mybiology

Norah Jones

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Preface

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1 Introduction

The concept of evolution, in the sense of a gradual development or change over time, has been a subject of contemplation and inquiry for civilizations throughout history. While ancient civilizations may not have had access to the scientific methods and knowledge that underpin modern evolutionary theory, they did observe and speculate about patterns of change in the natural world. For example:

1. **Ancient Greece**: The ancient Greek philosophers contemplated the origins and development of life, the diversity of species, and the process of change in the natural world, proposing early ideas that laid the groundwork for later theories of evolution. The pre-Socratic philosofer Anaximander proposed a theory of evolution where life originated from a primordial substance, the "apeiron", which evolved over time through a process of spontaneous generation and transformation. He speculated that simpler forms of life gave rise to more complex organisms, anticipating the idea of a progression or development of species. Almost one hundred years later, Empedocles in his *Theory of the Four Elements* proposed that all matter was composed of four fundamental elements - earth, air, fire, and water. He suggested that living organisms arose from combinations of these elements, hinting at a process of transformation and change over time.2. **Aristotle (384 − 322 BCE)**: Aristotle proposed a scala naturae (Great Chain of Being), which depicted a hierarchical order of existence with all living beings arranged in a graded scale from simple to complex. While not a theory of biological evolution, Aristotle's ideas influenced later thinkers and shaped medieval and early modern views of nature. Atomist philosophers such as Leucippus and his student Democritus proposed a materialistic view of the universe, suggesting that all phenomena could be explained in terms of interactions between atoms. While their ideas differed from modern evolutionary theory, their emphasis on naturalistic explanations contributed to humanity's ongoing quest to understand the origins and development of life on Earth, and opened the possibility of variation and change in living organisms.

2. **Ancient India and China**: Ancient Indian and Chinese philosophies also explored ideas related to the origins and development of life. For instance, Hindu and Buddhist cosmologies include concepts of cyclical time and reincarnation, which imply a process of change and evolution, and they are early attempts to understand the natural world and humanity's place within it. While not explicitly addressing biological evolution, Daoist texts such as the "Zhuangzi" and the "Dao De Jing" contained passages that reflected a cyclical view of time and the continuous transformation of the natural world. Central to the Chinese cosmology is the Yin-yang theory, which posited the dynamic interplay

between opposing forces. This concept of balance and change informed Chinese views of the natural world, including notions of growth, decay, and cyclical renewal. While early Buddhist texts did not discuss biological evolution, the idea of continual change and the cycle of birth and rebirth suggested a broader understanding of evolutionary processes. Hindu cosmology, as outlined in texts such as the "Puranas" and the "Bhagavad Gita," described cycles of creation, destruction, and rebirth spanning vast epochs of time. The concept of "yugas" or cosmic ages implied a process of change and evolution within the universe.

3. **Islamic Golden Age**: During the Islamic Golden Age, scholars like Al-Jahiz in the 9th century proposed a rudimentary form of natural selection in his work "Kitab al-Hayawan" (Book of Animals), where he speculated about how organisms compete for resources and adapt to their environments, suggesting that those best suited to their surroundings are more likely to survive and reproduce. Muslim philosophers such as Al-Kindi, Al-Farabi, Avicenna (Ibn Sina), and Averroes (Ibn Rushd) engaged in philosophical speculation and inquiry, drawing upon Greek, Persian, and Indian sources. They explored concepts such as the eternity of the universe, the nature of causality, and the possibility of spontaneous generation. Islamic scholars, including physicians, astronomers, and natural philosophers, observed and studied the natural world, including plants, animals, and celestial phenomena. While their inquiries focused primarily on practical and empirical aspects of nature, they contributed to a broader understanding of the diversity and complexity of life.

4. **Indigenous Cultures**: Indigenous cultures around the world often developed rich and diverse cosmologies, creation myths, and oral traditions that reflected their understanding of the origins and development of life, and about the diversity of species. These stories usually include elements of change, adaptation, and transformation over time, and offer unique insights into humanity's relationship with the natural world. Many indigenous cultures viewed time as cyclical rather than linear, with recurring patterns of creation, destruction, and renewal. This cyclical perspective encompasses the idea of continual change and transformation in the natural world, including the evolution of species over time. Some indigenous cultures have interpreted fossils, geological formations, and natural phenomena in ways that reflect their cosmological beliefs and spiritual worldviews. These interpretations differ from Western scientific explanations but provide cultural perspectives on the history and diversity of life on Earth.

While these historical perspectives on evolution greatly differ from modern scientific understanding, they reflect humanity's curiosity and attempts to make sense of the natural world and its processes of change. The development of modern evolutionary theory represents a culmination of centuries of scientific inquiry, observation, and experimentation, building upon and refining earlier ideas and insights.

In the centuries preceding Charles Darwin's formulation of the theory of evolution by natural selection, several thinkers proposed ideas and concepts that contributed to the development

of evolutionary thought. Some of the main thinkers of evolution in pre-Darwinian times include:

3. **Lucretius (c. 99 – c. 55 BCE)**: A Roman poet and philosopher, Lucretius wrote "De Rerum Natura" (On the Nature of Things), in which he espoused a form of atomism and proposed ideas about the origins and development of life through natural processes.
4. **Georges-Louis Leclerc, Comte de Buffon (1707 – 1788)**: Buffon, a French naturalist, proposed theories of transmutation and transformation of species in his work "Histoire Naturelle" (Natural History). He suggested that environmental influences could lead to changes in organisms over time.
5. **Jean-Baptiste Lamarck (1744 – 1829)**: Lamarck, a French naturalist, proposed a theory of evolution based on the inheritance of acquired characteristics. He suggested that organisms could change over time in response to environmental pressures, and these acquired traits could be passed on to offspring.
6. **Erasmus Darwin (1731 – 1802)**: Erasmus Darwin, an English physician, naturalist, and grandfather of Charles Darwin, proposed evolutionary ideas in his work "Zoonomia" and other writings. He suggested that life evolved from simpler to more complex forms through a process of gradual transformation.

