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Chris Freeman's concept of evolution—A critique of the misuse of biological analogies in macroeconomics

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ABSTRACT

On the occasion of the centenary of the birth of Chris Freeman, this paper presents an overview and analyzes his concept of economic evolution and his other contributions to the field of economics. Chris Freeman was one of the leading economists in the field of evolutionary economics during the second half of the twentieth century. Together with Richard Nelson and Sidney Winter, as well as a number of other scholars, he contributed to establishing and developing a research program which extends from opening the black box of innovation through to the macroeconomic implications of long-term changes in the economy, technology and social organization. Additionally, Freeman suggested a new macroeconomic foundation for microeconomics – the unfinished legacy of our science. The chapter investigates how these foundations were developed as a critical view of inadequate metaphors from biology.

1. Introduction

On the occasion of the centenary of the birth of Chris Freeman, this paper analyzes his concept of economic evolution and presents an overview of his discussion on the role of biological analogies for economics. Chris Freeman was one of the leading economists in the field of evolutionary economics during the second half of the twentieth century and, together with Richard Nelson and Sidney Winter, as well as a number of other scholars, he contributed to establishing and developing a research program which extends from opening the black box of innovation through to the macroeconomic implications of long-term changes in the economy, technology and social organization. As Joseph Stiglitz put it, "The development of 'evolutionary economics' is, I think, one of the more important unfinished legacies of the twentieth century. The movement from equilibrium models, derived from physics, to evolutionary, dynamic models, derived from biology and ecology, represents an important change in modes of thinking" (Stiglitz, 2000: 1448). The scope and limits of such models, inspired by biology and ecology, are discussed in this paper, considering Freeman's contribution to the subject.

Section 2 maps the evolution of Freeman's reading of political economy and the interpretation of his favorite authors, as he combined the contributions of Marx, List and Schumpeter, among others, who all played an important role in his views of macroeconomic dynamics.

Section 3 shows how Freeman became more engaged in macroeconomic research as time went by and briefly discusses his agenda for research on long term dynamics in economics. The fourth section summarizes some concepts of evolutionary biology and discusses how these were interpreted through the lens of analogies for economics. The fifth section discusses the neoclassical interpretation of evolution and its notion of the survival of the fittest, which contends the views of Freeman and his fellow economists. Finally, some conclusions are proffered in Section 6.

2. Freeman as an innovator pushing for innovation

The web repository of Freeman's major works – which is organized by family and colleagues – traces the more relevant phases of his career. His contributions encompassed seven fields of research. The dates and number of papers, chapters and books in each of these fields provide a portrait of Freeman's research focus through time, namely: (i) industrial innovation, 1961–1997 and 31 publications; (ii) science and technology and industrial policy, 1963–2001 and 22 publications; (iii) technology and development, 1968–2004 and 20 publications; (iv) innovation systems, 1970–2002 and 33 publications; (v) technology and society, 1971–2001 and 32 publications; (vi) science, technology and growth, 1981–1995 and 8 publications and, finally; (vii) technological change and economic theory, 1988–2002 and 11 publications. The list also illustrates how the author, although always concerned with innovation –

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the subject of his life's work – slowly expanded his interest from empirical work on firm and sectoral technological change and industrial policy, a task which extended from his most influential book, *The Economics of Industrial Innovation* (Freeman, 1974; whose third edition was co-authored with Luc Soete: (Freeman and Soete, 1997), through to macroeconomic dynamics and theory, of which the most powerful contribution was possibly the collective work *Technical Change and Economic Theory* (Dosi et al., 1988). His last book was dedicated to technological revolutions and long waves of economic development (Freeman and Louçã, 2001).

As some close colleagues of Freeman noted, he is known for his inclination for sound empirical work, for prospective analysis, and for heterodox theoretical approaches combined with his unique ability to establish a new reference research center on technological innovation and societal change (the Science Policy Research Unit [SPRU] at the University of Sussex, created in 1966 and headed up by Freeman for 15 years), as well as for launching a new academic journal to promote this new body of knowledge (Research Policy, of which he was the founding editor). In effect, he was a “social science entrepreneur”, who educated a large number of researchers and favored an agenda for real life economics (Fagerberg et al., 2011: 897).

Since his early academic work, Freeman was influenced, among others, by Marx, who generated “a lasting impression on his understanding of social, economic and institutional change” (ibid.: 899) and also by J.D. Bernal, a Marxist and a “visionary physicist” (Freeman, 1995: 9) who advocated the importance of science, R&D and industrial policy, and whose lectures he attended. He did not deviate from this guidance on social change, but it was only after acquainting himself with Schumpeter's work that he defined his own theoretical background to interpret economic dynamics. As a consequence, Marx and Schumpeter remained his lifelong references (Freeman, 1994: 463). In this sense, he established himself as a NeoSchumpeterian of a kind: “the description ‘NeoSchumpeterian’ is used here in a very broad sense to indicate the scope of the subject matter, rather than an ideological standpoint” (ibid.: 464). In fact, the essence of what Freeman adopted from his preferred predecessors was the historical inclination and attention to transformation and change. This is why he also studied other controversial economists, such as Friedrich List and his 1841 book on *The National System of Political Economy*, which rejected Say's law and anticipated the concept of a national system of innovation (Freeman, 1995: 5,7).

