The Origin of Life on Earth: An Economic Interpretation

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ABSTRACT

Economists believe that most theories in economics, if not all, can be formulated in terms of minimization or maximization of a suitable economic quantity. Recent studies in geophysics and biophysics have found convincing evidence that the principle driving the origin of life is energy-dissipation-driven adaptation of matter. In this view, life is a result of maximizing entropy production through a maximum dissipation of sunlight energy efficiently transforming it into heat. This suggests a possible analogy between economic principles and the physical processes underlying life's origin, with an implication that in a fundamental sense it is the economic forces that are responsible for the creation of life on Earth. To be more accurate, it is the physical forces based on the second law of thermodynamics driven by the fundamental economic forces of maximizing entropy along the evolutionary path of the universe that are responsible for the origin of life on Earth. This is not surprising considering the fact that the behaviors of most animal and plant species including their genome itself can be explained in terms of constrained dynamic optimization producing efficient outcomes through decentralized decision making.

Keywords: origin of life, energy dissipation, entropy production, constrained dynamic optimization, efficient decentralized decision making, second law of thermodynamics., economic principles in biology, self-organization, abiogenesis, thermodynamic adaptation.

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Economists believe that most theories in economics, if not all, can be formulated in terms of minimization or maximization of a suitable economic quantity. Recent studies in geophysics and biophysics have found convincing evidence that the principle driving the origin of life is energy-dissipation-driven adaptation of matter. In this view, life is a result of maximizing entropy production through a maximum dissipation of sunlight energy efficiently transforming it into heat. This suggests a possible analogy between economic principles and the physical processes underlying life's origin, with an implication that in a fundamental sense it is the economic forces that are responsible for the creation of life on Earth. To be more accurate, it is the physical forces based on the second law of thermodynamics driven by the fundamental economic forces of maximizing entropy along the evolutionary path of the universe that are responsible for the origin of life on Earth. This is not surprising considering the fact that the behaviors of most animal and plant species including their genome itself can be explained in terms of constrained dynamic optimization producing efficient outcomes through decentralized decision making. Colonies of ants and bees and trees in the forest are the good examples of this studied widely elsewhere in the literature. It is highly unlikely that the similarities between the efficient biological system and the efficient economic system, both with efficient decentralized signaling and responses, are merely coincidental. After all, evidence suggests that the origin of life was a result of economically efficient maximizing of entropy production through a maximum dissipation of sunlight energy driven by the fundamental economic forces.

Keywords: origin of life, energy dissipation, entropy production, constrained dynamic optimization, efficient decentralized decision making, second law of thermodynamics., economic principles in biology, self-organization, abiogenesis, thermodynamic adaptation.

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I. INTRODUCTION

Joseph-Louis Lagrange believed that most theories in physics, if not all, can be formulated in terms of minimization or maximization of a suitable quantity.[1] Economists believe that most theories in economics, if not all, can be formulated in terms of minimization or maximization of a suitable economic quantity.[2] In his 2013 paper Jeremy England proposed an idea that the principle driving the origin of life is energy-dissipation-driven adaptation of matter.[3] In this view, life is a result of maximizing entropy production through a maximum dissipation of sunlight energy efficiently transforming it into heat. This suggests a possible analogy between economic principles and the physical processes underlying life's origin. This implies that in a fundamental sense it is the economic forces that are responsible for the creation of life on Earth. To be more accurate, it is the physical forces based on the second law of thermodynamics driven by the fundamental economic forces of maximizing

[1] Clerke, AM. *Lagrange, Joseph-Louis*. Encyclopedia Britanica, 16 (11th ed.) 1911: 75-78.
[2] Samuelson, P. *Foundations of Economic Analysis*, Harvard University Press, 1947.
[3] England, JL. (2013)

entropy along the evolutionary path of the universe that are responsible for the origin of life on Earth. This is not surprising considering the fact that the behaviors of most animal and plant species including their genome itself can be explained in terms of constrained dynamic optimization producing efficient outcomes through decentralized decision making as can the human behaviors in the market economies.[4] Colonies of ants and bees and the trees in the forest are the good examples of this studied widely elsewhere in the literature. It is highly unlikely that the similarities between the efficient biological system and the efficient economic system, both with efficient decentralized signaling and responses, are merely coincidental.

The paper is organized as follows. This introduction is followed by a brief literature review in Ch. II. Chapter III discusses a wide variety of natural phenomena, both biological and physical, that can be explained by the economic principle of minimization or maximization of a suitable economic quantity which strongly suggests that the origin of life on Earth can also be explained by this principle. Chapter IV presents the conclusion of the paper.