These thinkers and others contributed to the development of evolutionary thought in pre-Darwinian times, laying the groundwork for Charles Darwin's theory of evolution by natural selection in the 19th century. While their ideas differed from modern evolutionary theory, they reflected early attempts to understand the origins and development of life on Earth.

In the centuries preceding the formulation of Charles Darwin's theory of evolution by natural selection, various ideas and concepts about the origins and development of life were proposed by philosophers, theologians, and naturalists. These pre-Darwinian ideas laid the groundwork for later evolutionary theories. Some of the main ideas about evolution in pre-Darwinian times include:

1. **Great Chain of Being**: The concept of the Great Chain of Being, prevalent in ancient Greek, Roman, and medieval Christian thought, posited a hierarchical order of existence, with God at the pinnacle and all living beings arranged in a graded scale from simple to complex. While not a theory of biological evolution, it implied a continuum of life forms and the potential for change over time within a fixed, predetermined framework.
2. **Transformational Theories**: Some ancient philosophers, such as Empedocles and Anaximander, proposed ideas of transformation and change in the natural world, suggesting that living organisms arose from combinations of fundamental elements or evolved from simpler forms over time.

3. **Vitalism**: Vitalism, a prominent idea in the medieval and early modern periods, proposed that living organisms possessed a vital force or essence that distinguished them from inanimate matter. While not explicitly evolutionary, vitalistic concepts contributed to debates about the nature of life and its origins.

4. **Spontaneous Generation**: Spontaneous generation, the belief that living organisms could arise from non-living matter under certain conditions, was a widespread idea in antiquity and the Middle Ages. This notion suggested a form of continuous generation and transformation of life forms but did not imply a process of biological evolution as understood today.

5. **Transmutation of Species**: Some naturalists in the 17th and 18th centuries, such as Jean-Baptiste Lamarck, proposed theories of transmutation or transformation of species. Lamarck's theory, for example, suggested that organisms could change over time in response to environmental pressures and that acquired traits could be passed on to offspring.

Overall, these pre-Darwinian ideas about evolution reflected early attempts to understand the diversity and complexity of life on Earth. While they did not constitute a comprehensive theory of biological evolution, they contributed to the intellectual foundations upon which Darwin later built his groundbreaking theory of natural selection.

2 Introduction

The main problem that trigger the need to search for a new analytical approach is the strongly established position of "profit maximization" as a fundamental concept that drives our understanding of the behavior of the firm.

According to the conceptualization of "profit maximization" decisions are made in a strictly rational manner by units that seek to maximize the benefits obtained.

The economic analysis literature of the first half of the 20th century is full of references to these profit-maximizing bases (Robinson 1969), a way of thinking about economics that reaches its zenith in Samuelson's famous quote "The very name of my subject, economics, suggests economizing or maximizing" (Samuelson 1972).

This does not mean that throughout this period of time there have been no authors who have questioned the entire conceptual and analytical apparatus around "profit maximization". In fact, there are a plethora of them.

Authors like Tintner (1941) who go so far as to state outright that maximization makes no sense in an environment full of uncertainties (a precondition for profits) that are produced by the inability of human beings to solve complex problems involving a host of variables, and imperfect foresight. According to the author, maximization cannot be used as the basis for selecting the action that will produce the result with the greatest profits over all other actions.

2.1 Individual vs system decisions

Alchian (1950) proposes an alternative method to solve this whole problem. It consists of treating decisions and selection criteria at the level of the economic system as more important than those made by individuals within it. This allows us to look at the interrelationship that exists between the environment and the individual behaviors that arise as a consequence of a process of natural selection.

The decision criterion in the firm's behavior is now the realization of profits, which in turn acts as a (natural) selection mechanism that allows some firms to survive while others disappear. This decision and selection process takes place in impersonal markets, which are completely separate from individual decisions, from the capabilities and motivations of the units that

decide, and even from their awareness of the functioning of this criterion. Simply realizing positive profits is enough to make a firm survive, no matter how, who or why it is achieved.

Alchian (1950) recognizes that the realization of positive benefits may go to the most daring or lucky, not necessarily to those who are best prepared or carry out a process of strong reasoning, preparation and execution. Therefore, a specific motivation is not strictly necessary for the firm to survive, since "as in a race, the award goes to the relatively fastest, even if all the competitors loaf".

2.2 Adoption Behavior: Chance and Luck as a means for success

Luck and chance can act in two ways: first when choosing an action to apply and its viability to realize benefits, second when deciding on a specific method of adaptation to a particular environment (Alchian 1950).

In this discussion, the debate arises about to what extent it is the survivor who manages to adapt to the environment, or whether it is the environment that actually adopts the survivor. In the first case, the adaptation process is something conscious. In the second, the survivor does not carry out any motivated or conscious process of change in search of adaptation, but rather it is the environment that adopts him.