This reference to previous economists was not uncritical. In a curious note mentioning past disputes in economics, Freeman distinguished himself from Schumpeter's assemblage of heterogeneous theoretical influences and attempts a synthesis of different schools of economics, recalling that Schumpeter tried – and failed – to bridge the now classic *Methodenstreit* between Schmoller and Menger of the end of the nineteenth century, and that therefore “the basic questions of how much does history matter, the role of country-specific institutions, and the limits of universal generalisations about economic behavior are still with us” (Freeman, 1994: 492). In one of his last contributions – an editorial that he co-authored with Keith Pavitt for the special issue of *Research Policy* on the twentieth anniversary of the publication of *An Evolutionary Theory of Economic Change*, by Nelson and Winter – these basic questions are summarized as: the inductive method and appreciative theorizing, the inclusion of history of technology in development studies, the research on the emergence of new products and changes in firms, and also the conceptualization of the role of government and international comparisons (Freeman and Pavitt, 2002: 1221). Realistic assumptions regarding uncertainty, learning and bounded rationality (Freeman, 1995: 15,17), including rejecting the treatment of technology as an exogenous factor in economics, or “manna from heaven” (Freeman, 1994: 465), were presented as conditions for the success of this approach. For Freeman, the two major themes were industrial innovation, leading to the policy-oriented national systems of innovations, and reasoned history, namely regarding technological revolutions and the conditions for the emergence of each new

techno-economic paradigm, which was a work that he developed in collaboration with Carlota Perez (e.g., Freeman and Perez, 1984).

We suggest that this program led to a vibrant invention of macroeconomic foundations for microeconomics, as innovation at the level of firms and sectors is addressed inseparably from its constitutive economic and socio-institutional frameworks. This rarely-noted feature is the hallmark of evolutionary economics and its development, which, according to Freeman, should avoid poor analogies from biology.

3. Evolutionary macroeconomics

From a sensitive notion of dynamics and change, Freeman's concept of evolution evolved through time, understanding evolutionary economics in the very broad sense of an approach which is concerned with both the empirical and logical analyses of reality and with dynamic processes. This is how the notion was proposed by Mayr: “Evolutionary thinking is indispensable in any subject in which a change in the time dimension occurs. However, there are many ‘kinds’ of evolution, depending on the nature of the causes that are responsible for the change, on the nature of the constraints, and on the nature of the success of the changes. The appropriate analysis of the different kinds of so-called evolution in different areas has not yet been undertaken. Nevertheless, there is no doubt that applying evolutionary principles has greatly enriched many areas of human thought” (Mayr, 1982: 627). Considering both the novelty of these notions in economics, and the difficulty to theorize dynamic processes generating structural change, Freeman was influenced by the earlier, yet insufficiently-structured approaches to economic evolution of Marx and Schumpeter, but his views were formed in the context of the second generation of evolutionary economists – who addressed the theoretical debates from rather diverse inclinations. Analogies with biological or ecological processes are common in the case of this generation, although they vary both in terms of reference and content; nevertheless, Freeman voiced strong reservations about the uncritical translation of biological concepts into economics.

Freeman's argument against “simply adopting wholesale concepts and methodology of biology” (Freeman, 1988: 1, 1991: xx) invoked a further reason for evolutionary economic theory, other than considering mutations and selection processes operating in economics at the level of firms and technological change. That reason was that economics should investigate interdependencies in social and economic evolution (Freeman, 1988: 4; 1991: 218), which was a question that became one of the focal points of his attention as time went by. Freeman explained this as the match or mismatch between the techno-economic paradigm and the socio-institutional system, constituting the essential metabolism of capitalism. As was well known by his students, the techno-economic paradigm describes “a cluster of interrelated technical, organisational and managerial innovations, whose advantages are to be found not only in a new range of products and systems, but most of all in the dynamics of the relative cost structure of all possible inputs to production” (Freeman et al., 1988: 10), or a “radical transformation in the prevailing engineering and managerial common sense for best productivity and most profitable practice, which is applicable to almost any industry” (Freeman, 1991: 224). The diffusion of innovation in the economies involves a trial and error process and drives institutional variety (Freeman, 1995: 18). As “its spread to other areas is usually heavily dependent on organisational and social changes” (Freeman, 1991: 224), this accounts both for technological revolutions and for the long periods of adaptation and social change that they perpetrate. Therefore, the study of long waves and transitions in the mode of development, such as the emergence of the information and communication techno-economic paradigm, became a fundamental contribution of his life work. In our view, this is the core application of the concept of evolution in Freeman's macroeconomics.

In different contributions, with no surprise, the author rejected the neoclassical view of a “representative agent” and described

heterogeneous economic forces promoting innovation and following non-optimal trajectories, which are institutionally and historically constrained: “Just as heterogeneity of firms and oligopoly have led Neo-Schumpeterians to discard the assumptions of representative agents and perfect competition, so heterogeneity of national systems of innovation and the hegemony of great powers have led them to discard notions of international convergence and to stress the phenomena of divergence in growth rates, ‘forging ahead’, catching up and falling behind” (Freeman, 1994: 466, 473, 484). Freeman’s last book recapitulated his lengthy research into these processes and how they were defined by technological revolutions, providing a historical description and conceptual discussion (Freeman and Louçã, 2001).

