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.

https://doi.org/10.1017/9781316477168.001 Published online by Cambridge University Press

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".

https://doi.org/10.1017/9781316477168.001 Published online by Cambridge University Press

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.

common elements. Humans are social animals, after all. For that reason, the diversity and subjective nature of individual preferences notwithstanding, social competition for survival and reproductive success over thousands of generations are likely to have left their traces in the human genome. Indeed, humans inherit motivational dispositions which they share with their likes (and in part also with many other species) with the usual genetic variance. These innate dispositions, finding an expression in their revealed preferences, can be conjectured to have been conducive to survival and reproductive success in the ancestral past, hence resulting in a selection advantage.[7]

Heritable motivational dispositions are, of course, not the only determinants of commonly shared preferences. Noncognitive (i.e., conditioning) learning enables humans to individually adapt their preferences and, hence, behavior (Leslie 1996). And so do their cognitive capabilities, allowing for cognitive goal setting and goal striving, which can create a motivation (i.e., a preference for acting) of its own (Bargh et al. 2010). As a result of cognitive and noncognitive learning, economic agents change their preferences and form new ones. This plasticity is subject to influences of the social groups and the culture to which the economic agents belong.

All these universally shared features in the preferences of human decision makers can be expected to leave their traces in the average choice behavior in suitably defined large populations of economic agents. (The observable variance in choice behavior is explained by the diversity of individual genetic endowments, conditioning histories, and cognitive goal-setting processes.) In the longer run, the average choice behavior determines which technological path tends to be pursued, which innovations tend to be adopted, and how institutions change (ignoring for the moment the complications due to unintended collective outcomes of individual choices). Specific hypotheses about the interpersonally shared motivational features should therefore provide the key for understanding what in the economic context the adaptive advantage is (see Witt

[7] Because genetic adaptation is very slow in terms of human time scales and selection pressure has decreased in recent times, they are still present without presumably having changed very much. Evidence for this hypothesis has been gathered in evolutionary psychology, see, e.g., Buss (2003). One of these motivational dispositions, arising from the need for cognitive and sensory stimulation, explains the just-mentioned human inclination to explore, search, and tinker.

2017). Reflected in the preferences revealed by the economic agents, these motivational features can be made the basis for ultimate explanations in evolutionary economics. The result would be an approach that, unlike Generalized Darwinism, refrains from a selectionist rhetoric and maintains the ambitions of a microeconomic foundation.

Three Waves of Thinking about Economic Evolution: A Brief Outline

The history of economic thought has seen many turns and changes for better or worse. The history of evolutionary thought in economics is no exception. A brief reconstruction helps in understanding what advances could be made and what further advances seem possible and desirable in the light of the discussion in the preceding section. In a rough outline, attempts to infuse evolutionary thought into economics have come in three waves. Each of the waves followed its own interpretation of evolutionary economics and took little notice of earlier interpretations. Despite the differences between them, there is, however, some common ground that the interpretations share.

The first wave of contributions has been triggered by Veblen (1898), the founder of the American institutionalist school. He was inspired by the Darwinian revolution ongoing at his time in the sciences. His endeavor – for which he coined the term "evolutionary economics" – was to extend the Darwinian theory of descent with variation to human behavior and human culture, including the economy. His interpretation of evolutionary economics can thus be inferred to rest on both a monistic ontology[8] and the assumption that, by recourse to Darwinian theory, ultimate explanations can, in principle, be accomplished. In the pursuit of his project, Veblen developed a narrative of the origins and the unfolding of the social organization of modern economies, particularly American capitalism. In this narrative he attributed a central role to innate instincts and learned habits. Thus, Veblen referred already to motivational forces driving the evolutionary process. Yet he failed to make explicit in what way he imagined them to constitute a general causal mechanism governing economic evolution. This is obvious in his major works

[8] For an excellent discussion of the ontology problem in economics, see Dopfer (2005).

(Veblen 1899, 1914) in which careful descriptions of the conditions of the capitalist society of his time are presented but no formal theory of how and why they have come about.

After Veblen the American institutionalist school that he had founded became increasingly vague with respect to its evolutionary legacy[9] and was eventually marginalized in the discipline. A new wave of evolutionary thinking emerged some seventy years after Veblen. It was launched in the form of a "neo-Schumpeterian" interpretation of evolutionary economics (Nelson and Winter 1974, 1975, 1977, 1978, 1980, 1982, 2002). In that interpretation, the label "evolutionary" is no longer referring to a monistic ontology as in Veblen. It instead stands for an analogy to biology, leaving aside the ontological relationships between economics and biology. A theory of industrial selection processes is constructed in loose analogy to the theory of natural selection.[10] On this basis, Nelson and Winter outline a historical explanation of the form (2) of how firms and industries evolve as follows.

The entirety of organizational routines and techniques applied by the firms in an industry are considered the analogue to the gene pool of a natural species. Routines and techniques are assumed to be subject to inertia (an assumption closely related to the theory of organizational ecology, Hannan and Freeman 1977). Therefore, changes over time in an industry are not brought about by the firms' efforts to mend poorly performing routines or techniques. Change is rather caused by market competition which, analogously to natural selection, is assumed to

[9] Veblen's successors kept the label "evolutionary economics". Yet they successively abandoned the Darwinian connotations, retaining only Veblen's historicizing style of analysis and his critical attitude toward contemporary capitalism (see Hodgson 2004).

