PART I

Introduction

1 *Evolutionary Economics*
Taking Stock of Its Progress and Emerging Challenges

ULRICH WITT AND ANDREAS CHAI

Introduction

Economic analysis is no less evolving than the economy itself. In a previous era, economics was considered to be the "queen" of the social sciences that possessed a relatively autonomous and somewhat elitist character. Now a brief review of the current literature in various subfields of economics reveals emerging synergies and increasingly blurred demarcation lines between the economic literature and neighboring disciplines. Some notable examples include the increasing prevalence of psychological approaches to account for seemingly irrational behavior in behavioral economics; the rise of neuro-economics that builds a bridge between neuroscience and traditional models of decision making; growing evidence that social networks and peer behavior can play a key role in individual preferences, and the growing links between the international trade literature and economic geography. Words once foreign to economists, such as "dopamine", "control group", and "network effects", have become familiar terms in the debate. Taken together, this trend seems to be irreversible and points to a future where cutting-edge research in economics is more integrated with scientific developments in neighboring fields.

This renaissance begs us to consider how the deeper methodological paradigms and principles found in other scientific fields compare to those found in canonical economics. For much of the history of economics, great scholars such as Alfred Marshall, Thorstein Veblen, and Friedrich A. Hayek have wondered to what extent economists can learn from biology and its Darwinian theory of evolution – without having much impact on their ideas. Human beings who run the economy are, after all, a biologically evolved species. It seems that almost every day new evidence is reported in the popular media that differences between humans and other animals are not as clear as once thought: crows are found to use tools; monkeys can talk. On the flipside, some people certainly do act like animals.

In that sense, why not consider an extension of the naturalistic perspective to economic behavior and the human economy? By such an extension, evolution would immediately become relevant to explaining what capacities, attitudes, and preferences are part of the human inheritance and how these endowments set the frame for the unfolding of the economy. Obviously, a perspective like this is not common in economics. In fact, it is not even a commonly shared perspective in evolutionary economics (unlike in evolutionary psychology or evolutionary anthropology). Since the term "evolutionary economics" was introduced to a broader audience by Veblen (1898), different conceptions and interpretations have been, and still are, associated with it (see Witt 2008a). In addition, the different interpretations have focused rather selectively on different economic topics.

For example, the main topic in neo-Schumpeterian research initiated by Nelson and Winter (1982) is the dynamics of firm organizations and industries. These dynamics are explained by means of a loose analogy to natural selection models and models of biological population dynamics. Accordingly, the authors of these contributions regard them as "evolutionary" qua the analogy to, and particular modeling tools borrowed from, evolutionary biology. In contrast, Veblen's (1899, 1914) topic was the evolution of economic and social institutions. He considered his contribution to be "evolutionary" because he tried to deal with his subject from the point of view of an extended version of Darwin's theory of descent. Other scholars focus on still other topics and may have still other notions of an "evolutionary" economics in mind.

In view of the diversity of interpretations associated with, and topics explored under, the label evolutionary economics, advances in the field depend not least on whether and how convergence to a coherent understanding of a common core can be achieved. (To that end, just enumerating a few shared theoretical features such as dynamics, bounded rationality, disequilibrium analysis, etc. – important as they are – is not sufficient.) Furthermore, it will be necessary to deal inclusively with all the topics of the different approaches. The scope of the evolutionary approach needs to be extended to the entire domain of economics from individual economic behavior to its aggregated consequences at the macroeconomic level, including normative aspects of welfare and policy making.

The chapters in this volume present advances in both respects. Some of the chapters – written by authors holding different views of

evolutionary economics – extend the corresponding theorizing to topics that either have not been explored yet or not in any depth. These chapters offer new insights. They thus exemplify how their take on evolutionary economics helps to foster the understanding of economic problems and phenomena that goes beyond the grasp of canonical economics.[1] Other chapters address the conceptual problems related to the different interpretations of an evolutionary approach in economics and discuss possibilities for their integration.