Freeman was happy to pursue these theoretical challenges, both in empirical work and in a general overview of historical change in modern economies. As he noted, in opposition to the traditional concept of price flexibility, which is a *sine qua non* condition for the attainment of general equilibrium, Schumpeterian competition for new products and processes implies imperfect competition, as limited information imposes incompleteness of markets and contracts. In that case, “many of the standard results do not, in general, hold: the market economy is not, in general, Pareto efficient; the distribution of income matters, e.g., for whether the economy is Pareto efficient, so that issues of distribution and efficiency cannot be separated; equilibrium may be characterized by supply differing from demand (e.g., credit rationing, unemployment). Moreover, while much of conventional economics was developed under the hypothesis of convexity of production sets and preferences (based on diminishing returns), nonconvexities are pervasive in information economics” (Stiglitz, 2000: 1469–70). This realistic description of nature had been taken up by evolutionary economists, who concentrated on two major themes: (i) innovation as the pulsation of capitalism (Goodwin, 1985), and; (ii) the macroeconomic adjustment processes it generates, both of which are interpreted as cycles or waves of creation and destruction. Chris Freeman, with some of his contemporaries and collaborators, addressed these themes rephrasing evolutionary economics as a population approach, describing heterogeneous and non-neoclassical-rational agents, and considering their interactions, institutions, strategies and learning processes, at different levels and rhythms.

The incompleteness of this research agenda has also been pointed out. First, its promoters “have not developed so far their analysis of institutional forms or of aggregate formal models of the economy” (Freeman et al., 1988: 12). A coherent explanation for how the institutional system resists, adapts and transforms as the new techno-economic paradigm is being diffused has not been presented to date, although important contributions have been made (Perez, 2002). Second, the analysis of the tension between the techno-economic paradigm and the social and institutional system requires the definition of the “adjustment process, [which] (...) is achieved only through social and political changes to accommodate the characteristics of radically new technologies” (Freeman and Soete, 1994: 35). An adjustment should have successive encapsulations through time, namely: i) the establishment of the accumulation regime built around the triumphal techno-economic paradigm; ii) the adaptation of the institutional system as part of that regime, and; iii) changes in the international order. For this, only some concrete analyses and a sketch of a theory have been offered to the date, and the study of the *modus operandi* of the modern economy through systemic crises and processes of adaptation requires not only historical research on each of these processes, but also a general description of the structural evolution they represent.

A relevant test for this approach was the analysis of the fourth long wave, as it upswing led to a long downturn, that is currently labeled “secular stagnation” by some economists, and as the techno-economic paradigm based on information as communication technologies expanded. Freeman and Soete presented this process “as a new techno-economic paradigm affecting the design, management and control of production and service systems throughout the economy, based on an

interconnected set of radical innovations in electronic computers, software engineering, control systems, integrated circuits and telecommunications, which have drastically reduced the cost of storing, processing, communicating and disseminating information” (Freeman and Soete, 1994: 42). Earlier, Carlota Perez had proposed the notion of a “meta-paradigm” or a “technological style” organizing the development of changes in production (Perez, 1983); then, both she and Freeman adopted the notion of a techno-economic paradigm constituting the framework for innovation and economic change. The question remains as to which large social innovations are required to match the scale that is compatible with that change (Freeman et al., 1988: 61), and the resulting structural crises (Louçã, 2020, 2021).

Finally, Freeman’s scholarly knowledge was on display when he addressed the holy grail of economics, i.e., why do long-term growth rates diverge so much in the long-term, discarding explanations advanced by the New Growth Theory or by Paul Krugman regarding the “East Asia Miracle” as being “very unconvincing” (Freeman, 2002: 192). For Freeman, the higher growth rates of the UK in the eighteenth century and of the US during the second half of the nineteenth century and the first half of the twentieth century are explained by several factors, including their national systems of innovation, those ecosystems that included environmental conditions, social attitudes, endowments and networks for scientific or technological advances, that together result in the creation of competitive advantages. That would explain the accumulation of skills and tacit knowledge which propelled these economies farther and faster than other previous comparable economies. In the case of the UK, Freeman notes the fundamental role of science and of industry, and also the importance attributed to economies of scale, that were ascertained early on by Adam Smith and others. In the case of the US, Freeman argued that its national system of innovation most closely resembled that of the UK and that it has benefited from much larger potential economies of scale. However, these economies of scale and the associated growth only materialized after large investment in infrastructures. Further, Freeman emphasized that the respective national systems endowed economies with specific advantages, given the key technologies and industries of each era. In the future, however, the unknown remains. Indeed, Freeman was unsure which national system of innovation conferred the greatest competitive advantage in the present, highlighting the preliminary lead of the US in future-oriented software industries. The message is that long-term growth is not simply the result of the accumulation of capital, labor, or technological progress – for something more exists that evades precise characterization and is not readily identifiable, namely human agency and the social framework, which are the forces that drive the national systems of innovation. This edifice of power and decisions, and other instances of the economic and social processes, cannot be represented as simile to biological evolution.

4. The evolving concept of evolution

This section first summarizes how the connection between Darwinism and economics was established, then characterizes the role of metaphor in Darwin’s work, outlines the main building blocks of modern biology in the third subsection and, in the final subsection, their contrast with the Lamarckian view is discussed.