II. LITERATURE REVIEW

The Bible describes the birth of the universe and the earth; "In the beginning God created the heavens and the earth. The earth was without form and void and darkness was over the face of the deep. And the spirit of God was hovering over the face of the waters. And God said: 'Let there be light,' and there was light."[5] Scientists believe that around 13.8 billion years ago the universe started with a Big Bang, an explosion with unimaginable force of a very tiny point into which every speck of its energy was jammed into. Immediately after the Big Bang the universe was formless made up of virtually weightless hot gases, surprisingly similar to the conditions described in the Bible. The early universe was too hot for electrons to remain bound to atoms. The first elements, hydrogen and helium, couldn't form until the universe had cooled enough to allow their nuclei to capture electrons, about 380,000 years after the Big Bang. Then as the universe got cooler with continuous expansion, slightly heavier but still very light gases emerged followed by even heavier elements as the universe continued to cool. The universe followed an evolutionary path of increasing entropy based on the second law of thermodynamics. Along the evolutionary path nevertheless, the total energy of the universe would have to remain constant to preserve the first law of thermodynamics. Along this path the lighter atoms combined themselves to form heavier atoms as the universe was getting cooler with continuous expansion. The Earth formed roughly 4.5 billion years ago, still a ball of hot gases. By the time the conditions were ripe for the birth of life on Earth there would have emerged a sufficient variety of atoms to allow the first organic molecule to be formed, for example, RNA (Ribonucleic acid). Scientists estimate that life probably began between 3.5 and 3.9 billion years ago.

There exist a number of hypotheses in the literature on the origin of life on Earth. The Oparin-Haldane hypothesis suggests that life arose gradually from inorganic molecules, with "building blocks" like amino acids forming first and then combining to make complex polymers. The Miller-Urey experiment provided the first evidence that the organic molecules needed for life could be formed from inorganic components.[6] Some scientists support the RNA world hypothesis, which suggests that the

[4] You, JS. (2023a)
[5] Genesis 1:1-3, *Study Bible*, English Standard Version, Crossway: Wheaton, Illinois, 2008
[6] In 1924 a Russian scientist named Alexander Oparin and, in 1929, an English scientist named J. B. S. Haldane, proposed that life arose from inorganic matter mixed with other compounds (known as the *primordial soup*) under an oxygen-deprived (reducing) atmosphere and gradually evolved into more complex organisms over time. This is known as the Oparin-Haldane or heterotrophic theory of the origin of life. They suggested that this inorganic matter may have experienced reactions caused by lightning that resulted in the formation of amino acids and other important building blocks for the formation of life, thus creating the primordial soup. Reactions within this primordial soup could have then allowed for the formation of molecules of greater complexity, such as proteins, and eventually evolution into complex organisms.

first life was self-replicating RNA[7]. Other ideas include the pre-RNA world hypothesis and the metabolism-first hypothesis. Organic compounds could have been delivered to early Earth by meteorites and other celestial objects. The deep-sea vents theory is still another theory on the subject[8] for which empirical evidence is still lacking.

III. THE ECONOMIC PRINCIPLE OF MINIMIZATION OR MAXIMIZATION OBSERVED IN NATURE

Evidence seems to suggest that the driving force behind all activities of animals and plants and indeed all organisms in the organic world including humans is economic in nature. Their behaviors seem to be driven by the objective of constrained dynamic optimization under the environmental constraints they are faced with, i.e., that they behave rationally. The evidence for this proposition is rooted in a wide range of observations on the behaviors of many plants and animals and indeed in how their genome is organized and functions. Behaviors of the colonies of ants and bees are good examples of what may be characterized as constrained dynamic optimization resulting in efficient decentralized decision making as are the trees in the forest (You, 2023a). Recent research seems to suggest that the motive of economic efficiency underlies the origin of life itself as life can be viewed as the *inevitable spontaneous outcome* of *economically efficient* energy-dissipation-driven organization of matters along the evolutionary path of increasing entropy production.

Recently reported research findings in geophysics and biophysics strongly suggest that the origin of life on Earth was an inevitable outcome of the tendency of increasing entropy or the second law of thermodynamics (Michaelian, 2011; England, 2013). According to this view, the principle driving the origin of life on Earth is energy-dissipation-driven adaptation of matter. To borrow Michaelian's words: "Understanding the thermodynamic function of life may shed light on its origin. Life, as are all irreversible processes, is contingent on entropy production. Entropy production is a measure of the rate of the tendency of Nature to explore available microstates. The most important irreversible process generating entropy in the biosphere and, thus, facilitating this exploration, is the absorption and transformation of sunlight into heat. Here we hypothesize that life began, and persists today, as a catalyst for the absorption and dissipation of sunlight on the surface of Archean seas." "RNA and DNA are the most efficient of all known molecules for absorbing the intense ultraviolet light that penetrated the dense early atmosphere and are remarkably rapid in transforming this light into heat in the presence of liquid water. From this perspective, the origin and evolution of life, inseparable from water and the water cycle, can be understood as resulting from the natural thermodynamic imperative of increasing the entropy production of the Earth in its interaction with its solar environment." In this view, life is a result of maximizing entropy production through a maximum dissipation of sunlight energy efficiently transforming it into heat. In other words, the molecules are driven by the fundamental forces of nature to solve the constrained dynamic optimization problems they are faced with. The result is an efficient maximization of entropy production which reflects what may be termed "the economic law of evolution," *economic in the sense of maximizing efficiency*. A similar view is advanced by England. According to England, "when a group of atoms is driven by an external source of energy (like the sun or chemical fuel) and surrounded by a heat bath (like the ocean or atmosphere), it will often gradually restructure itself in order to dissipate increasingly more energy." This could mean that under certain conditions, matter inexorably acquires the key physical attribute associated with life.