[10] For a recent assessment see Winter (2014). Unlike Nelson and Winter, Andersen (2009) tries to interpret Schumpeter himself as sticking to a "selectionist" evolutionary approach despite Schumpeter's (2002[1912]) explicit rejection of biological analogies. Indeed, Schumpeter's theory of how capitalism is driven by the emergence and diffusion of innovations seems to be anchored in a quite different strand of thought. This is the nineteenth-century diffusionism school (Kobayashi 2014). It was founded in social and cultural anthropology by the German geographer Friedrich Ratzel and was given prominent expression in the "Kulturkreis" doctrine of the ethnologists Frobenius and Graebner, whom Schumpeter knew; see Schumpeter (1955, Part IV, Chap. 3, Sec. 2b). As has been argued elsewhere (Witt 2008b), Schumpeter can therefore only be considered an evolutionary economist if the notion of evolution is defined in such a way that it includes nonselectionist diffusionism as well as selectionist interpretations.

winnow out firms with routines that perform poorly. As a consequence, the composition of the industry's pool of routines and techniques is changing over time. Hence, the industry's adaptation dynamics is fueled by the heterogeneity of firms and their routines, resulting in profitability differentials.[11]

Firm heterogeneity can be captured by frequency distributions over their various properties and, in particular, their profitability. Price and cost competition within an industry that results in a selection process should then come down to systematic changes of the frequency distributions, particularly the unit cost and profit distributions. This can be modeled by means of a replicator dynamics that describes how both the composition of firms/routines and the price level in the industry converge simultaneously to an equilibrium state in which only the most efficient firms survive (see Metcalfe 1994; Holm et al. 2017).

Nelson and Winter's synthesis has more recently been blended with traditional research on the industry life cycle going back to Abernathy and Utterback (1978). The result has been fruitful explanations of the form (2) of the history of, for instance, the American automobile industry (Klepper 2002), the world synthetic dye industry (Murmann 2003), and the American tire industry (Buenstorf and Klepper 2009). All are characterized similarly by the "shake-out" phenomenon (Klepper and Simons 2005). Another important branch in the present writings associated with this brand of evolutionary economics continues Schumpeter's original research interest in innovations and their impact on the economy outside the framework of the natural selection analogy. In this branch, historical explanations of form (2) have been developed for the economic competitiveness and growth of entire nations (Rosenberg and Birdzell 1986; Amendola and Gaffard 2006; Metcalfe et al. 2006), the regional and international division of labor (Brenner 2004; Los and Verspagen 2006; Fagerberg et al. 2007), and the role of the institutional framework of national innovation systems (Lundvall 1992), to give a few examples.

In any case, with the exception of Joel Mokyr's works, historical explanations of the form (3) – ultimate explanations of the observed economic changes as manifestations of one and the same general

[11] To capture the heterogeneity of firms, the construct of a "representative" firm often found in economic textbooks has to be replaced by population thinking. The latter is a prerequisite for understanding selection processes which always operate on the heterogeneous composition of populations; see Metcalfe (2008).

causal mechanism – are neither attempted nor intended. If they were, it would make sense to choose an individualistic approach also in the strongly supply-side-centered Schumpeterian and neo-Schumpeterian context. Resource saving, technical progress, cost and price cutting, product innovations, etc., are driven, after all, by motivations that are expressed by the agents' preferences. They warrant an analysis that, moreover, would have brought the neo-Schumpeterian approach closer to Veblen's focus on the motivations driving the economy. Yet from the outset the neo-Schumpeterian program had little interest in the motivational side – unlike Schumpeter himself.[12]

When Nelson and Winter (1982, Chaps. 2 and 3) reflect on (organizational) behavior, they focus on and challenge the optimization hypothesis. Setting the trend for most neo-Schumpeterians after them, they substitute it with the notion of bounded rationality. The latter goes back to Simon (1955) and March and Simon (1958) who deal with the procedural aspects of *how* decisions are made. Like in the canonical approach the motivational aspects (i.e., the specific reasons for *why* decisions are made) is left open. Decision makers are assumed to have limited cognitive (and managerial) abilities. They therefore handle repetitive choice situations by resorting to behavioral routines that proved to have satisfactory results in the past rather than mulling over in each and every case what the optimal choice might be.[13] This is assumed to be true even more so for the concerted decision making in firm organizations – hence, the inference that firm behavior is largely guided by organizational routines (Cyert and March 1963; Simon 1979).

More recently, the bounded rationality premise has also been a constituent for applying simulation tools, particularly agent-based modeling, in evolutionary economics. The topics investigated in these new extensions revolve around the Schumpeterian themes of firm growth; industrial, innovative dynamics and their aggregate effects (e.g., Saviotti and Pyka 2008); or go in the direction of complexity

[12] To give reasons for why the elitist entrepreneurs Schumpeter (1934[1912]) had in mind pursue their path-breaking, incalculable, innovative undertakings, he reflected in detail about their nonpecuniary motivations.