4.1. The romance between Darwin and economics

The impact of Malthus’s theory of population on the formulation of Darwin’s hypothesis was recounted in his *Autobiography* and is certainly one of the most well-known cases of metaphoric translation in modern science: “In October (1838), that is fifteen months after I had begun my systematic inquiry, I happened to read for amusement ‘Malthus on Population,’ and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these

circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. The result of this would be the formation of new species. Here then I had at last got a theory by which to work” (Darwin, 1876: 120, our emphasis). Although the author does not mention the tension, this reading, “for amusement”, disturbed his revered and proclaimed adhesion to purely inductive Baconian principles – as a new hypothesis was formulated on purely analogical terms. Yet, for the purpose of this paper, it is equally relevant that Darwin had read Smith’s *The Theory of Moral Sentiments* by the same time (1838–1839) and that he had summarized *The Wealth of Nations*. Babbage – who attended the same intellectual circles as Darwin and who studied the effects of specialization and division of labor – may have eventually contributed to Darwin’s attention to the Smithian argument.

When *The Origin of the Species* was published, it made an impression among economists of different inclinations. Friedrich Engels, who bought one of the copies of the first edition (all the 1250 copies were sold in one day), wrote to his friend Karl Marx that it was “absolutely splendid”. One year later, Marx introduced it to Ferdinand Lassalle in a letter, saying: “Darwin’s work is most important and suits my purpose in that it provides a basis in natural science for the historical class struggle (...). Despite all shortcomings, it is here that, for the first time, ‘teleology’ in natural science is not only dealt a mortal blow but its rational meaning is empirically explained” (Marx and Engels, 1860, MECW, vol. 41: 246–7). In a letter the same year, John Stuart Mill wrote that Darwin’s book “far surpasses my expectation. Though he cannot be said to have proved the truth of his doctrine, he does seem to have proved that it may be true” (Mill, 1860, CW, vol. 15: 695). Darwin was innocent of these infatuations and, when approached by Marx, who had sent him a copy of Volume One of *Capital*, responded on October 1st, 1873, apologizing for not intervening in such a distant province of thought: “I thank you for the honor which you have done me by sending me your great work on *Capital*; & I heartily wish that I was more worthy to receive it, by understanding more of the deep & important subject of political economy” (Darwin, 1873).

In any case, Smith he had read. Smith suggested social interactions led to the emergence of order, rather than to disorder or disharmony, but, on the contrary, Malthus argued that potential disorder could arise from social complexity (this was, of course, what brought him so much attention and forced him to publish anonymously). Each opposite direction originated a peculiar trend in “population thinking” in social sciences, whereby Spencer, Hayek and others suggested evolution to be the creation of some “spontaneous order”, while Malthus and others feared that “spontaneous disorder”. Therefore, this early biology-economics metaphoric bridge implied non-trivial and opposed avenues for interpreting social dynamics (Louçã, 1997).

4.2. The inventive role of metaphor

Darwin’s magnum opus is dedicated to the study of variation under domestication and then, by analogy, in the realm of Nature. Previous authors, such as Leyell, denied natural selection (Ruse, 1982: 46), although the founder of modern biology challenged that view. For the concept of natural selection was by itself a metaphorical device, as recognized and praised by Darwin, who presented it as a complementary heuristic process to define hypotheses about the common descent of all species (Darwin, 1859: 454–5). Using that liberty, he argued for the recourse to imagination for the interpretation of facts (ibid.: 263) and for the legitimacy of speculation based solely on some facts, even if this could lead to a questionable conclusion (Darwin, 1871: 926f.). However, this refers to the logic of the argument, since the use of metaphor, by means of analogy, is not sufficient to prove a hypothesis. If, in retrospect, this view of analogy is extended to the influence of Malthus’s book, it can be hypothesized that it provided Darwin with an inspiration, rather than a method of research.

The use of metaphors in scientific language or reflection, as an impertinent and eventually innovative process of denotation, is a topic

of much discussion, and this is not the place to reconsider it (an overview is included in Louçã, 1997: 50f.). It is sufficient to indicate that different contributions to literary theory and epistemology register three classes of metaphors, namely: (i) simpler substitution metaphors, which transmit literal expressions from one field to another (Black, 1962: 31); (ii) comparison metaphors, which operate as transfers of language from one field to another, suggesting some semantic changes, and; (iii) interaction metaphors, which affect sense and reference, proposing new patterns of implication (Hesse, 1980: 120f.; and also Ricoeur, 1977). Later in the next section a case of a comparison metaphor (Alchian’s model of biological mutations transposed to the notion of adaptation and fitness of firms) and its critique by an economist rejecting the adequacy of that notion (Penrose’s repudiation of the analogy between random mutations and purposeful innovations) will be presented.

Even though biological metaphors are widely used in economics, they have long been looked upon with suspicion and as not being sufficiently scientific. Evidence of the promotion of powerful alternatives – presented as being more rigorous – is provided by the case of the neo-classical revolution, which was inspired by the concepts and even the mathematical formalism of thermodynamics (a detailed discussion is proposed by Mirowski, 1989), even if many rejected the adequacy of this metaphor from physics (e.g., Prigogine and Stengers, 1985: 207). But one of the founders of neoclassical economics, Alfred Marshall, was the initiator of the idea that biology could indicate the Mecca for dynamics. In turn, Schumpeter – who is considered to be one of the inspirators of evolutionary economics – expressed changing opinions on the subject. In an early book, he argued that the “evolutionary idea” based on Darwin was “discredited”: “Here [in the class of ‘metaphysical’ tendencies], too, belong all kinds of evolutionary thought that center in Darwin — at least if this means no more than reasoning by analogy (...). But the evolutionary idea is now discredited in our field, especially with historians and ethnologists, for still another reason. To the reproach of unscientific and extra-scientific mysticism that now surrounds the ‘evolutionary’ ideas, is added that of dilettantism. With all the hasty generalizations in which the word ‘evolution’ plays a part, many of us lost patience. We must get away from such things” (Schumpeter, 1911: 43). Yet, at the end of his career, Schumpeter accepted a trivial notion of Evolutionism as a convenient reference for studying change through time: “Social phenomena constitute a unique process in historic time, and incessant and irreversible changes are their most obvious characteristic. If by Evolutionism we mean not more than recognition of this fact, then all reasoning about social phenomena must be either evolutionary in itself or else bear upon evolution. Here, however, evolutionism is to mean more than this. One may recognize the fact without making it the pivot of one’s thought and the guiding principle of one’s method” (Schumpeter, 1954: 435). At the very same time, he contradictorily praised Walrasian economics as being “the only work by an economist that will stand comparison with the achievements of theoretical physics” (ibid.: 827).

