New Controversies in Evolutionary Biology: Lessons for Economists?

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The special curse, as one may call it, of the Encantadas... is that to them change never comes; neither the change of seasons nor of sorrows. Cut by the Equator, they know not autumn and they know not spring; while already reduced to the lees of fire, ruin itself can work little more upon them. The showers refresh the deserts, but in these isles, rain never falls. Like split Syrian gourds left withering in the sun, they are cracked by an everlasting drought beneath a torrid sky.

So Herman Melville described the Encantadas, or enchanted isles, better known to us as the Galapagos Islands. These remarkable islands are where the young Charles Darwin made observations that would lead to his theory of evolution by means of natural selection. The flora and fauna of the Galapagos Islands represent a truly remarkable example of evolution through natural selection; of gradual adaptation to environmental conditions through tiny changes accumulating through eons in a basically static situation. Out of Darwin’s observations came the Theory of Natural Selection which debunked once and for all, at least among educated people, the idea of the immutability of species.

The theory of natural selection described a part of reality that was obviously true. Organisms do adapt and change in response to environmental conditions. In the twentieth century Darwin’s theory was combined with modern genetics to become the Modern Synthesis of evolutionary biology. According to this view, evolution proceeds by small, gradual changes which lead to new species, given a sufficient amount of time. By the 1960s evolutionary theory had reached such a state of orthodoxy that the established view saw all evolutionary change as the product of gradual accumulation of small changes favored by natural selection. Every feature of an organism, from size and shape down to the most minute anatomical detail, was seen to be the result of some objective cause. This viewpoint was dubbed by Gould and Lewontin (1979) as the “adaptationist program”.

In the 1970s the prevailing orthodoxy began to be challenged by the historians of biology, the paleontologists. The first focus of the attack was the idea of gradualism. In terms of the fossil record, as Darwin himself conceded, few examples of gradual change from one species to another have been found. The fossil record for a particular branch typically remains unchanged for millions of years, then shows a rather abrupt replacement by a related but quite different form. Until recently, the lack of intermediate steps between fossil forms was attributed to deficiencies in the fossil record. That is, the intermediate steps are there; we just haven’t found them. Gould and his co-workers urge the adoption of the alternative idea of “punctuated equilibria”. According to this view, evolution occurs not by gradual changes but by quantum leaps from one form to another. It is the pattern that is important here, not the specific number of years involved; this may vary from species to species and from place to place. According to the advocates of the punctuated equilibrium model, the fossil history of most species includes the features of stasis and sudden appearance; features that are inconsistent with the notion of gradualism.

The attack on the idea of gradualism was the first “beachhead” of the new critics of the modern synthesis. But it soon became apparent that once gradualism was abandoned, the idea that natural selection of individual organisms was the only driving mechanism behind evolutionary change also came under attack. Biologists became to ask the question “does macroevolution exist?” Can there be selection processes which operate at levels above that of the individual organism?
The concept of economic evolution implicit in the neoclassical theory of the firm is analogous to the Darwinian synthesis in evolutionary biology. Economic change occurs through myriad successful innovations. Within an industry, individual firms adopt new, more efficient techniques or else they are replaced by firms that do. Eventually, the cumulative effect of these changes may result in a product or process that bears little resemblance to its forerunner. Marginal analysis depends on the assumptions of gradualism and equilibrium. The world of modern economic theory is much like the world of the Galapagos Islands; a static world of gradual change where nothing much happens, where events occur in isolation. As in the adaptationist program in biology, each characteristic of an existing firm, as well as each firm itself, is seen to be the result of selection by the marketplace. And since this selection is based on an objective, (and desirable) optimizing process, profit maximization, and the end result is that the “best”, “most efficient” firms survive. As the selection process progresses through time, economic evolution results in an increasing efficiency of production, in higher quality products for a given expenditure, and in the survival of the “best” firms selected by the criterion of profit maximization. Although the term “survival of the fittest” has become a source of embarrassment in evolutionary biology, it still holds sway in economics.

Even economists who are critical of the neoclassical paradigm, like Nelson and Winter (1982), who call for an evolutionary approach to modelling economic change, build models that are driven only by natural selection at the margin. In these evolutionary models the locus of selection is the firm; it is the firm that must make a positive profit in order to survive and it is the firm that becomes extinct if it fails to do so for any length of time.

If economic change through time is characterized by punctuated equilibria, by periods of relative calm, broken by sudden disruptions, a problem arises for the adaptationist view of economic evolution. During turbulent conditions, the success or failure of a firm may be unrelated to the “fitness” of that firm in terms of its profit making ability. Perfectly adapted firms may be eliminated through no fault of their own when the business climate suddenly changes. To make a case for this assertion, even if economic history is characterized by punctuations, these catastrophic events such as wars, depressions, energy crises, large-scale banking failures, or whatever, must cause more than a simple magnification of the natural process of weeding out less fit firms. These punctuations in economic history must be analogous to the event that caused the extinction of the large dinosaurs. After thriving for 150 million years they were wiped out overnight in geological terms by some cataclysmic event which made the climate cooler, perhaps an enormous meteor striking the earth or a very large volcanic eruption. An unforeseeable event rendered them unfit to live in a world that was suddenly completely different.

Similarly, firms in the economic environment may be buffeted by forces over which they have no control, and which randomly confer selection advantages and disadvantages. The main thought of this note, drawing on biological controversies, is that selection based on efficiency is only one of many ways an economic entity may be “chosen” for survival. The view of economic change argued for here is a hierarchical one. Different kinds of selection processes work at different levels and on different units. Differential survival through time may be affected by what happens to individual production techniques, individual firms or industries or even entire countries.