In reality, it is the environment that determines the possible paths to success, or in other words, the path that a survivor must follow to become one. These paths are constantly changing, and what at a given moment in time made some individuals successful and others not, some time later it will make those who were previously unlucky now successful and able to survive (Alchian 1950).

In the context of adoption by the environment, the individual doesn't really need to do anything, other than want to play this game (that is, making a decision when it is necessary to make it). According to Alchian himself, this somewhat random behavior that individuals may have does not eliminate the possibility that the decision made by one of them is appropriate for survival. Additionally, individual behavior resulting from motivation and foresight is always different from one individual to another, and if the pattern of all individuals is observed in aggregate, it is not very different from a random distribution of actions.

A model dominated by chance also does not mean that it cannot be analyzed, explained and diagnosed by an economist. The economist can explain what types of behaviors are more likely to lead a firm to survive compared to others if he knows what the requirements for survival are, and without firms having to know what these requirements are, even more so if the objective is to explain what happened in the past rather than making a prediction. "The essential point is that individual motivation and foresight, while sufficient, are not necessary" (Alchian 1950).

With regards to the methods of analysis that can be used by economists, the analyst will only need some circumstances (economic environment) and some participants (firms) to diagnose the conditions under which they will be most likely to be successful.

2.3 Adaptive Behavior: Imitation and Trial and Error

Everything said above does not mean that firms do not act with foresight and purpose-oriented motivations. In reality, Alchian's proposal is made up of both elements, the random and the purposeful. "The pursuit of profits, and not some hypothetical undefinable perfect situation, is the relevant objective whose fulfilment is rewarded with survival" (Alchian 1950).

That said, aiming to realize positive profits does not mean that it is easier to conclude about how firms can adopt actions that realize profits. This is a very high goal too. The existence of uncertainty diverts any effort to successfully conclude what the recipe for success is.

Adaptive firm behavior occurs in two ways: by imitating the things that work in successful companies (so that those who imitate them can quickly implement them and achieve success more quickly) and by trial and error. This is what Alchian calls "codified imitations of observed success" (Alchian 1950). This type of behavior relieves the need to make decisions and make conscious innovations.

The second type of adaptive behavior pointed out by Alchian is trial and error. Some authors consider that through the firm's adoption of various appropiate actions the trend is the convergence to a "profit maximization" equilibrium. However, in a changing environment, this is simply not possible since the comparability of resulting situations is destroyed. Trial-and-error is simply survival or death, but not the basis for a profit-maximization method of analysis.

2.4 Tools

"All the preceding arguments leave the individual economic participant with imitative, venturesome, innovative, trial-and-error adaptive behavior. Most conventional economic tools and concepts are still useful, although in a vastly different analytical framework-one which is closely akin to the theory of biological evolution" (Alchian 1950).

"The economic counterparts of genetic heredity, mutations, and natural selection are imitation, innovation, and positive profit" (Alchian 1950).

"The formalization of this approach awaits the marriage of the theory of stochastic processes and economics-two fields of thought admirably suited for union" (Alchian 1950).

2.5 Implications

"(…) the prevalence of a type of behavior depends upon both this probability of viability and the probability of the different types being submitted to the economic system for testing and selecting" (Alchian 1950). "One is the probability of appearance of a certain type of organization (mutation), and the other is the probability of its survival or viability, once it appears (natural selection). There is much evidence for believing that these two probabilities are related" (Alchian 1950).

"In summary, I have asserted that the economist, using the present analytical tools developed in the analysis of the firm under certainty, can predict the more adoptable or viable types of economic interrelationships that will be induced by environmental change even if individuals are unable to ascertain them" (Alchian 1950).

"Like the biologist, the economist predicts the effects of environmental changes on the surviving class of living organisms; the economist need not assume that each participant is aware of, or acts according to, his cost and demand situation" (Alchian 1950).

3 Reasons

Alchian Alchian (1950) submits that there is a double reason to ask for a new economic analysis. These are an incomplete information in the functioning of the economic system and uncertain foresight. The latter recognizes the role of prediction that every economic analysis must play if it's to be good.

This vision proposed by Alchian in 1954 moves away from the typical axiom of **"profit maximization"** and the prediction of the individual behavior of the firm as primary means for understanding the behavior of the firm. Instead, Alchian provides a solution by suggesting the adoption of biological evolution and natural selection as thinking paradigms. The introduction of this new approach allows Alchian to treat an economic system as an adaptive "mechanism" able to choose among those "(…) exploratory actions generated by the adaptive pursuit of"success" or "profits"."

"The assumption that firms try to maximize their profits is rejected by Alchian, not for empirical reasons arising from a study of how firms actually do behave, but for logical reasons arising from the existence of uncertainty. He holds that in the presence of uncertainty no unique maximum profit position exists; that it is therefore impossible to give any meaning to the proposition that firms try to maximize profits; and that, consequently, a mere desire for maximum profits provides no guide for action. On the other hand, he is pre- pared to admit"motivated purposive behavior" and to recognize that firms are in business to make a profit, although apparently he feels that even this modified motivation is going a bit far.