[7]The "RNA world" theory states that life may have begun with molecules of RNA (Ribonucleic acid), which are able to perform self-replication and catalyze reactions. Over time, these molecules evolved to become more complex organisms.

[8]The deep-sea vents theory involves deep-sea hydrothermal vents, which are geologic structures that spew molecules that have abundant hydrogen. Billions of years ago, these molecules may have then clumped together and experienced chemical reactions, which may have resulted in the emergence of life. The world's oldest fossils, containing microorganisms and dating to between 3.8 and 4.3 billion years old, were discovered in hydrothermal vents in Quebec in 2017.

From the standpoint of physics, there is one essential difference between living things and inanimate clumps of carbon atoms: The former tend to be much better at capturing energy from their environment and dissipating that energy as heat. A plant, for example, is much better at capturing and routing solar energy through itself than an unstructured heap of carbon atoms. Thus, under certain conditions, matter will spontaneously self-organize. This tendency could account for the internal order of living things and of many inanimate structures as well." England observes: "Snowflakes, sand dunes and turbulent vortices all have in common that they are strikingly patterned structures that emerge in many particle systems driven by some dissipative process."

It is worthwhile remembering the different functions of RNAs and DNAs. The main function of DNA is to store and replicate genetic information, while RNA's main function is to copy DNA's genetic information to build proteins needed for building the organs of the body. This genetic information accumulated and constantly updated throughout the process of economic natural selection is an outcome of the long evolutionary process since the beginning of life (You, 2023b). Contrary to popular understanding, the brain designed by the DNAs does not control the body functions but the body including the brain functions as an integral system of signals and responses without a central control. This is a highly efficient biological system with decentralized signaling and responses – a product of economic natural selection. Any biological system designed to be controlled by a central command would not have the kind of flexibility and adaptability required for survival in the constantly and often unpredictably changing environment. This is akin to a highly efficient economic system:

"The illusion that economies run better if somebody is in charge of them – and decides what gets manufactured where and by whom – has done devastating harm to the wealth and health of peoples all over the world, not just in the former Soviet Union, but in the west as well. From the Roman Empire to the European Union, centralized decisions about what to invest in have been disastrously worse than the decentralized chaos of the market." (Ridley, 1999).

IV. CONCLUSION

Economists believe that most theories in economics, if not all, can be formulated in terms of minimization or maximization of a suitable economic quantity (Samuelson, 1947). Recent researches in geophysics and biophysics have revealed convincing evidence that the principle driving the origin of life on Earth is energy-dissipation-driven adaptation of matter (Michaelian, 2011, and England, 2013). In this view, life is a result of maximizing entropy production through a maximum dissipation of sunlight energy efficiently transforming it into heat. This implies that in a fundamental sense it is the economic forces that are responsible for the creation of life on Earth. To be more accurate, it is the physical forces based on the second law of thermodynamics driven by the fundamental economic forces of maximizing entropy along the evolutionary path of the universe that are responsible for the origin of life on Earth. This is not surprising considering the fact that the behaviors of most animal and plant species including their genome itself can be explained in terms of constrained dynamic optimization producing efficient outcomes through decentralized signaling and responses (You, 2023a). It is highly unlikely that the similarities between the efficient biological system and the efficient economic system, both with efficient decentralized signaling and responses, are merely coincidental. After all, there exists a persuasive thermodynamic imperative that the origin of life was a result of economically efficient maximizing of entropy production through a maximum dissipation of sunlight energy driven by the fundamental economic forces along the evolutionary path of the universe. The strength of the Michaelian-England hypothesis is the spontaneity and inevitability nature of energy-dissipation-driven adaptation of matter as the principle driving the origin of life without having to rely on the possible involvement of an external source such as meteorites or other celestial objects or on the probabilistic nature of the deep-sea vents hypothesis for which empirical evidence is lacking.

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