[13] Starbuck (1963). Limited cognitive capacity is also a central hypothesis in the more recent brand of behavioral economics. However, the consequences emphasized in that approach are different ones, namely various systematic biases in decision making and the need to resort to standardized decision heuristics, see, e.g., Kahneman (2003).

economics (Elsner et al. 2014). Other research efforts in the neo-Schumpeterian camp are now directed at intensifying innovation studies and empirical work on industrial dynamics. In contrast, the original, evolutionary inspiration seems to have lost momentum.[14]

Evolutionary theorizing in economics is now pushed in a new, and once more different, wave of contributions. It emerged in the aftermath of the game-theoretic revolution in microeconomics and the subsequent rise of experimental economics. The new wave is disjoined from, and does not take notice of, the previous ones.[15] In several respects the contributions to this new wave interact with contemporary efforts in the sciences to gain a better understanding of human sociality. Where they do, they follow a monistic ontology and acknowledge that the consequences of human sociality for economics need to be seen within the wider framework of the evolution of the species (see, e.g. Gintis 2007). Yet it is also recognized that the broader frame leaves room for specific influences of human culture.

In the human sciences, a debate beginning in the 1970s on the relevance of sociobiology raised questions about social behavior that appeared to be "altruistic" and difficult to align with the prevailing notion of "selfish" genes (Dawkins 1976). In order to help resolve the puzzle, evolutionary game theory was developed as a new analytical tool.[16] The debate triggered a series of comparative works that

[14] See, for example, the handbook of neo-Schumpeterian economics edited by Hanusch and Pyka (2007) in which reflections relating to evolutionary content cover not even 50 out of 1,170 pages.

[15] While the terms "evolutionary", "evolution", etc., are frequent in these contributions, particularly in relation to evolutionary game theory, the term "evolutionary economics" is hardly ever used, perhaps because it is perceived as being associated with the concurrent neo-Schumpeterian school. Bibliometric search of the economic literature discloses that the terms "evolution" and "evolutionary" are now more closely associated with the new wave than with neo-Schumpeterian evolutionary economics; see Silva and Teixeira (2009) and Hodgson et al. (2014).

[16] Unlike rational game theory, evolutionary game theory assumes that strategies are not subject to deliberate choice. The relative frequencies with which the strategies are played are rather seen as an expression of the behavioral repertoire encoded in the gene pool of a species and as being subject to natural selection. Accordingly, the payoffs reflect the heritable strategies' contribution to reproductive success (Maynard Smith 1982). Under these assumptions "altruistic" behavior has been explained alternatively as a phenomenon of reciprocity (Trivers 1971), of inclusive fitness (Hamilton 1964), or of group selection (Wilson and Sober 1994).

confirmed genetic influences on human social behavior. At the same time, however, the comparisons revealed important differences between human social behavior and the behavior of other social animals. Most importantly, humans are capable of social cognitive learning by which they can go beyond their inherited behavior repertoire. They can establish cooperative modes of behavior in social interactions and transmit them between generations in a process of cultural inheritance.[17]

Laboratory experiments in economics also revealed that participants often engage in other-regarding and cooperative behavior in strategic interactions instead of a "self-interested" utility maximization (e.g., Güth et al. 1982; Andreoni 1995; Hoffman et al. 1996). Likewise, field studies pointed to a high prevalence across different cultures of other-regarding or "altruistic" behavior (Henrich et al. 2004). Thus, some way had to be found in economics to theoretically account for these findings. For a while evolutionary game theory was considered a potential candidate rivaling with rational game theory in resolving the puzzle.[18] However, perhaps because of the cognitive bias of economic decision theory, at the end of the day rational game theory prevailed – albeit with some adjustments.[19]

In the terms of the preceding section, the explanations given for other-regarding and cooperative behavior and its consequences are proximate explanations (if not simply rationalizations as Smith 2015 argues). The question that remains is that of the ultimate explanation:

[17] Animals are to a certain extent also capable of adapting their social behavior through reinforcement and conditioning learning, yet an intergenerational transmission of these acquired forms is rare and, at best, rudimentary (see Brown and Richerson 2014). The unique human condition of inheriting genes *and* culture led to the "dual inheritance theory" (Cavalli-Sforza and Feldman 1981; Lumsden and Wilson 1981; Boyd and Richerson 1985), which extends the basic model of sociobiology.

[18] In the discussion it was suggested to interpret the convergence to an equilibrium described by evolutionary games as a learning rather than genetic process, more precisely as an interactive reinforcement learning; see Börgers and Sarin (1997), and Brenner (1998).

[19] See, e.g., Binmore (2006), Gintis (2007), and Bowles and Gintis (2011). In rational game theory the puzzle of other-regarding individual behavior can be resolved by a simple modification of the assumption about the players' preferences. Other-regarding behavior results when the players choose the strategy that maximizes the utility derived not from their own payoff but from the somehow weighted sum of their own payoff and the payoff accruing to the other player(s).

What is the reason for why such behavior could evolve? Economists here borrow the answer given in evolutionary anthropology: in an environment such as the one faced by the early humans living in small groups in ancestral times, other-regarding behavior can have a reproductive advantage (Richerson and Boyd 2005). A genetic disposition accounting not only for one's own payoff but also for the payoff of other group members, can therefore be assumed to have been favored by natural selection in ancestral times. If so, it can be argued that such a social preference is still genetically represented in human behavior today and is therefore likely to influence the utility maximizing strategy choices to a certain extent.

However, other-regarding preferences are not the only social dispositions humans inherit. There is also a tendency to free-ride, to aggressively strive to dominate, and to selfishly manipulate and deceive others.[20] In a cooperative social environment, such behavior would have a selection advantage over other-regarding behavior and, if not kept in check, would drive other-regarding behavior to extinction. The challenge for explaining why a cooperative mode of social behavior could evolve is therefore to find reasons for a balance between these two opposing dispositions.