Once it is allowed that firms do try to make profits, it is not difficult to go a bit further and assume that in general they tend to try to make, if they think they can, a bit more profit than they are making. The question, then, is what difference does it make whether any individual firm knows the best way of going about its business - or indeed whether there is any "best" way before the event. This would make a great deal of difference if the economist were attempting to predict the actions of any particular firm. But the economist does not attempt such predictions - nor could he succeed if he tried, as Alchian rightly emphasizes. **The economist uses the model of the profit-maximizing individual firm, not to predict the actual conduct of any firm, but merely as an analytical technique to assist him in understanding the effect of change on prices, production, employment, etc.** For this purpose it makes no difference whether the conduct of any particular firm can be predicted, whether any firm at all can actually succeed in maximizing profits or even whether uncertainty makes it impossible to say that any particular profit is a maximum" (Edith T. Penrose 1953) En realidad lo que está diciendo aquí Penrose es que sus dos enfoques, el suyo y el de Alchian, se

parecen más de lo que parece porque ambos tratan de servir como instrumentos para explicar el comportamiento de la firma, no para predecir la conducta de la firma.

"Attempts radically to alter the framework of existing theory are always likely to meet resistance, but progress comes from the interaction between innovation and resistance to innovation" (Edith T. Penrose 1953)

A valuable benefit of this new perspective is that economic analysts can, according to Alchian, now confront problems that were previously considered aberrant or that required an ad-hoc analytical apparatus.Ultimately, it is an approach that widens the capabilities of economic analysis and prevents the analyst from having to introduce unrealistic assumptions to reach any coherent result.

However, Alchian's innovative approach remains half-finished because he assumes that he will continue using the same conceptual apparatus of his analytical predecessors. That is to say, the same concepts used in the type of analysis based on profit maximization seem to continue serving under its new perspective.

"Thus a certain elementary theoretical function (i.e. prices and demand) seems adequately to describe actual hu- man behavior; other elementary functions may describe technological facts, such as production conditions. Our task is to explain, in terms of such elementary relations, other more complicated ones which we also observe" "Cita del autor: R. Bye said (p. 282):"The ultimate justification of all science is the power it gives us to make things go the way we want them to." Whether ultimate or not, it is an important object of science. "(Marschak 1941)

"

4 Social Scieces

EStas son las ciencias sociales que se han visto afectadas por el papel de la biología:

4.1 Antropología

4.2 Psicología (o Developmental Psychology)

Según esta visión, el desarrollo psicológico es el resultado of heredity and environment.

4.2.1 Hebbian theory

"On another note, the long-standing notion"cells that fire together, wire together" derives from **Hebbian theory** which asserts that synaptogenesis, a developmental process with great epigenetic precedence, depends on the activity of the respective synapses within a neural network. Where experience alters the excitability of neurons, increased neural activity has been linked to increased demethylation.[28]" (wikipedia, epigenetics)

"Hebbian theory is a neuropsychological theory claiming that an increase in synaptic efficacy arises from a presynaptic cell's repeated and persistent stimulation of a postsynaptic cell. It is an attempt to explain synaptic plasticity, the adaptation of brain neurons during the learning process. It was introduced by Donald Hebb in his 1949 book The Organization of Behavior (…)"Cells that fire together wire together" (…) Hebb emphasized that cell A needs to "take part in firing" cell B, and such causality can occur only if cell A fires just before, not at the same time as, cell B (…)"

"The theory attempts to explain associative or Hebbian learning, in which simultaneous activation of cells leads to pronounced increases in synaptic strength between those cells. It also provides a biological basis for errorless learning methods for education and memory rehabilitation. In the study of neural networks in cognitive function, it is often regarded as the neuronal basis of unsupervised learning." (Hebb 2005) [1]" (https://en.wikipedia.org/wiki/Hebbian_theory)

4.2.2 Erik Erikson

A revisar Erik Erikson y su visión sobre las etapas de desarrollo evolutivo psicosocial.

"Favorable outcomes of each stage are sometimes known as virtues, a term used in the context of Erikson's work as it is applied to medicine, meaning"potencies". These virtues are also interpreted to be the same as "strengths", which are considered inherent in the individual life cycle and in the sequence of generations.[57] " (wikipedia, Erik Erikson)

"a comprehensive psychoanalytic theory that identifies **a series of eight stages** that a healthy developing individual should pass through from infancy to late adulthood (…) the results at each stage, either positive or negative, influence the results of the succeding stage" (wikipedia, Erikson's stages of psychosocial development)(Erikson 1993)

"He began by working with Freud's theories specifically, but as he began to dive deeper into biopsychosocial development and how other environmental factors affect human development, he soon progressed past Freud's theories and developed his own ideas (…) Erikson's stage theory characterizes an individual advancing through the eight life stages as a function of negotiating their biological and sociocultural forces.[6] The two conflicting forces each have a psychosocial crisis which characterizes the eight stages. If an individual does indeed successfully reconcile these forces (favoring the first mentioned attribute in the crisis), they emerge from the stage with the corresponding virtue (…) The stage challenges that are not successfully overcome may be expected to return as problems in the future. However, mastery of a stage is not required to advance to the next stage." (https://en.wikipedia.org/wiki/Erikson%27s_stages_of_psychosocial_development)

4.3 Economía y Negocios

4.4 Sociología

5 Analogies

5.1 Why Analogies?

"Economics may gain much, as it already has, from the concepts and methods of analysis of other disciplines." (Alchian 1950)