In this conundrum, several reasons suggest not defining the agenda of evolutionary economics by following Darwinism. One was pointed out by one of the authors of this paper, who argued that “Darwinian evolution represents essentially an allegory for economics: it provides a new vision, escaping from the mechanistic prison, but the attempts to generate precise biological analogies orienting the research in economics are doomed to fail. No economic analogue exists for the replication unit in biology and the discrimination between genotype and phenotype is not relevant in society, neither is social evolution identifiable by natural selection processes. Indeed, an excessive expectation attributed to the metaphor the power of selection of specific hypotheses and of defining models for analysis, with scarce results” (Louçã, 1997: 4). The instrument of metaphor, or analogy, may provide an inventive translation of concepts from one science to another, but it does not constitute a map for research, neither a method for proving hypotheses.

4.3. The principles of Darwinism

Malthus' and Smith's positions regarding the unintended consequences of individual behavior were in opposition, and the contrast of perspectives would not have been lost on other scientists who read their seminal works. In any case, there was no reason to apply their explanatory devices in biological studies. In fact, Darwin proposed the following general principles for framing biology – which are independent of his occasional readings of economics:

1. The theory of common descent with modifications through natural selection, which determines variation, as the “predominant power” in a slow process of historical change: “Of all these causes of change I am convinced that the accumulative action of Selection, whether applied methodically and more quickly, or unconsciously and more slowly, but more efficiently, is by far the predominant power” (Darwin, 1859: 100). Yet, Darwin accepted that production of variability could also emerge from the following origins: (i) inheritance; (ii) reversion, and; (iii) use and disuse (*ibid.*: 169, 203–4, 231, 435). Genetic change – a concept that would clarify these views – remained unknown until the revelation of Mendel's genetic laws by the end of that century.

2. The use of heuristic devices, such as the search for the “missing links” (Darwin, 1859: 341), which in fact became a source of the confirmation and development of Darwinian theory. That was the “canon” which “every fresh addition to our knowledge tends to make more strictly correct”, or the basis for natural history (*ibid.*: 445). Stengers and Schlanger interpreted these missing links as suggesting a “dramatic discontinuist”, given their emphasis on the role of mutations and selection (Stengers and Schlanger, 1991: 112), although Darwin used the *natura non facit saltum motum* to indicate his belief in the long-term continuity of the processes of selection and adaptation.

3. An organic “population thinking” for the adaptation and consequently the effect of selection in species and populations, rather than just in single individuals.

4. Finally, the rejection of both essentialism and Lamarckian teleological evolution by the intrinsic drive to perfection, given the indeterminacy of biological phenomena (“I believe in no law of necessary development”, Darwin, 1859: 348).

Except for the general intuition that dynamics and change drive evolutionary processes, and for the organic population thinking, these principles do not apply in economics. Different heuristics are called for, as demonstrated by the example of the use and misuse of the Lamarckian alternative to the Darwinian synthesis.

4.4. Lamarck as an alternative to Darwin

Lamarck, in contrast with Darwinism, argued that the evolution of species is driven by the environment in which they exist, and that species develop characteristics (the use or disuse thereof) during their lifetime, as they adapt to changes in their environment, which they pass on to their offspring. In spite of these principles having no direct translation in economics, social or cultural evolution has instead been commonly metaphorized as a Lamarckian process by many evolutionary economists (Clark and Juma, 1987: 40; Mani, 1991: 36, 55–56; Faber and Proops, 1991: 58; Goonatillake, 1991: 40; Saviotti and Metcalfe, 1991: 12–13; Hodgson, 1993: 234; Nelson, 1995: 54). One of them claimed that “the biological evolution is Darwinian; it does not transmit acquired characters. Tradition, on the contrary, is definitely Lamarckian, that is, it transmits only acquired characters” (Georgescu-Roegen, 1971: 359), with some economist consequently announcing their “espousal of Lamarckism” (Nelson and Winter, 1982: 11). Freeman noted that “at the very least any good biological model [in economics] would have to be Lamarckian and not Neo-Darwinian”, although he suspected the adequacy of that inspiration (Freeman, 1991: 213). The notion that this very analogy is refuted in biology was also obvious for some of these authors (Nelson, 1995: 90) and yet they used it for the sake of establishing a readable narrative in the frame of the authority of

evolutionary biology.

In our view, there are two main reasons to avoid this analogy between economic dynamics and Lamarckism. The first reason is that it suggests a form of selection that ignores uncertainty and obtains a desired final result. That was of course the reason why it featured so well among neoclassical economists, as is demonstrated below. The second reason is that it metaphorizes a hypothesis that is rejected in its own domain, at least contemporarily, and therefore provides no bond between economics and biology.