The reason may be conjectured to be that over thousands of generations of reproduction within the small ancestral human groups, a genetic disposition for developing emotional bonds to the own group may have been selected for. (Such emotional bonds support a high degree of internal cooperation, as it was necessary in ancestral times for child rearing, successful hunting and gathering, the defense against predators, and being able to compete with rivaling species for food sources.) As a consequence, the ambivalence in human social behavior has different effects in in-group vs. out-group interactions. Identification with an "own" group fosters group loyalty (particularly in the confrontation with other groups; see Bowles 2008) and other-regarding preferences in interactions with members of their own group. By the same token, it diminishes aggression, dominance striving, free-riding, and other selfish tendencies. Where such behavior nonetheless occurs within the group, it can be suppressed (if not too

[20] These inclinations can be conjectured to be an inheritance of our primate ancestors (Eibl-Eibesfeldt 2004, 525–560) and can still be observed as common attitudes in competition for resources and mating opportunities in many primate species.

frequent) by ostracism that is mediated by a spontaneous formation of corresponding coalitions (see Boehm 2001). Hence, a pro-social maximization of utility derived from own payoff and the payoff of others seems to be contingent on whether or not interactions are framed as an in-group activity.

The third wave of evolutionary theorizing now under way in economics has been fruitful in advancing the understanding of pro-social behavior and its evolutionary background. It has replaced the narrow self-interest interpretation often associated with Robbins's definition of economics by an interpretation allowing for the complex contingencies under which social behavior can range from altruism and cooperation to pure self-interest and opportunism. It is worth noting that social preferences are ultimately explained as inherited motivational dispositions in a way comparable to the ultimate explanation suggested in the preceding section for preferences in the context of nonstrategic economic behavior. However, not least because of the dominant analytical role of game theory, the explanation is limited to preferences relevant for economic behavior in social interactions. Such a limitation may be acceptable for an individualistic version of sociology (as claimed by Gintis and Helbing 2015). But the innate motivations and preferences relevant for other important parts of economic behavior such as consumption can evidently not be fully covered by this approach. There is, thus, still some way to go for the individualistic theorizing in evolutionary economics until the many additional aspects that matter are integrated (see Burnham et al. 2016 for a list of them).

Advancing Evolutionary Economics: Methodology, Theory, and Normative Judgement

This volume presents important extensions of the methodological, theoretical, and normative underpinnings of an evolutionary approach to economics. Some of the chapters take a bird's-eye view of the evolutionary process in the economy. Other chapters elaborate on special problems that need to be solved in order to make progress in evolutionary economics. Brian J. Loasby's Chapter 2 marks the beginning of a section on conceptual and methodological issues. With the outline of a counterfactual history of economic thought in the twentieth century he offers a broad orientation on theoretical developments that could have taken place but did not, in contrast to those

that did. In this way he characterizes a kind of mental ecology of economic ideas in which the three just-discussed waves of evolutionary contributions tried to gain a foothold in economics.

Loasby explains that a significant point of controversy was the notion of market equilibrium and the concepts for the equilibrating process by which it was supposed to be attained. Since Walras, canonical economic theorizing worked on, and eventually succeeded in, proving in a thought experiment that a unique *general* economic equilibrium is logically possible under properly chosen assumptions about the price mechanism and the behavior of the market participants. The further question of how that equilibrium might be reached simultaneously in all markets was more difficult. Walras imagined an equilibrating process run by an auctioneer linking the change of price to the sign of the excess demand function in each market. However, this construction forced Walras to resort to a fiction. He had to assume that no production and exchange take place before the auctioneer's adjustment of price quotes has reached the equilibrium price (see also Fisher 1983).

As Loasby points out, the main opponent to the general equilibrium approach was Marshall. Focusing only on equilibrating market processes in single industries, he was less ambitious. On the other hand, his partial analysis did not force him to invoke Walras's no-false-trading and no-production fiction. While Marshall was lacking an analytical apparatus to present his dissenting views, the neo-Schumpeterian analogy to natural selection processes can provide one. The models by Nelson and Winter and Metcalfe that were mentioned in the preceding section discuss equilibrating processes in single industries while not excluding that production and trade take place already at nonequilibrium prices. Metcalfe (2002) even proves rigorously that the competitive price adjustment driving a shake-out process in the industry eventually results in an equilibrium constellation.

This may not be surprising as, from a formal point of view, the replicator dynamics and the optimization-based auctioneer's rule are not much different (see Joosten (2006). Regarding the explanation of the equilibrating process, the neo-Schumpeterian selection models still fit a rather conventional format.[21] The major difference between the

[21] In the same vein Mirowski (1983) criticizes a lack of new insights offered by the market process simulations in Nelson and Winter (1982).

canonical and the neo-Schumpeterian interpretation is that the latter looks beyond the market equilibrium and the equilibrating process. The canonical interpretation treats disruptions of the equilibrium as "exogenous shocks" that require no explanation. In contrast, following Schumpeter (1934[1912]), the neo-Schumpeterians see a substantial part of the disruptions as being caused "from within" the economy, as Schumpeter already put it. The key hypothesis for explaining this part of the market process is entrepreneurial innovativeness resulting in a "creative destruction" of the preexisting market conditions. The details of what enables a seemingly incessant stream of innovations to countervail the equilibrating processes in the markets are not yet well understood.[22] Loasby rightly insists in his thoughtful piece that to make progress, inquiry into the role of knowledge creation in the economy (enabling entrepreneurs to carry out "new combinations") will be of central importance.