"The purpose of analogical reasoning in which we consciously and systematically apply the explanation of one series of events to another very different series of events is to help us better to understand the nature of the latter, which presumably is less well understood than the former. If the analogy has really helpful explanatory value, there must be some reason for believing that the two series of events have enough in common for the explanation of one, mutatis mutandis, to provide at least a partial explanation of the other. This type of analogy must be distinguished from the purely metaphorical analogy in which the resemblances between two phenomena are used to add a picturesque note to an otherwise dull analysis and to help a reader to see more clearly the outlines of a process being described by enabling him to draw on what he knows in order to imagine the unknown. Analogies of this sort are not only useful but almost indispensable to human thought.The biological analogies of the firm are not of this metaphorical type or there would be no call to push them into service to help explain the development of firms" (Edith Tilton Penrose 1952)

"In the notion that a firm is an organism akin to biological organisms, there is an implication that, since all such organisms have something in common, we can use our knowledge of biological organisms to gain more insight into the firm" (Edith Tilton Penrose 1952)

"The characteristic use of biological analogies in economics is to suggest explanations of events that do not depend upon the conscious willed decisions of human beings. This is not, of course, characteristic of biology as such, for some branches of biology are concerned with learning processes and decision making, with purposive motivation and conscious choice in men as well as animals. In this, biology overlaps sociology and psychology and, in a sense, even economics. Information drawn from these branches of biology can be useful in helping us to understand the behavior of men and consequently of the institutions men create and operate. **In using such information, however, we are not dealing with analogies at all, but with essentially the same problems on a more complex scale**. But, paradoxically, where explicit biological analogies crop up in economics they are drawn exclusively from that aspect of biology which deals with the non-motivated behavior of organisms or in which motivation does not make any difference." (Edith Tilton Penrose 1952). **The use value of the biological analogy is found not in its metaphorical value, nor even in the use of**

the analogy itself, but in that it constitutes the lower level of the complex analysis suite from which emanates the behavior of individuals and the societies at a much higher level of analysis.

"The desire to draw biological concepts into the explanation of social affairs is hard to understand since for the most part they add to rather than subtract from the difficulties of understanding social institutions (…). The appeal of such biological analogies to the social scientist plainly springs from a persistent yearning to discover"laws" that determine the outcome of human actions, probably because the discovery of such laws would rid the social sciences of the uncertainties and complexities that arise from the apparent "free will" of man and would endow them with that more reliable power of prediction which for some is the essence of "science." (Edith Tilton Penrose 1952)

"It should be noted that the distinction to be made is not that between human and non-human beings but between actions that are in some degree bound up with and determined by a reasoning and choosing process, no matter how rudimentary, and actions that are, as it were,"built into" the organism, or into the relationship between the organism and its environment, and cannot be altered by conscious decision of the organism itself." (Edith Tilton Penrose 1952)

"The information that we possess about the behavior of firms, small as it is, does furnish us with some plausible explanation of what firms are trying to do and why. **Biological explanations reduce, if they do not destroy, the value of this information and put nothing in its place**" (Edith Tilton Penrose 1952)

"The varieties of biological phenomena are so numerous that a parallel may be found somewhere for every conceivable type of social situation. There is even apparently a type of symbiotic growth among algae and fungi which combine to form characteristic lichens that can be compared to the growth of a firm by merger. Very curious"parallels" are sometimes drawn" (Edith Tilton Penrose 1952)

"But in seeking the fundamental explanations of economic and social phenomena in human affairs the economist, and the social scientist in general, would be well advised to attack his problems directly and in their own terms rather than indirectly by **imposing** sweeping biological models upon them" (Edith Tilton Penrose 1952)

5.2 Main Types of Biological Analogies

"Biological analogies in particular have been widely used in discussions of the firm. Probably the best known and most common of these analogies is that of the **life cycle**, in which the appearance, growth and disappearance of firms is likened to the processes of birth, growth, and death of biological organisms. Marshall's reference to the rise and fall of the trees in the forest is an oft-quoted example of this type of analogy." (Edith Tilton Penrose 1952)

"Recently, two additional biological analogies have been presented -**a natural selection analogy**, dubbed by one writer viability analysis, and the **homeostasis analogy** designed to explain some aspects of the behavior of firms. The former, like the life cycle analogy, is for use in long-run analysis only. The latter is exclusively for short-run analyIn summary, this book has no content whatsoever. Both are supposed to represent improvements on the existing theory of the firm at the core of which lies the chief target of attack - the assumption that firms attempt to maximize profit" (Edith Tilton Penrose 1952)

"The chief danger of carrying sweeping analogies very far is that the problems they are designed to illuminate become framed in such a special way that significant matters are frequently inadvertently obscured. Biological analogies contribute little either to the theory of price or to the theory of growth and development of firms and in general tend to confuse the nature of the important issues." (Edith Tilton Penrose 1952)

5.3 The "Life Cycle" Theory of the Firm (Kenneth Boulding)

"Implicit in the notion that firms have a"life cycle" analogous to that of living organisms is the idea that there are "laws" governing the development of firms akin to the laws of nature in accordance with which living organisms appear to grow, and that the different stages of development are a function of age." (Edith Tilton Penrose 1952)

"The purposes a life cycle theory of the firm would serve are obvious, yet the theory as a bare undeveloped hypothesis has existed for a long time and nothing has been done to construct from it a consistent theoretical system with sufficient content to enable it to be used for any purpose whatsoever. The basic hypothesis is not one from which significant logical consequences can be deduced, such as can be deduced,' for example, from the proposition that firms attempt to maximize profits. Supplementary hypotheses about the kind of organism the firm is and the nature of its life cycle are required. Although we have a respectable collection of information about firms, it has not stimulated economists even to suggest the further hypotheses necessary to the development of a life cycle theory of the firm. This, I think, is primarily because the available evidence does not support the theory that firms have a life cycle characterized by a consistent transition through recognizable stages of development similar to those of living organisms. Indeed, just the opposite conclusion must be drawn: the development of firms does not proceed according to the same"grim" laws as does that of living organisms. In the face of the evidence one is led to wonder why the analogy persists and why there is still a demand for a life cycle theory of the firm" (Edith Tilton Penrose 1952).