In the present introductory chapter we offer a broad orientation regarding the particularities of evolutionary theorizing in the economic context. We examine the ontological and methodological challenges that an evolutionary approach faces and outline the different responses that have been given to these challenges over the history of evolutionary economics. In the second section we will claim that it is an empirical fact that the economy evolves and that its evolution therefore requires an explanation. We discuss why canonical economics has difficulties recognizing this fact and coping with it. We then turn to the problem that the unfolding of the economy is a historical process. Evolutionary theorizing presupposes that there are recurrent patterns in this process and a mechanism or mechanisms that cause them. As will be shown in the third section, the questions of what these patterns are and what causal mechanisms generate them have been answered quite differently in the more than a hundred years of evolutionary theorizing in economics. This theorizing has appeared in three distinct waves. Each one had a distinct *leitmotiv* and took rather little notice of earlier waves. Building on the preceding reflections, we give a short preview in the fourth section of the eleven chapters following in this volume and explain how they contribute to advancing evolutionary economics. The last section presents the conclusions.

On the Difficulties of Recognizing and Explaining Economic Evolution

Imagine the following hypothetical situation. An economist studying consumer behavior has an exchange with a biologist studying animal foraging behavior. What hypotheses could the two mutually agree

[1] By canonical economics, we mean the standard textbook versions sometimes – misleadingly – labeled "neoclassical".

on? For the biologist it may stand to reason that price and income constraints are likely to influence human behavior. It is equivalent to the fact that an animal's choice of food depends on the physical effort required to obtain it and the animal's time constraint. However, the economist and the biologist are less likely to agree on the assumption that the observed behavior is a result of optimization. The biologist would likely wonder why the economist is so focused on proving the optimality of observed behavior. As a biologist she would rather be interested in explaining the motivational mechanism that stimulates the animal to act, such as hunger, thirst, or curiosity. The economist, in turn, is unlikely to pay heed to the motivations underlying consumption behavior. He would be content with invoking a utility function in which it is left open what the variable utility represents. Considering why certain things like food may in certain quantities be part of the utility function, and how these quantities may be influenced by biological factors is perceived by economists as unnecessary.

The difference in interpretations is deeply rooted in how economists conceive of their own discipline. Many of them subscribe to what Robbins (1932, 15) postulated: "Economics is the science which studies human behavior as a relationship between ends and the scarce means which have alternative uses." This postulate is usually interpreted to emphasize that human agents "economize" and choose actions in recognition of the opportunity costs, i.e. the foregone outcome of actions not chosen. The postulate can be given different interpretations. It can mean that economics is a kind of engineering science figuring out what economic agents ought to do in order to find the most efficient way of using their means for their ends. Alternatively, the postulate can be understood to call for an explicative science of human behavior based on the hypothesis that the agents actually make efficient choices. It is a widespread conviction, if not a dogma, that the constrained maximization calculus is constitutive for both interpretations and, hence, the defining property of economics.

The scarcity of means available for pursuing alternative ends is, of course, a situation not only faced by humans. It is a universal condition of life on earth. But this fact is far from implying universal efficiency (see Dupré 1987). On the one hand, it is true that, under natural selection pressure, organisms tend to develop traits efficiently adapted to what their environment requires for survival and

reproduction (Ghiselin 1974). On the other hand, nature is rather wasteful in building up selection pressure by using ample resources to generate a larger number of living beings than can be supported by the existing resources.[2] (Partial) efficiency is therefore only one aspect among many in biological research devoted to explaining the organism's actual functioning and its determinants. More important than that is the explanation of the evolution of the function under natural selection.

The functioning of organisms can be explained by physiological, molecular, and other conditions. This is called a *proximate* explanation in biology. Since the particular functioning is assumed to be a result of descent (with variation), one also needs to explain *why* this functioning has emerged. Usually this kind of explanation – called the *ultimate* explanation – focuses on an adaptive advantage that the functioning has endowed its carriers with in natural selection during the phylogeny of the species.[3] An illustrative example is the case of the evolution of flight. A proximate explanation for this functioning refers to the shape and movement of wings and tails, bodyweight–to–wing size ratio, buoyancy force, etc. The ultimate explanation for the evolution of flight draws on the hypothesis that flight endows organisms with an advantage in terms of escaping predators, accessing food (e.g., by capturing small prey, see Gauthier and Padian 1989), or other instances proven to enhance reproductive success.