Crucial contributions to that inquiry have been made by Joel Mokyr (e.g., 1990, 2002) who reviews many of his insights in his rich Chapter 3. His topic is the evolution of useful knowledge, which he considers the major driver of economic evolution and growth. Taking the perspective of evolutionary epistemology, Mokyr conceives of the evolution of human knowledge as being governed by the principles of blind variation, selection, and retention suggested by Campbell (1965).[23] The principle of variation refers in Mokyr's interpretation to how the huge variety and variability of useful knowledge has historically emerged from past innovations. In its enormous variety, useful knowledge must be constantly reproduced from generation to generation (with possible additional variation) – the equivalent of the principle of inheritance. And since the generation of useful knowledge is "super-fecund" in producing variability, not all variants can be preserved. Selection takes place by the fact that some knowledge (e.g., a particular technique) is chosen over other variants to be maintained and handed down.

[22] As pointed out elsewhere (Witt 2009), part of the problem is that answering these questions faces serious epistemological constraints that are difficult to overcome.

[23] As mentioned in the previous section, the proponents of Generalized Darwinism claim that these principles govern the evolution of all complex population systems from the species in living nature to human languages or the economy; see Hodgson and Knudsen (2010).

The claims of proponents of Generalized Darwinism, like Mokyr, regarding the explanatory power of the three abstract principles of variation, selection, and retention are under debate in evolutionary economics. For Mokyr there is a general, causal mechanism that shapes the evolution of the economy through the creation and selective replication of propositional and prescriptive knowledge. It can serve as a basis for ultimate explanations. For the opponents of Generalized Darwinism, in contrast, these principles are only a device that may guide the attempt to detect a common abstract mechanism underlying many seemingly diverse processes in different disciplinary domains. In Chapter 4, inspired by the philosophy of science, Jack Vromen outlines reasons that speak for that position.

Vromen argues that by invoking the three abstract principles "top down" for identifying the same features in evolutionary processes in different disciplinary domains, an attempt is made to unite the different domain-specific phenomena under the working of one and the same mechanism. Following philosopher Philip Kitcher, Vromen points out that, if successful, such a unification is an explanation of an own kind. Yet "unification-as-explanation" is different from causal explanations. To arrive at the latter, additional causal hypotheses are required, which are specific to the disciplinary domain – in this case, the economy and its evolution. Hence, whether or not one wishes to find inspiration by the abstract principles of Generalized Darwinism in looking for such causal hypotheses, the principles themselves cannot serve as such hypotheses.[24]

Proponents of Generalized Darwinism in evolutionary economics rarely formulate necessary "auxiliary", domain-specific, causal hypotheses (for an exception see Mokyr's chapter in this volume). They rather construct an abstract analogy between genotypes and phenotypes on the one side and "replicators" and "interactors" on the other. The universal patterns of causation in economic evolution are expected to follow from the interplay of replicators and interactors in the same way as descent with variation of the species is causally explicable by what happens in the interplay of genotypes and

[24] Indeed, Aldrich et al. (2008) admit that the principles of variation, selection, and inheritance only offer "an overarching theoretical framework in which theorists can develop auxiliary, domain-specific explanations".

phenotypes under natural selection pressure. By this construction, Vromen objects, Generalized Darwinism runs into a dilemma. On the one hand, the aim is to have three principles that are universally applicable, because all domain-specific remnants from evolutionary biology are claimed to have been stripped off. On the other hand, the principles do not suffice for the causal explanations of evolutionary processes, and the domain-specific remnants from evolutionary biology enter through the backdoor as the necessary "auxiliary" hypotheses in the disguise of the replicator–interactor construct.

Chapter 5 by Richard H. Day marks the beginning of a section on macroeconomic topics with contributions written from different evolutionary perspectives. Day presents a perspective on how the human economy has progressed in the very long run. This perspective blends ideas that he had developed in an earlier work, such as those on adaptive economic change (Day and Cigno 1978) and chaotic dynamics (Day 1982), with specific hypotheses about the historical unfolding of the economy. Economic development is portrayed as a sequence of distinct stages. It moves from hunting and gathering to quasi-settled agriculture and herding, settled agriculture, complex societies and city states, trading empires, industrial economies, and the nation-state and has now arrived at the present global information economy. Each one of these stages is characterized by a distinct interplay of production technologies, trading institutions, governance structures, and population dynamics. The result is a typical pattern of growth, maturation, and decline in the macroeconomic performance over time. The decline triggers a chaotic transition phase paving the way for the next stage.

With respect to the general causal mechanism underlying the transformation of the economy in each stage and the transitions between them, Day argues that a more detailed analysis would be desirable. However, to accomplish this, macroeconomic theory needs to be augmented with a number of features. Among his theoretical desiderata are a birth-welfare threshold that represents a standard of living below which societies perish; diseconomies related not only to inputs but also to coordination and complexity; the social infrastructure of societies and its administrative technology; and the possibility of switching between multiple technological regimes. Enhanced in this way, the theory would suggest a specific historical explanation of the

earlier-discussed form (2).[25] Day's framework promises advances particularly for understanding the factors and nonlinear dynamics that are critical for triggering transition phases. Day discusses exemplarily what lesson the case of the disintegration of the Soviet Union in the 1990s carries in this respect. Furthermore, he reflects on the conditions that would point in the light of his theory of economic evolution to the possibility of a future decline of the United States. Day concludes the chapter by pondering what implications this framework has for understanding the limits to growth.