In articles in the journal Paleobiology Elizabeth Vrba and Stephen Jay Gould (1982, 1986) distinguish between “sorting” and “selection”. Sorting is a broad term meaning mere differential survival rates, Darwinian selection acting on agents in the struggle for existence is one cause of sorting. There can be, however, other reasons for differential survival, including pure chance. Sorting is nothing more than a description of differential representation through time without any statement as to causation. The term selection, on the other hand, implies causality; an agent survives because it is more efficient and thus wins out over others in the struggle for existence. Natural selection acts on agents in the struggle for existence, and those agents which are more “fit” to survive. The distinction is important because sorting, other than that produced by selection, is not the result of the static efficiency of an agent but rather historical accident, historical archaeology (what biologists call preadaptation) or many other factors outside the purview of standard theories.

In the economic world there is scarcely a
limit to the number of possible levels of classifications and combinations of classification of the process of sorting. Three are proposed here.

1. At the first level, the bottom of the hierarchy, is the standard model of competitive selection at the margin. Change in this case arises through internal sorting of a steady stream of inventions available for innovation. Sorting at this level is directly analogous to the Darwinian model in biology. Since causality (through increased efficiency) is implied at this level sorting here may be called selection. In terms of innovative activities this type of sorting is known as "rationalization". Rationalization innovations or process innovations are under the control of the firm. These are changes in the way firms produce things which will result in lower costs. Cost reductions result from intra-firm decisions to innovate. At this level, evolutionary change takes place through "selection" and is adequately described by the neoclassical model.

2. The next hierarchy, following the biological literature, may be called preadaptation. A firm may gain an advantage from an innovation arising from without, that is from outside its own decision-making parameters. For example, there usually exists a variety of firms with an array of techniques available to produce a given product. One of these techniques may suddenly be favored over another because of changes in the efficiency with which its inputs are produced. One firm may survive another, not becuase of its own efficiency but because it is preadapted to take advantage of improvements in techniques of another firm from which it buys inputs. Sorting of this sort occurs because of the prevalence of complementarity in economic life. A well-known example is the survival of the non-optimal QWERTY typewriter keyboard (David 1985).

Whenever we observe the predominance of one technology or one outcome over its competitors, we should be very cautious of any interpretation that suggests that this outcome is the result of the winner's innate superiority. In the presence of historical lock-in, in the presence of increasing returns to scale, in the presence of pure uncertainty, nothing guarantees that the "fittest" firm will survive (Arthur 1989, Mokyr 1990). Unforeseen advances in one firm, or even in an entire industry can give a survival advantage to firms linked to industries in which innovations occur. It was improvement in semi-conductors that led to tremendous productivity gains in the computer industry, which in turn spread to virtually all other sectors of the economy.

3. At the top of this admittedly simple hierarchy are process which may be called "Schumpeterian". These processes involve sweeping new changes that sort at the level of entire markets, or even entire economies. Schumpeterian changes have the effect of "reshuffling the deck" and sweeping away even some of the most efficient techniques.

Causality in terms of evolutionary change may originate at the bottom or at the top of the hierarchy. An example of a top down change is the energy price shock of the seventies. These economy-wide shocks affected industry mix; energy intensive industries grew less than average during the 1970's. The use of inputs complementary with energy was affected. And at the bottom of the hierarchy, rationalization led to the selection of energy efficient production techniques. Causality may also run from the bottom up. Improvements in a technique through rationalization will result in the selection of complementary techniques and may also so lower the cost of a commodity that the industry mix in the economy will be changed. Sorting at the top of the hierarchy always implies sorting at lower levels. Sorting at the firm level implies the survival of techniques associated with surviving firms. Sorting at the industry level means the differential survival of firms in those industries. Sorting (that is selection) of techniques at the bottom of the hierarchy may or may not affect higher levels.

The implications of the existence of hierarchical sorting processes for economic policy are considerable. The policy recommendations of economists, even those least wedded to a simple-minded market ideology, are based on notions of natural selection. We strive to ensure a "level playing field" by smoothing our imperfection in the market. We are against any policies we perceive as giving one firm an unfair advantage over another. We rely on natural selection to ensure the most efficient economic outcome. Economists have such an antipathy to government involvement in the economy because of the belief that it interferes with selection, hindering the progressive drive toward increased efficiency through time.

To the extent that changes in the economy
are driven by higher-level sorting, this antipathy is unwarranted. By ignoring other forms of sorting we are denying a role for the government in economic processes not based on competitive selection but on chance, cooperation, or many other factors over which enlightened intervention may have a beneficial influence.

There is a growing use of truly evolutionary models among economists, particularly among economic historians. More importantly perhaps, philosophers of science are now trained in evolutionary biology not classical mechanics. This promises to free all of social science from the straightjacket of the model of science that says that prediction is the end all and be all of good science. Models that are explanatory (pattern models rather than predictive models) are now accepted, even by such traditionalists as Karl Popper himself, as being scientific. Fortunately most of the world is not like the static equilibrium of the Galapagos Island where nothing much happens. We live in a quirky place where Dinosaurs can live happily for 150 million years and then disappear abruptly and where economic fortunes can change overnight. Such a world cannot be explained by streamlined models of optimality and marginal change.

References