"Clearly the one thing a firm does not have in common with biological organisms is a genetic constitution, and yet this is the one factor that determines the life cycle of biological organisms." (Edith Tilton Penrose 1952) In this regard, see the use of the genetic analogy made by Nelson and Winter's Nelson (1985) regarding what constitutes the genetic basis of the firm by assimilating it to the skills and abilities the firm posseses and that are transmitted from one employee to another in an evolutionary process along time.

Willingness vs Not Willingness (Motivated vs Non-Motivated Behavior) in the growth pattern of the firm: "We have no reason whatsoever for thinking that the growth pattern of a biological organism is willed by the organism itself. On the other hand, we have every reason for thinking that the growth of a firm is willed by those who make the decisions of the firm and are themselves part of the firm, and the proof of this lies in the fact that no one can describe the development of any given firm or explain how it came to be the size it is except in terms of decisions taken by individual men" (Edith Tilton Penrose 1952). Sorry but I disagree. This statement conflicts with the perspective provided by Alchian Alchian (1950), according to which the behavior of the firm has an adoptive part (not linked to the will of the units that make the decisions in the firm), and an adaptive part (which does depend on the willpower of decision-makers).

"There can be no doubt, I think, that to liken a firm to an organism and then attempt to explain its growth by reference to the laws of growth of biological organisms is an ill-founded procedure (…) besides being ill-founded, this type of reasoning about the firm obscures, if it does not implicitly deny, the fact that firms are institutions created by men to serve the purposes of men. It can be admitted that to some extent firms operate automatically in accordance with the principles governing the mechanism constructed, but to abandon their development to the laws of nature diverts attention from the importance of human decisions and motives, and from problems of ethics and public policy, and surrounds the whole question of the growth of the firm with an aura of"naturalness" and even inevitability." (Edith Tilton Penrose 1952). No one, not even Alchian, rests the firm's growth on a strictly "natural" conception, but rather on a combination between what is natural and what is directed by humans through their decisions.

"My original criticism of the"viability" analysis was simply that it gives an inadequate and inconsistent account of the significance of human motivation in economic affairs. (This is precisely the reason, incidentally, why the biological model fitted it so well" (Edith Tilton Penrose 1952)

5.4 The Natural Selection (Viability) Analogy

"The idea of the survival of the fittest, however, was first suggested to Darwin by a work in the social sciences-Malthus on population." (Edith Tilton Penrose 1952)

"The purpose of the theory is to get around a logical difficulty alleged to be inherent in the assumption that firms attempt to maximize profits in a world characterized by uncertainty about the future. If uncertainty exists, firms cannot know in advance the results of their actions. There is always a variety of possible outcomes, each of which is more or less probable. Hence the expected outcome of any action by a firm can only be viewed as a distribution of possible outcomes, and it is argued that while a firm can select those courses of action that have an optimum distribution of outcomes from its point of view, it makes no sense to say that the firm maximizes anything, since it is impossible to maximize a distribution.

Hence profit maximization as a criterion for action is regarded as meaningless. According to the"viability analysis," however, this is not a serious difficulty for the economist if he draws on the principle of natural selection and considers the adaptation required of firms by their environment." (Edith Tilton Penrose 1952)

"The alleged superiority of"viability" over marginal analysis lies in the claim that it is valid even if men do not know what they are doing. No matter what men's motives are, the outcome is de- termined not by the individual participants, but by an environment beyond their control. Natural selection is substituted for purposive profit-maximizing behavior just as in biology natural selection replaced the concept of special creation of species." (Edith Tilton Penrose 1952)

"To be sure, the two assumptions rest on vastly different factual foundations and should not be treated as analogous. We can only say that there is some evidence that such a psychological motivation is widely prevalent and that we have found we can obtain useful results by assuming it. If we abandon this assumption, and particularly if we assume that men act randomly, we cannot explain competition, for there is nothing in the reproductive processes of firms that would ensure that more firms would constantly be created than can survive; and certainly from observations of the real world we can hardly assume that competition is so intense that zero profits will result in the long run or that only the best adapted firms can survive."(Edith Tilton Penrose 1952)

"Underlying the viability analysis is the assumption that, even if firms can and do make more or less intelligent choices, they can do nothing in unpredictable ways to"force" the environment to "adopt," and thus make successful, the results of their action. The concept of the environment of firms on which the economist using "viability" analysis bases his predictions is by no means clear." (Edith Tilton Penrose 1952)

"It is these unpredictable possibilities of altering the environment by man that create difficulties in comparing the economist to the biologist observing the processes of natural selection and studying the nature of adaptation. Animals, too, alter their environment, but in a rather unconscious fashion without much deliberation about different probable outcomes of their actions. **The possibilities open to animals of affecting their environment in a given period of time are so much more restricted than those open to men that the biologist has a very much easier task, for the relative consistency of animal behavior and the relatively narrow limits within which animals can act give him a more secure basis for prediction**." (Edith Tilton Penrose 1952)