The topic in André Lorentz's Chapter 6 is the Kaldor-Verdoorn law, highlighting a special macroeconomic phenomenon. The law claims that productivity growth in a sector of an economy (e.g., an export sector) is positively related to the growth of output of that sector. The law has been applied to explaining *inter alia* the emergence of efficiency-based international specialization patterns. The law is originally a generalization inspired by the empirical observations Verdoorn had made. As such, it is not entirely clear what the causal mechanism underlying the proposed law is. In his chapter, Lorentz sets out to offer a theoretical explication of the law by means of a micro-founded macro model of an economy using agent-based modeling for that purpose. For the economy as a whole, the relationship stated by Verdoorn's law implies increasing returns when output expands. Lorentz's model derives these increasing returns at the macro level as an emergent property of the processes of innovative technical change at the micro level.

His analysis is an excellent example of recent neo-Schumpeterian theorizing aiming at explanations of the form (2), in his case of the historically observed increasing returns in the process of economic growth. The "evolutionary" part of the explanation is the analogy to natural selection. Accordingly, Lorentz starts from differences between firms in improving their technology by investments. Over time, these differences change the cost structure in the economy, which, in turn, gives rise to a competitive selection process among the

[25] As in the case of all stage theories, an empirical test of the theory is difficult; see Popper (1960). The idea that societies progress to ever higher stages of development is a characteristic of many economic stage theories from, e.g., Spencer to Marx and Rostow. For the difficulties of testing such theories and contradictory empirical evidence see Currie et al. (2010).

firms. This process is modeled by means of a replicator dynamics analogously to Fisher's fundamental principle of natural selection.[26] The process is fueled by innovations – the analogue to genetic mutations – which in Lorentz's model are generated in a random fashion contingent on technological opportunities arising with a growing capital stock. The more capital and innovations there are, the greater the rate of innovativeness and of the growth of labor productivity. Knowledge spillovers taking place in the industries allow imitating firms to improve their production technology as well, with the result of overall increasing returns. The Kaldor-Verdoorn law follows by implication. Lorentz's neo-Schumpeterian micro-foundation of the law does not have to assume the existence of static increasing returns as traditionally considered elsewhere. Where increasing returns are caused according to Lorentz's model, they are intrinsically dynamic.

The section devoted to advances in theorizing about institutional evolution begins with Dennis C. Mueller's Chapter 7. He takes a wide-ranging, critical tour through institutional economics, public choice, and political science inquiring especially into the role of the rational actor model in these disciplines and its limitations. The rational actor is but a variant of a fully informed Robbinsian decision maker, a theoretical fiction already discussed earlier. Mueller's criticism of the fiction is not only based on the objections against the rational actor model raised in the growing field of behavioral economics (see Camerer and Loewenstein 2004). He is also concerned with the fact that the focus on rationality has impeded the understanding of ethical influences that are especially relevant in the context of political choices. The limitations of the rational actor model turn already up in the well-known voting paradox, implying that rational voters would never vote given the negligible influence on the turnout that an individual vote has. For Mueller the fact that the opposite can be observed indicates that ethical considerations induce behavior that cannot be satisfactorily explained by the rational actor model alone.

[26] The principle states that the relative frequency of individuals with fitness higher (lower) than the average fitness in a population increases (decreases). The pace of adaptation of the average fitness to the level of the individuals with the highest fitness is proportional to the fitness variance in the population; see Hofbauer and Sigmund (1988, Chap. 4).

Mueller's criticism is framed by broader reflections on the evolution of both rationality and ethics in humans, but also of superstitious and mythical thinking. These reflections – drawing on the recent discussion in evolutionary psychology – tie in to what has been labeled earlier the third wave of evolutionary theorizing in economics. In the light of these reflections Mueller goes on discussing the evolution of political institutions, particularly democratic institutions. Special attention is paid to the role of religion for the political organization of societies. While the role of religion in this context is often seen in supporting, if not enabling, the emergence of cooperativeness, Mueller develops a further, more skeptical argument. He explains that the functioning of a democracy requires both the capability and the willingness to make rational, ethically committed collective decisions. In his view, some forms of religious belief are not supportive of these requirements.

Formal organizations, i.e. the class of designed and deliberately implemented institutions, are the topic of Chapter 8 by Roger D. Congleton. He takes an evolutionary approach to these institutions in which two issues are of particular interest. One of the issues is the explanation of typical features of the institutions' historical unfolding from their creation to the subsequent adaptations. The other issue is the explanation of how they "function", i.e. of the way in which their governance structure works, as a result of the historical adaptation process and its necessities and limitations. Congleton's chapter deals with both issues concurrently.[27]

He starts from the observation that many private and nonprivate organizations such as business corporations, political bodies, and religious bodies have an organizational governance structure that follows the "king-and-council" template, as he calls it. This template is made up of a special set of organizational rules dividing the decision-making authority between two bodies. On the one side there are "formeteurs" (an individual or a small group) corresponding to the role of the king. They have created the formal organization with the purpose of generating surplus by team work synergies. In order to

[27] Yet another comparative approach that has recently been proposed is that of deriving inspiration from social biomimicry. This approach analyzes similarities and differences between the working of deliberately designed institutions in the human sphere and organizational features that have evolved under natural selection in social insects; see Fewell (2015).

accomplish their goals, they define the rules, recruit the team members of the organization, and determine the distribution of the rewards that can be reaped by forming the organization. On the other side there is a subgroup of senior team members forming the council. The council members have at least an advising function in the formateurs' decision-making process, but often also a partial decision-making power as well.