[2] Moreover, natural selection improves adaptation by favoring heritable traits in a population that are only relatively a better fit for reproduction. When only competitors with weak traits are present in the population, this means that the selected traits may not be very efficient. (Heritable traits that are not relevant for reproductive competition may not even be subject to any gradual improvement.) This may also be true when an ecosystem implies conflicting selection tendencies so that natural selection tends to strike a compromise between them. As a result functional adaptation may be suboptimal in some traits as, for example, in the case of sexual selection; see Wilson (2000, 318–327).

[3] Proximate and ultimate explanations are part of the elaborate scheme of explanatory strategies developed in biology (see Tinbergen 1963). The criterion for an adaptive advantage is roughly to do better than competitors within the species in terms of the number of offspring carrying on the heritable trait to the next generation. On the definitional issues see Lloyd and Gould (2017). The hypothesis of an adaptive advantage can be tested by examining the fossil record of the species in view of what is known about the selection conditions faced by the species in their ancestral environment.

The difference in how economics and biology portray the consequences of scarcity is also salient when the economist's analysis of consumption is compared with the biologist's inquiry into foraging behavior. The latter observes that animals instinctively respond to (or "function" in) an environment with heavy fluctuations in the availability of food by massively expanding their food intake when food becomes available (e.g., Staddon 2009, Chap. 9). The instinctive response is brought about by an innate regulatory mechanism of the animals' metabolism (proximate explanation). The reason for why this instinctive response evolved can be explained by the advantage that such an adaptation of the regulatory mechanism has had for bridging frequent phases of starvation and thus for survival and reproduction chances (ultimate explanation).

In contrast, an economist analyzing strong fluctuations in the availability of food (and corresponding variations of food prices) would typically assume that consumers respond to these variations in a way that maximizes their utility function. Whatever the arguments of their utility functions (apart from food) may be, the usually assumed shape of the function implies the following: by the joint outcome of the income and substitution effect, a smaller quantity of food relative to the quantity of other budget items will be consumed, if the price of food goes up and vice versa (neglecting the possibility of a Giffen case).

The comparison raises a couple of interesting questions. First, what is the methodological status of the economist's analysis? Is it a rationalization (rather than an explanation) of the observed behavior in terms of an ad hoc specified utility function? Or should the analysis be seen as the equivalent of a proximate explanation, in this case, of how rational consumers "function"? Or is there even a basis for ultimate explanations, if canonical economics is interested in such explanations at all? We will come back to this issue in a minute. A second question that the comparison raises concerns the power of the utility maximization hypothesis if it is indeed used for explanatory purposes. All that can be derived from the hypothesis is the direction in which the optimal quantity of food consumption changes: it increases for lower food prices and vice versa. A different question is whether and when an increase in food consumption caused by decreasing food prices results in overeating. This cannot be answered without making a connection to physical variables and mechanisms in the first place.

However the connection is made, let us assume that consumers face a long-run trend of decreasing (relative) food prices and time costs of food consumption and/or rising income. Under such conditions, consumers have been observed to develop an obesity disease (Cutler et al. 2003). From the perspective of behavioral economics, the effect points to tensions between what Kahneman (2013) has called the fast, automatic system 1 and the slow, deliberate system 2. The former triggers the impulse to eat; the latter controls and reflects on the consequences of food intake. The distinction between the two systems obviously amounts to a major revision of rational choice theory. However, evolutionary economics suggests going even a step further, namely to explain why the impulse to overeat exists in the first place and for what reasons it has emerged. The answer is likely to be that consumers – as human animals – inherit the same evolved instinct to overeat as the biologist observes it in other animals. Yet food being constantly available in a First World environment, the still-present ancestral instinct expressed through system 1 results in what evolutionary biology calls a "mismatch" (Burnham 2016), if consumers are not sufficiently able to control their instinctive impulse through system 2.

This point highlights the difference an evolutionary approach to economics makes. It extends the focus beyond proximate explanations of the "functioning" of the economy and its agents – important as they are. Analogously to ultimate explanations, attention is directed in addition to the explanation of the historical change. This can be observed everywhere in economic behavior, technology, economic mechanisms and institutions, and even in macroeconomic regularities. At least in this respect the various approaches to evolutionary economics seem to agree despite their differing views of how to accomplish the task. However, explanations of the historical change can take quite different forms, which do not all amount to ultimate explanations. It is therefore useful to clarify what the ambition of an evolutionary approach shall be in this respect.