"It is not possible to go very far with this aspect of the matter because the authors of the viability approach have given us no hint of what they mean by the environment. . It is vaguely referred to as an"adoptive mechanism" (…)" (Edith Tilton Penrose 1952)

"By its very nature a prediction of the kinds of firms that will survive in the long run must take account of all the reactions and interactions that a given change in the environment will induce. With our present knowledge this is impossible, and the assertion that"the economist, using the present analytical tools developed in the analysis of the firm under certainty, can

predict the more adoptable or viable types of economic interrelationships that will be induced by environmental change even if individuals themselves are unable to ascertain them" places the wrong interpretation on the kind of thing the economist can do. **If he can predict the consequences of environmental changes, it is not because certain types of interrelationships are more "viable" in a long-run sense, but because he has an idea of how people will behave**. He knows little about long-run viability since he knows very little about all of the secondary and tertiary reactions that will in the end determine the "conditions of survival"-at least he has as yet given little convincing evidence of such knowledge." (Edith Tilton Penrose 1952)

"After all, one of the more powerful effects of uncertainty is to stimulate firms to take steps to reduce it by operating directly on the environmental conditions that cause it and men have a greater power consciously to change their environment than has any other organism (…). It is by no means"straightforward" to assume non-motivation, for without motivation economic competition, leading to the elimination of all but the best adapted within a community, cannot be assumed. Hence, if the operation of natural selection through competition is made the guiding principle of the analytical technique, then an assumption equivalent to profit maximization must be made and the professed raison d'etre of the viability approach disappears." (Edith Tilton Penrose 1952)

5.5 The Homeostasis Analogy

"Organisms are so constructed that there is a certain"equilibrium" internal condition which their bodies are organized to maintain. Any disturbance of the equilibrium sets forces in motion that will restore it (…) Once again we find the characteristic of the biological analogy - action taking place in human affairs without the intervention of human decisions based on deliberation and choice."(Edith Tilton Penrose 1952)

"Homeostasis is a word drawn from physiology, but it describes a characteristic of any activity that takes place within a framework so constructed that certain types of action are automatically induced without any interference from whatever agency is responsible for the construction. This notion can be extended from the physio-chemical reactions which take place within a living organism in order to maintain a constant internal environment, to include the operation of a thermostatically controlled heating or air conditioning system36 and even the conduct of a game of tag according to predetermined rules." (Edith Tilton Penrose 1952)

". There can be little doubt that the more complex an organ- ization becomes, the more necessary it is to establish areas of quasi- automatic operation. The importance of routine as a means of taking care of some aspects of life in order that others may be given more attention has frequently been stressed. The fact that many business decisions are not"genuine decisions," but are quasi-automatic and made routinely in response to accepted signals without a consideration of alternative choices has misled many into attacking the assumption that firms try to make as much money as they can-particularly where it can be shown that the rules

governing the routine actions are not fully consistent with profit maximization" (Edith Tilton Penrose 1952)

"The theory of homeostasis provides a formal framework of explanation into which many routine responses can be fitted, but it throws no light at all - nor does it claim to- on why and how the"ideal" relationships between the relevant variables which the firm is now attempting to maintain were originally established or on the conditions under which decisions may be made to alter them. **Strictly speaking, the basic principle is not a biological one at all in spite of the name given it. It is a general principle of organization, examples of which may be found in biology, in mechanics and in social organization**, and if one chooses to introduce into economics another mysterious word borrowed from another science-well, that is a matter of taste"(Edith Tilton Penrose 1952)

6 Methodology

The methodology uses the bases of a meta-theory and meta-history, parting from a seminal work in that of Marshall. From there the author draws and follows a timeline with which a progress in the motivations and contributions made by biology in economics and business studies can be traced. - How a seminal work is defined? - How the author decides to entretain around a certain seminal work and the works around it?

The meta-analysis is nit exhaustive not complete, The conclusions are extracted once saturation is achieved.

7 Scheme

It is important to clearly establish the differences that distinguish an evolutionary process from another of change or transformation. Although these are related concepts in evolutionary theory, they actually denote different processes that act on different agents, which is why they tend to be confusing even among some specialists.

Evolution is an overarching process that drives change in populations over generations. This means that evolutionary processes do not operate at the level of a specific individual or organism, which would only change or transform. Evolution therefore represents the cumulative effect of the inherited changes made by the characteristics of the individuals of a population, on which a selection process operates affecting the frequency of traits within a population over time. Change encompasses a broad spectrum of morphological or behavioral alterations within individuals from a variety of factors, including environmental pressures and reproductive patterns. Transformation suggests more profound or significant shifts in form, structure or function of individuals.

ORIGIN

The problem of the origin is associated with that of the "Problem of Generation" and its accompanying theories of generation. An analysis of the origin involves the need to explore for evidence of the past in search for a better system. The following are some of the theories to consider when addressing the problem of generation of the original structure:

- Spontaneous generation
- Preformationism (forms that are predetermined)
- Pre-existence
- A mold that is fixed.

STRUCTURE

The main issue when considering Structure is to establish what the analytical unit of the system is (and what its main basic components are). In the case of natural evolutionary theory, this unit has traditionally been the organism, but also the population and later, after modern synthesis, the gene. It is the analyst's job to determine as clearly as possible which is the "unit" on which the evolutionary analysis of the system will focus.