Darwin himself did not reject the idea of the inheritance of acquired characteristics as a relevant form of production of variation, and even in his last works he maintained this hypothesis: “I may take this opportunity of remarking that my critics frequently assume that I attribute all changes of corporal structure and mental power exclusively to the natural selection of such variations as are often called spontaneous; whereas, even in the first edition of ‘The Origin of the Species’, I distinctly stated that great weight must be attributed to the inherited effects of use and disuse, with respect both to the body and mind. I also attributed some amount of modification to the direct and prolonged action of changed conditions of life” (1874 preface to *The Descent of Man*; Darwin, 1871: viii). In this sense, Darwin accepted the relevance of the inheritance of acquired characteristics in such different domains as domesticated and wild animals (Darwin, 1859: 72, 75), plants (*ibid.*: 74) and human beings (*ibid.*: 49–50, 74). But he considered, nevertheless, the natural selection process as the crucial one, since “natural selection had been the chief agent of change, though largely aided by the inherited effects of habit, and slightly by the direct action of the surrounding conditions” (Darwin, 1871: 92).

It is plausible that Darwin insisted on the inheritance of acquired characteristics simply because he did not know about the genetic production of variation – which is the reason why his explanation was clearly insufficient. In any case, he rejected the teleological approach of Lamarck, which was also that of his own grandfather, Erasmus Darwin, a forerunner of Lamarck's theory of the inheritance of acquired characteristics, or “soft inheritance”. As he wrote in his *Autobiography*, the reading of both did not “produce any effect on me” (Darwin, 1876: 49). In a letter to Lyell, sent at the time of the publication of *The Origin*, he restated that he did not incorporate a single fact or idea from Lamarck's work (*ibid.*: 153). In any case, it was only Wallace, the independently co-founder of evolutionary biology, who completely rejected the Lamarckian concept of inheritance of acquired characteristics: “The hypothesis of Lamarck – that progressive changes in species have been produced by the attempts of animals to increase the development of their own organs, and thus modify their structure and habits – has been repeatedly and easily refuted by all writers on the subject of varieties and species, and it seems to have been considered that when this was done the whole question has been finally settled; but this view here developed renders such an hypothesis quite unnecessary, by showing that similar results must be produced by the action of principles constantly at work in nature” (Wallace, 1858: 112).

The question arising from the economic analogy with the Lamarckian theory of the inheritance of acquired characteristics is that, on the one hand, if it is literally considered, it is wrong, since it suggests a destiny for evolution. On the other hand, if it is a simple formal analogy, it leads to nowhere. On the contrary, scientists should consider the process of social learning as the cultural production and transmission of information, as being rather distinct, and indeed, as an alternative to biological transmission: “This gives man a second evolutionary system superimposed on top of the biological one, and functioning by means of a different system of information transmission” (Waddington, 1975: 288). In fact, in social life, no single entity carries the information, it is not produced at one single point of time but it is continuously changed, the modes of “para-genetic transmission” are multiple and, crucially, human beings learn how to learn and communicate what they know. Moreover, divergences of lineage in biological evolution exist which have no possible subsequent reunification, whereas this is the norm in

cultural lineages and is also a major source of variation. In economics, coordination replaces non-purposeful transmission and intentionality challenges inner natural dynamics. Therefore, understanding the specificity of society leads to the rejection of the Lamarckian metaphor for cultural evolution. Nevertheless, in spite of objections, some neoclassical economists were mobilized by and adopted the Lamarckian view, as interpreted by Herbert Spencer and his heirs in sociobiology, as well as the concept of intelligent design leading to evolution (a topic that was criticized by Winter, 2016: 22).

5. Freeman's review of the debate on neoclassical evolutionism

How evolution and Lamarckian teleology were perceived by neoclassical economics is the theme for the next subsection, and the limits of the biological analogies for evolutionary economics are addressed in the following one, noticing Freeman's critique to both neoclassical interpretations and the poorly translated biological analogies. What emerges is how he challenged the conceptually narrow transposition to economics of biological transmission mechanisms, favoring instead a historical approach to understand the economies, given that he also conceived the work of the economist as a builder of alternatives for social transformation, alien to the blind reproduction processes in biology.

5.1. *The survival of the fittest*

Darwin only introduced the concept of the "survival of the fittest" after some resistance and as a version of Spencer's notion of linear progress, which had been proposed before the publication of his own book in 1859. Even so, Darwin built a wall between his theory and Spencer's: "I (...) use the term 'struggle for existence' in a large and metaphorical sense, including dependence of one being to another, and including (which is more important) not only the life of the individual, but *success in leaving progeny*" (Darwin, 1859: 116, our emphasis). His metaphoric use of the expression "survival of the fittest", or even that of the milder "struggle for existence", rejected the concept of individual fitness, as defined regardless of other beings. It was precisely that misuse of Darwinism that was employed by Hayek, who praised the representation of competition and selfishness as a common trend in nature and concluded that "in many respects Darwinism is the culmination of a development which Mandeville more than any other man has started" (Hayek, 1978: 265), a preposterous claim.