The question is why and how organizational change is very often attracted to the king-and-council structure. Congleton suggests that a special causal mechanism is at work, thus offering an explanation of the form (2) for this evolutionary regularity. In a nutshell, his explanation goes as follows. With a growing size of the organization, the intensity of control through the formeteurs decreases and requires delegation of decision-making authority (and responsibility) to senior team members. This requires corresponding adaptations of the organizational decision-making procedures. If such an adaptation fails or the opportunity for undertaking it is missed, the organization runs the risk of efficiency losses. Since, as a consequence of resource scarcity and competition with rivals, organizations are under selection pressure, severe efficiency losses tend to threaten the survival of the organization. Congleton argues that the king-and-council template therefore has a high probability of spreading among organizations that grow large, either because it is selected for or because it is deliberately adopted by imitation by the formeteurs who recognize its superior performance in other organizations.

In Chapter 9 Reinoud Joosten elaborates on informal institutions or, more specifically, on whether and when they do, or do not, fail to emerge spontaneously. Joosten explores a situation in which a self-imposed obligation to keep to a rule would constitute an informal institution if everybody were to obey to it. Under what conditions is abiding by the rules to be expected from rational players when following the rules is costly? The particular case serving the exemplary discussion is individual negligence in taking care of a freely accessible commons. Such behavior often results in small-scale pollution. If everybody acts in the same manner, the cumulative effect eventually adds up to a major degradation of the environment.

To capture the unfolding nature of the environmental degradation process, Joosten makes use of an advanced class of game-theoretic models (indicating that his work relates to the earlier mentioned third

wave of evolutionary theorizing in economics). These are "frequency-dependent games", i.e. games in which the players' payoffs vary over time with the frequency of the previously chosen strategies. The payoffs represent the utility that the players obtain from the current state of the environment. The payoffs are also contingent on whether the players choose the strategy of conforming to the costly non-negligence rule. The latter always results in a lower payoff than the negligence strategy. Hence, from a rational choice perspective, a variant of the commons dilemma – a social trap (Cross and Guyer 1980) – is implied here in which the immediate utility gain from negligence conflicts with the cumulatively arising disastrous long-term consequences.

To ease the investigation of the intricate, time-distributed unfolding of the external effect potentially implied by the frequency-dependent game, it is assumed that the players are fully informed about the strategies and short- and long-term payoffs.[28] On this basis, Joosten is able to derive a solution that mimics the standard framework of repeated games. This means, *inter alia*, that the players are assumed to be involved in a rather direct strategic interaction, allowing a certain level of social control. Under that condition the players can threaten with the disastrous consequences of a permanent own negligence in order to discipline fellow players and to induce them to play by the rule. Indeed, Joosten derives a set of subgame-perfect equilibria of the game in which the degradation of the commons is prevented: for all players the best choice is to avoid entering the social trap, provided they are sufficiently patient. If, as often in reality, the assumed level of social control cannot be exerted or the time horizon of the players is rather short-lived, the fate of the common environment is, of course, likely to be a different one.

Chapter 10 by Christian Schubert turns to a special subset of institutional problems. These are the problems of regulating land-use conflicts by law and/or by court decisions, including the problem of compensating for governmental takings (i.e., expropriation of private property in land). These problems form a core research topic of the law and economics (L&E) literature. Schubert's reflections can

[28] The evolutionary process from which an institution like this emerges is not addressed. An explanation of such a historical adaptation process would presuppose incompletely informed players and an inquiry into their learning and imitation behavior.

therefore also be seen as a critique and suggested revision of the L&E approach to land-use issues from an evolutionary point of view. As he points out, the relevant tenets of L&E are informed by a thought experiment introduced by Coase (1960). Coase portrayed a bilateral conflict in the use of agricultural acreage and tried to derive conditions (summarized in what has afterwards been called the Coase theorem) under which it can be solved if the sole criterion is the efficient use of the land.

Schubert argues that this framework fails to do justice to the actual complexity of the evolving, competitive process of land uses, which in the majority of cases takes place in urbanized agglomerations. Neighborhood externalities and spillovers should therefore be expected to regularly generate repercussions that involve competing, if not conflicting, land-use intentions of a multitude of land owners/users. This fact is not sufficiently done justice to, Schubert claims, by lumping together the consequences of the involvement of many agents in an inflated transaction cost variable. Moreover, the static efficiency concept implicit in the solution of the bargaining games usually applied in L&E for modeling land-use conflicts does not suit the actual dynamics of urban agglomerations. They are subject to continuous transformation processes resulting from changing utilization patterns, which reflect, in turn, changes in technology and adaptations to changing traffic, cost, and revenue structures. A regulation of land use that only accounts for efficiency under the momentarily prevailing constraints may therefore be at odds with dynamic efficiency. The latter may, for instance, be obstructed by regulations that are efficient only under present conditions but invoke barriers that drive up the costs of future conversion needs.

