, based on his opinion about population described as an aggregate with renewal processes, and especially based on his reputation and knowledge. In fact, Lotka defined Bioeconomics or Biophysical economics as a profound correlation between the biological laws and the thermodynamic laws inside the permanent competition for energy and material resources [3].

But the real father of the Bioeconomics was Nicholas Georgescu-Roegen (1906-1994), a well known Romanian-born and finally American statistician, mathematician, economist and bioeconomist, the major author of the interpretation of economics through the new paradigm of the so-called Bioeconomics. His essential conception and his defining manner are based on physics turned entropy into Bioeconomics [4, 5].

The new paradigm of bioeconomics is still difficult to define, especially because some ambiguities developed during the last decades. Thus, the modern economist can find three important sets of questions that need answers:

Bioeconomy or Bioeconomics? Is Bioeconomics different from bioeconomy? Are these terms synonymous? Bioeconomy defines a set of specific economic activities and political projects, while bioeconomics has numerous different important significances: a) a study of how organisms of all kinds earn their living in nature's economy (Reinheimer, 1913); b) a relationship holding between the biological laws of evolution and the laws of thermodynamics (Lotka, 1925); c) a research paradigm [6] combining two independent, though in many respects related, scientific disciplines: economics and biology (Witt, 1999); d) a specific type of economy [7] where the basic building blocks for materials, chemicals and energy are derived from renewable biological resources (McCormick & Kautto, 2013).

What does Bioeconomics mean for his originator Nicholas Georgescu-Roegen, as a different type of economics? Which is the most important aspect in Bioeconomics? In Nicholas Georgescu-Roegen's research approach, or scientific vision Bioeconomics became: i) a real solution to unavoidable ecological disasters that would make the survival of the human species the shortest of all on this globe; ii) a combination including evolution of biology, economics and thermodynamics; iii) an approach to the economic process seen as an extension of biologic evolution (human ability, and ultimately the capacity of the species, of developing tools and generating detachable organs, or extensions of the human body, redefined as exosomatic organs, which becomes a biologic component of bioeconomics); iv) a physical view (econophysics) does exist at the very start of bioeconomics as incapacity of classic economics to understand and recognize the economic process of cumulative (irreversible) change, caused by the mechanist dogma.

## 2. THE ECONOMIC PROCESS AS AN ENTROPIC PROCESS

The economic process was, is, and will still be, an entropic process in Bioeconomics, where four postulates are essential in Nicholas Georgescu-Roegen's view:

I. The qualitative changes caused by the extensions of the human body contributed to the stagnation of the progress of classical (mechanist) economics, the degradation of the environment by man and the human race, destroying the economic process.

II. There is an irreductible, permanent opposition between the economic process in the mechanist and thermodynamic views: the entropy of a closed economic system continually and irreversibly rises to a maximum value, the energy available being transformed into unavailable energy, until it disappears. Modern Malthusianism (the Bartle law): exponential economic growth is correlated with the increasing penury of resources. There is no absolute substitutability.

III. Starting from thermodynamics and the second axiom, the idea emerges that matter is subject to the same degradation as energy is (the example of irretrievable rubber, of plastic, etc.)

IV. Not even the most efficient recycling system will be able to stop the degradation of resources! This is how entropy works today in contemporary bioeconomics!

The seven findings or derived principles of bioeconomics remain the following objectives from Nicholas Georgescu-Roegen work [8, 9]:

1. The technological optimism of classical economics is absolutely unreasonable and groundless.

2. Production implies the transformation of a limited stock of raw materials and energy, and is in accordance with the laws of the economy. Economic growth is only an apparent increase in the ratio of outputs per inputs, and a genuine entropic degradation of the resources and energy.

3. The Earth has limited resources and energy, and is not the property of a given generation.

4. The principle of the conservation of resources and energy is fundamental.

5. The excesses of classical consumerism must be deterred, the resources should be made global, which includes *human resources, who should no longer possess a passaport* (Georgescu-Roegen).

6. Policies based on bioeconomics imply no risk, since the economic process is irreversible.

7. Restricting life focused on exosomatic comfort, which is short and tumultuous, and the expansion of a lifestyle that seems to be more monotonous, and yet longer.

The excessively structured and monopolized economic process has an ever higher entropy. Entropy can also change a clasical econonomic program into a bioeconomic one that looks like Nicholas Georgescu-Roegen's program described by Nicholas Wade in *Penthouse, not in a cave* [4] in only three common points:

a) diminishing weapon production to total disappearance;

b) diminishing population to the level of food ensured by organic farming;

c) consumption for consumption's sake, or trendy consumption should be seen as a type of bioeconomic crime legally punished (e.g. changing one's car yearly).

## 3. BIOECONOPHYSICS/ECONOBIOPHYSICS

Biology, Physics and Economics together mean in the last two decades not only clasical Bioeconomics but much more, Bioeconophysics, as a new science, including their specific models or bioeconophysics models. The first model of the classical bioeconomics was rather a descriptive one (Lotka-Voltera model), but the new models of bioeconophysics are more efficient (e.g. the econophysics and sociophysics models). Biophysical Economics or Ecological Economics are, in different contexts, somehow similar to Econobiophysics or Bioeconophysics.

The economic process consists in the continuous transformation of low entropy into high entropy and thus Biology and Physics are apparently in a state of permanent confruntation, and the autonomy of classical economics is an illusion. Physics exerts isolation through experiment, while biology emphasizes the importance of nullification of isolation, or laying stress on the outer milieu. Economic systems cannot be taxonomized in detail in a biologic manner, starting from individuals to the species, etc. even some trends in experimental economics constantly try to do this complete taxonomy.

Bioeconophysics has characteristic conceptual dualities [10, 11, 12]. In thermodynamics there are two essential variables: temperature and pressure. By making use of temperature and pressure, the two laws of thermodynamics are determined. Economic theory also focuses on two parameters: capital and labour. Accountancy leads to equations that correspond to the laws of thermodynamics. Capital and temperature, labour and pressure, surplus/deficit and heat/loss of heat, the production function and entropy, the living standards and energy, become similar concepts or conceptual dualities through the similarity of economic and thermodynamic theory. Biology is also a natural science, whose theory also centres on two parametres: living plants and animals, which are assimilated to heat and entropy. Living plants and animals are the same thing as heat, while the DNA becomes entropy. Photosynthesis is a Carnot production process, etc.

A new theory is not necessary in order to delimit the full understanding of bioeconophysics, but only a reinterpretation specific to trans-, inter- and multidisciplinary researches.

## 4. CONCLUSIONS

The new science of bioeconomics considers that some patterns of biological evolution can be applied in the economic behavior of consumers, producers, the market, etc., as many of the same causal interactions and survival elements are found there as well as in nature (e.g. a theory of homogeneous middleman groups as adaptive units, the bioeconomics of cooperation, etc.) In biology, groups of organisms coexist together to make the best use of resources and to live together, while promoting the survival of the fittest.

Bioeconomics is not the science of behavioral finance, but it represents another example of economic theory that differentiates itself from the boundaries of classical economics, and tries to better explain the complexity of economics in the present time.

Bioeconophysics expressly recognizes the quality of the physical models applied in bioeconomics and their high degree of clarity and prognosis.

The new civilizations are trying to create a wholly new world order. Policies and predictions, even global, will fail if they are incompatible with the universal economic reality. Only used together will competition and cooperation be useful for the success of adaptation and innovation. Information, or modern knowledge in an economy, does not replace energy, and energy use is unlikely to diminish.

Production resources should not be sacrificed by trade, and subsidies removed to achieve greater economic efficiency.

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