A predecessor of Hayek's claim was Armen Alchian, who introduced the "saga of evolution" in order to save neoclassical economics (Mirowski, 2011: 247). In a 1950 paper, Alchian argued that economic analysis should adopt "a Marshallian type of analysis combined with the essentials of Darwinian evolutionary natural selection" (Alchian, 1950: 213), in order to solve some of the difficulties of the neoclassical theory. According to him, the introduction of a realistic assumption of uncertainty refuted a profit-maximization behavior of firms, since the objective function would become opaque, and the management of firms would be restricted to some perception of the distribution of potential outcomes of expected profits (ibid.: 212). In this case, the very concept of an optimal distribution is ambiguous, and Alchian suggested an alternative: that the "realized positive profits" should be the criterion for viability and therefore for success, since positive profits imply relative superiority, and firms with no profits disappear.

In order to reinforce the Darwinist analogy, Alchian introduced chance – "fortuitous circumstances" – as a method for achieving success, along with trial-and-error, imitation and other adaptive processes. In this context, mutation was described as the creation of a new type of organization, and selection indicated the probability of its survival, or its viability. The author mapped his analogy: "The economic counterparts of genetic heredity, mutations, and natural selection are imitation, innovation, and positive profits" (ibid.: 220). So, the maximization hypothesis was replaced by a competitive system in which agents merely

tried to obtain profits: "The suggested approach embodies the principle of biological evolution and natural selection by interpreting the economic system as an adoptive mechanism which chooses among exploratory actions generated by the adaptive pursuit of 'success' or 'profits'" (ibid.: 211). In this case, selection is supposed to proceed at two levels: (i) the environment supports and reinforces firms that are innovative and or competitive (through the realization of positive profits); (ii) the firm adapts to a competitive behavior by chance-mutation transformations or by imitation. The problem for this metaphor, of course, is that the adaptation of firms does not necessarily induce innovation: in biology, mutation is a random process, neither explainable nor explanatory for social evolution, therefore contracting the evolutionary interpretations of economic dynamics a discussion on Schumpeter's rejection of the description of economic innovation as random impacts is provided in Louçã, (2001), and imitation is a strategy of the follower and not a genuinely creative behavior; their effect on the environment is *prima facie* unpredictable. On the other hand, Alchian's viability hypothesis requires that evolution increases efficiency, although this is not necessarily the case in biology and it is evidently not always the case in social life.

This point was taken by Edith Penrose, who emphasized that analogy is a tricky business: "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" (Penrose, 1952: 804). In particular, she criticized this model since there is no analogue for genetic heredity and since behavioral imitation among species cannot be compared to social evolution. Furthermore, randomness of mutations cannot be paralleled with purposeful action, which is the characteristic of economic and social choices, and therefore randomness is unable to explain competition (ibid.: 808, 812, 814). Alchian replied that the analogy was "merely expository" (Alchian, 1953: 601). In her final rejoinder, Penrose graciously noted that "competition cannot reasonably be expected to exist if men are presumed to act randomly" (Penrose, 1953: 605), as economic and social life are about choices and not chance. From this exchange, Freeman concluded that "Edith Penrose made perhaps the most devastating critique of biological analogies in her attack on the analogy between the growth of animals (and plants) and the growth of firms and other attempts to give explanations of human affairs that do not depend on human motives" (Freeman, 1991: 219).

In spite of the debate, this attempt to incorporate Darwinist competition in general equilibrium economics, in order to protect it from the ravages imposed by the incorporation of uncertainty, was shortly afterwards echoed by Milton Friedman, in his famous essay in 1953. The traditional hypothesis of "maximization of returns" was predicated in a natural selection process: "The process of 'natural selection' thus helps to validate the hypothesis – or, rather, given natural selection, the acceptance of the hypothesis can be based largely on the judgement that it summarizes appropriately the conditions for survival" (Friedman, 1953: 22). Unsurprisingly, the author presented this natural selection metaphor as being consistent with a physics meta-metaphor: "In short, positive economics is, or can be, an 'objective' science, in precisely the same sense as any of the physical sciences" (ibid.: 4). Forcing the equilibrium conceptualization of biology, neoclassical economics closed the circle and returned to its cherished truths of the mechanical analogy.

5.2. *The limits of the biological analogy*

Freeman was eventually the first senior economist to consider the Alchian-Penrose debate as an important contribution to the understanding of evolutionary economics, and to share her denial of the reductionist analogies between biology and economics. In this sense, he contradicted preliminary suggestions, such as that of Veblen, who had much earlier suggested a concept of evolution that would benefit from many different streams from several sciences, essentially from natural

sciences (Veblen, 1898: 373). However Freeman looked specifically at the biological metaphor and argued that it generates “serious dangers” and “it is important not to be carried away by evolutionary analogies and to mistake the analogy for the reality” (Freeman, 1991: 211, 213). Indeed, the adaptation of concepts such as that of a genotype or a phenotype, or of fitness and competition as survival of the fittest, is absent in Freeman’s work. He considered that “despite the positive stimulus to be derived from biological analogies, there is no real substitute for the development of models and theories which take into account those specific features of social development and technical change which are uniquely human and which indeed vary with each successive technological revolution” (ibid.: 212). In still stronger terms, he later added: “It would of course be as dangerous for economic theory simply to adopt wholesale concepts and methodology of biology as of physics” (Freeman et al., 1988: 1). The author feared a mode of theoretical justification based on an analogy that ignored the requirement of precise inspection of data on technological, social and economic change, which configures a process that is not comparable to nature.