ENVIRONMENT

The environment surrounding the chosen unit of analysis exerts various types of forces that act on the structure to provoke a process of change, with greater or lesser intensity, and in one direction or another.

The forces of change originating in the environment force the unit to change, so it is essential that the analyst analyze the environment in depth as a key impact driver, understanding the role of the environment in the evolutionary process of the system.

The connection between the environment and the origin is a key issue as well, since the direction of the change, if it exists, and the intensity or depth of the change that may take place in the structure of the unit may sometimes depend on it.

It is important when analyzing the environment to specify the type of force applied to the structure, and its sources in said environment.

BEHAVIOR

Behavior is the way in which the structure articulates a response to the pressure exerted by environmental forces. Behavior establishes the boundaries within which the structure is capable of absorbing the forces of the environment and giving an adaptive response to the new situation or challenge posed by the environment.

The result of the behavior, which takes place within the boundaries established by the structure of the unit, can give rise to three types of adaptive responses by the system:

- New system qualities (traits)
- Loss of system qualities (traits)
- Modification of system qualities (traits)

CHANGE

Both the structure and the behavior are permanently immersed in a process of change, since the unit is always sensitive to the forces exerted on it originating in the environment. The overall evolutionary process of the unit will depend on the way in which these forces affect the unit.

The characterization of the change process must be carried out considering the following key dimensions, all of them closely related:

1. The direction or trend of the change process. This question has historically been part of the discussion on evolutionary theory, with different approaches given by different authors.
2. The change driver, whether it is a single one or a set of drivers that configure the change process.
3. The mechanics of the process, whether gradual and slow, or sudden and in jumps, or any intermediate alternative in the continuum formed by these two extremes.

4. The time scale on which the change process takes place. This can develop over a vast amount of time or a small amount of time, or somewhere in between.

Some important considerations to keep in mind are that the process of change always implies progress, but it can also involve regression.

DISCUSSION

On the Origin

The idea of the Origin is consubstantially associated with the idea of an end, since everything that begins must necessarily have an end.

On the Environment

We do not know the forces (and their sources) that operate driving the process of change in the individuals of a population.

Apart from the forces that operate at the level of individuals, it is necessary to know what the transmission mechanisms are like from the environment to the individual, between individuals, and vice versa, from the individual to the environment.

What is the materiality of the pressure for change exerted by an environmental force?

On Change

We know what an individual is today, but we do not know how an individual became what it is today. This necessarily raises the need to study the historical past as a source of knowledge to understand the process of change or evolution followed.

It is necessary to know which components of the individual's structure (or flows) the forces of the environment act on, or on which behaviors the forces of the environment have an impact.

Also relevant is the question of how the development process of an individual is like, both before conception (embryonic development) and during its life period.

Does the change caused by forces in the environment respond to any reason or objective? Is there any direction, goal or trend? And if there is one, what is the justification for it to exist? Is there any type of constraint associated with the development of the individual that conditions or limits the process of change? Can we rule out that the individual's process of change does not have a teleological character (e.g. a guiding principle, a force, etc.) towards a specific end/goal?

To what extent is the timeline for the adoption of changes a key factor that determines the individual results of the change? It is key when analyzing change to elucidate the timeline in which it unfolds.

On Evolution

When studying the evolution of a population, classification or taxonomy becomes relevant, since it requires discipline in the knowledge of the building blocks and the relationships (or degrees of relationships) between individuals.This generally opens new avenues to trace (and understand) the past of evolution and be able to foresee the next steps it will go through.

8 Discussion

The introduction of Biology has these forms, el conjunto de las cuales muestra una línea creciente de aportación a la profundidad del análisis económico y al papel más ligero o pesado en el que interviene en la resolucion de problemas ccomplejos:

- **Biology as a theoretical framework**, sienta las bases conceptuales y relacionales sobre las que iniciar un análisis complejo en ciencias sociales y en economía. Se trata de un marco teórico que sirve de inspiración para afrontar una primera explicación o una ampliación de la explicación de un problema social complejo sin tener que recurrir a un largo proceso de construcción teórica. Esto no significa que la teoría biológica sea siempre asimilada por la económica, sino que esta última sirve como espejo sobre la que construir un andamiaje teórico de forma más robusta y rápida.
- **Biology as a metaphora**, esto nos permite mejorar la explicación de los fenómenos económicos y reforzar nuestros argumentos al utilizar cadenas causales que ya están investigadas y demostradas en biología
- **Biology as a paradigm**, nos permite enfrentar el análisis económico teniendo delante un marco causal ya demostrado que podamos usar como referencia, tanto en el uso de los conceptos como en los flujos de interacción entre ellos. Digamos que el análisis económico no parte de cero ni necesita inventar un adamiaje metodológico y conceptual cada vez, sino que podemos recurrrir a la biología para que nos aporte un marco de reflexión y pensamiento (que podemos ir adaptando a las estructuras y comportamientos que vamos descubriendo en economía) y que nos ahorra mucho tiempo y esfuerzo.
- **Biology as a canvas** to draw computational methods directamente aplicables a los procesos de resolución de problemas, i.e. captura de datos, modelos lógicos, procesamiento y funcionamiento de la información e interpretación de los resultados. Esto facilita y amplia nuestras capacidades a la hora de recurrir a herramientas que ya están diseñadas y han sido probadas en la resolución de problemas complejos y que podemos manipular y hacer crecer en un entorno computacional.

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