There are (1) historical explanations attributing observed changes to singular, historically unique, and therefore always different, causes. This form of explanation can frequently be found in historiographic research. Since it is an application of "situational logic" (Popper 1960, Chap. 31), i.e. based on ad hoc hypotheses rather than a more general theory, it will be left aside here. Another form is (2) historical

explanations attributing a special class of observed changes to a special pattern of causation. Hence, different recurrent aspects of economic change are explained by different hypotheses. An example is the set of hypotheses proposed by Nelson and Winter (1982) for explaining industrial transformation processes (see the next section). The pattern of causation that these hypotheses suggest is special in the sense that an extension to other classes of economic changes (in the case of Nelson and Winter, e.g., those occurring on the demand side) is not possible and not intended.[4]

Finally, there is a form (3) of historical explanations that attributes *all* observed evolutionary change to the *same* pattern of causation. This is the form of ultimate explanations. It requires a theory of a general, causal "mechanism" of evolution that manifests itself in all instances of the ongoing evolution. In biology, the Darwinian theory satisfies this requirement. The causal mechanism is constituted by the interaction of several processes. One of them is natural selection winnowing out less well-reproducing traits. Another one is allelic variation due to mutation, gene flow, and random drift in intergenerationally transmitted traits, as well as developmental and epigenetic variation (Gilbert and Epel 2009). A third process is that of geographic isolation allowing the branching off of different lines of descent. Further, there is a process of ecology and niche building that feeds back on variation and natural selection (Odling-Smee et al. 2003). Can the evolution of the economy be expected to be governed by a similarly general, economic, causal mechanism? Are all instances of the ongoing evolution of the economy a manifestation of such a mechanism so that ultimate explanations are possible at all?

An answer in the affirmative has been suggested by the proponents of Generalized Darwinism (see Hodgson 2002; Aldrich et al. 2008; Hodgson & Knudsen 2010). As the label indicates, it is claimed that the general causal mechanism postulated by the Darwinian theory for the natural sphere is valid for all domains in which evolutionary processes occur. An abstract reduction of the mechanism

[4] Another, earlier example is the "causal-genetic method" of explaining the emergence and change of economic institutions proposed by Menger (1985) [1883] and applied by him to the evolution of money. The Austrian school of economics, which Menger founded, did not adopt his method, missing the early chance to put forth a genuinely evolutionary approach; see Witt and Beck (2015).

is represented by Campbell's (1965) principles of variation, selection, and replication.[5] To put flesh on the bare bones of the principles, one can focus on the variation and selective replication of knowledge constructs and technological practices in economic evolution, as Mokyr (1990, 2002) has done (see later). Like in meme theory (Roy 2017), the differential replication of impersonal knowledge constructs and practices can be argued to depend on the extent to which they entail an adaptive advantage for their "carriers".

In the case of economic agents as carriers, this interpretation begs the question of what constitutes the adaptive advantage. Is the criterion for the advantage an objective one, such as reproductive success? Or is the advantage determined by the various agents' subjective preference satisfaction criteria? Since the relevance of reproductive success as an advantage measure is not obvious in modern economies, the straightforward measure seems to be subjective preference satisfaction. This would sit well with the idea of a Robbinsian decision maker. But ultimate explanations require hypotheses about a *general* mechanism. How can they be formulated on such a basis?

Abstaining from the selection and replication rhetoric, one could think of utility maximization (together with the usual assumptions about the properties of the utility function, see, e.g., in Mas-Colell et al. 1995) as implying the general causal mechanism. However, this canonical option lacks the substance necessary for deriving nontrivial ultimate explanations. In an individualistic framework the substance required for meaningful ultimate explanations would have to come from specific hypotheses about the content of the agents' preferences.[6] Moreover, hypotheses about interindividually shared content would be needed to avoid being drawn into the situational logic of historical singular-case explanations of the form (1).

From an evolutionary point of view, the preferences and utility functions of individuals living in a community quite likely share

[5] Campbell's principles are not a complete representation of the mechanism. In fact, doubts can be raised as to whether they are an accurate representation of "Darwinism". Some variants of Darwinism do not accept all the principles; see Levit et al. (2011).

[6] Whether optimization or some form of bounded rationality adequately represents decision-making behavior in a particular choice situation would be a different, and often less momentous, issue. Bounded rationality is significant, however, in the context of innovative behavior, which is the main source of variation in economic evolution.