In a detailed account of the limits of the biological analogy, Freeman presented two major arguments for the difference between biology and economics. The first essential difference concerns the nature of mutations. For, if the analogy is established, it should be noted that mutations are purposive in the economy and not in biology (ibid.: 213, 217). The second difference is as relevant: environmental selection operates in economics at three levels, namely the natural context, the inbuilt structure, and the institutional framework, which results in diverse operational implications for R&D systems, firms, industrial sectors and regions alike, as well as the national economy and social system. Therefore, social life consists of a composition of several layers of complexity. Given the purposefulness of human organization, the social learning processes, the intensive acquisition of knowledge, and the co-determination of social factors, all represent the peculiarity of capitalism: “In fact, the capacity to generate a wide variety of potential new products, services and organisations and to confront them on a trial and error basis with these various selection processes over a prolonged period is probably the strongest single evolutionary advantage of capitalist institutions themselves” (ibid.: 228–9). That was the reason for Freeman’s suggestion of moving away from simple biological analogies: “in the end social scientists have really no alternative but to go beyond analogies and develop their own evolutionary models” (ibid.: 229).

Richard Nelson, another of the founders of modern evolutionary economics, followed a different path, but approached similar conclusions. In his reference work co-authored with Sidney Winter, they had suggested to look at firms as the unit of analysis and to use the analogy of the survival of the fittest (Nelson and Winter, 1982: 41–5). But, in a detailed review of the field up until 1995, Nelson reconsidered the value of that analogy. Rejecting the mechanical models as being incompetent to understand path-dependent evolution and the nonexistence of a unique selection equilibrium (Nelson, 1995: 49, 53), he contended that the notions of sociobiology are inadequate for economics, in the same way as the concept of optimization or Herbert Spencer’s peculiar view of the survival of the fittest (ibid.: 51, 57, 61). This is why, “like Marshall, most of these writers, while drawn to biological conceptions or metaphors, have resisted simply transferring evolutionary concepts used in biology to their area of inquiry, but rather have tried to analyze the evolutionary dynamics at work here in its own right” (ibid.: 53). In this appraisal concurring with Freeman, Nelson used an adapted concept of fitness of firms, not of individual agents, and argued that the “concept of routines is analytically similar to the genes in biological theory, or the memes or culturgen in sociobiology”, yet he also noted the crucial difference between routines and genes, as the former can be modified, and the need to understand the co-evolution of technology, industrial organization, and institutions, which determines economic outcomes (ibid.: 68, 78, 83). This is a demanding research agenda. Freeman favored the same strategy: “Neo-Schumpeterians have not on the whole succeeded in developing a behavioural theory relating firm strategy to

routines and rules of thumb. Business studies theorists and economists have remained too far apart in this area” (Freeman, 1994: 486–7).

This was reinforced by Brian Loasby, who rejected the economic mainstream reference to biological selection processes, arguing that in Darwinism ex-post evolution has its origins in random mutations, while in neoclassical economics it is motivated by ex-ante choices, assuming optimality and perfect information under rational expectations. Therefore, “the selection (of technology) criteria correspond to neither biological concepts of ‘fitness’ nor standard economic notions of optimality” (Loasby, 2002: 1227). The inadequacy of this type of analogies was also noted by the distinguished zoologist Ernst Mayr: “The indiscriminate application of the term ‘evolution’ however, has led to some unfortunate formulations, if not absurdities. Non biologists who favor the evolutionary conceptualization are often unaware of the Darwinian and Neo-Darwinian theory and may, for instance, promote orthogenetic schemes, such as the theory that human culture automatically passes through a series of stages from that of the hunter-gatherer to that of the urban megapolis. Teleological principles have been very popular among those who have used evolutionary language outside of biology, but when these teleological schemes were refuted, it was thought that this refuted the whole concept of evolution. A study of such literature demonstrates rather painfully that no one should make sweeping claims concerning evolution in fields outside the biological world without first becoming acquainted with the reasoned concepts of organic evolution and, furthermore, without a most rigorous analysis of the concepts he plans to apply” (Mayr, 1982: 627). This adequately summarizes Freeman’s view on evolution without teleology, precisely what implies the responsibility of the economist.

6. Conclusion

If we take evolutionary economics as a research on the pulsation of capitalism, including the adaptive processes and social and institutional disputes, and the macroeconomic coordination and adjustment it calls for, it is certain that Chris Freeman’s work excelled in both domains. He researched innovation and produced a large amount of empirical work in that area, which became a reference for students of technology and social change. He founded a research center that grew to attain an impressive standard in the profession and was a joint founder of a journal that became one of the leading international academic publications. But his key legacy is to be found in the fields of evolutionary economics and of macroeconomics, where he helped define the field of modern evolutionary economics. For that, and following Edith Penrose, together with Richard Nelson, Sidney Winter, and other economists, Freeman defied the over simplistic biological principles and analogies. Finally, he added weight to the challenge of evolutionary economics, in opposition of neoclassical doctrines, as he contributed to a new agenda in macroeconomics.

This is why he presented that agenda as a defiance: “I don’t think you’ll change the main paradigm of neoclassical economics, I think you have to attack it head on in the center. (...) Most of the people working on innovation systems prefer to work at the micro-level. They are a bit frightened still of the strength of the neoclassical paradigm at the macroeconomic level. But I think that’s where they have to work. You have to have an attack on the central core of macroeconomic theory. It is happening but not happening enough” (interview with Naubahar Sharif, October 24 2003, quoted in Fagerberg et al., 2010: xxx). His contribution to that task was a gigantic achievement, even if it remains an unfinished, ever-in-progress, legacy.

Declaration of Competing Interest

No conflict of interest is declared by the authors.

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