Finally, the framework invoked by Coase's thought experiment ignores that any regulation proposed for the emerging conflicts can be contested by questioning its legitimacy. Schubert holds that any practically relevant regulation needs to also take the normative legitimation problem into account. Legitimacy is contingent on the extent to which regulations respect informal institutions that have evolved in a society, particularly the social norms of distributive and procedural fairness. By referring to these additional criteria, Schubert connects to a topic that is central to much of the research in the previously mentioned third wave of evolutionary theorizing in economics. If taken seriously, a corresponding extension of L&E needs to solve two

problems on which Schubert elaborates in more detail. One of them is to construct concrete measures for distributive and procedural fairness. The other problem is to properly weigh those measures against the efficiency criterion wherever tensions between the two criteria are implied.

If the results of the evolution of the economy are subjected to a normative assessment, this is not without problems, as the chapters by Dennis C. Mueller and Christian Schubert show. Further facets of such a normative assessment are discussed in the two chapters forming the last section of the present volume. An important facet is the question of what role welfare theory can play in an evolutionary approach (i.e., the assessment of the welfare effects of economic evolution). Do the intertemporal transformations of the economy also transform the very welfare measure(s)? If so, in what way can welfare theory be modified to account for these transformations? These questions are center stage in Chapter 11 by Martin Binder and Ulrich Witt. Their point of departure is the role that innovations and innovativeness play in the course of economic evolution, an issue that figures prominently in the neo-Schumpeterian approach to evolutionary economics.

Innovations help to tap new resources and to raise resource efficiency by pushing technical and organizational change. Innovations give birth to a plethora of new goods and services, many of which trigger a new demand, contributing to a growing consumption. There is no doubt, thus, that innovativeness contributes to economic growth, to improving labor productivity and working conditions, and to rising the standard of living. For these reasons, innovations and innovativeness are usually considered highly welcome not only among the neo-Schumpeterians but also among policy makers and in the public. However, in terms of a welfare-theoretic assessment it is less clear whether the role of innovations can indeed be given that much credit.

As Binder and Witt point out, there are two main reasons for that. The first one is simply that, by a kind of innovation optimism, it is often ignored that innovations can cause negative externalities. These externalities are frequently notoriously difficult to anticipate and therefore unknown when innovations are introduced. Before such innovations are stopped, they can thus develop consequences rated disastrous by any welfare measure. The second reason is that, at least

as far as consumption goods and services are concerned, innovations create a demand that did not exist before. This fact points to an innovation-induced change of preference of the consumers. However, when innovations can influence the measuring rod by which their welfare effects are supposed to be assessed, an unambiguous judgment on the welfare effects is difficult, if not impossible. Can the problem be resolved by replacing preference satisfaction as the measuring rod by some other measure? Exploring in more detail how the problem might be solved, Binder and Witt review different approaches to welfare theory that use different measuring rods. As their discussion shows, however, a fundamental ambiguity in the normative foundation of the welfare judgment regarding the role of consumer innovations remains.

Consumer behavior in modern, innovative economies and, in particular, its sustainability is also the central aspect of economic evolution that Andreas Chai addresses in his Chapter 12. Many commentators have by now launched the ecological argument that current consumption trends are unsustainable. With his discussion of recent developments in evolutionary consumer theory, Chai is able to shed new light on the problem. He argues that a lack of sustainability is at least in part due to consumer preferences being determined by factors that are beyond the control of the individual, such as technological paradigms, social factors, and institutions. The consequence is that consumer preferences tend to be subject to "lock-in" effects to the extent to which these factors are themselves subject to lock-in effects.

Drawing on insights from evolutionary consumer theory, Chai seeks to clarify the precise conditions and learning regimes under which observed preferences are less likely to be cognitively reflected upon by consumers. This leads him to redefine from an evolutionary perspective the concept of consumer sovereignty, the basic condition upon which the theory of consumer welfare is founded. Chai argues that beyond considering the extent to which preferences are satisfied at one given point in time, from a dynamic perspective it is also essential to consider whether agents possess an opportunity to learn and revisit their preferences over time. This distinction can then be used to discriminate between, on the one hand, instances in which consumer preferences are satisfied but "locked-in" and, on the other hand, situations in which preferences may not be satisfied, but the agents have the ability and opportunity to learn and reflect on their preferences.

Conclusion

We have outlined how an evolutionary approach to economics affects the definition of, and perspective on, economic problems, despite the fact that, unlike in biology, psychology, or anthropology, the core of an evolutionary approach is still subject to debate in economics. To understand the present situation we have suggested taking a diachronic perspective on the contributions to evolutionary economics in the literature. In such a perspective three different waves of evolutionary theorizing can be identified. In each single wave the core is implicitly or explicitly defined differently, and evolutionary reasoning and modeling (where modeling is relevant) focus on different topics. We have argued therefore that advances in evolutionary economics can be made in two ways.

One of them is by research that develops new insights and contributes to an improved understanding of each of the topics. The basis is here the reasoning and/or modeling specific to the corresponding wave of evolutionary theorizing. The other way of making progress is to move the evolutionary approach to economics closer to a common understanding of its core. This requires more conceptual and methodological work to be done in the future. In our short preview of the subsequent chapters we have argued that both ways are represented in this volume. Some of the chapters contribute to advancing specific topics, while other chapters make progress with the debate on the core of evolutionary economics. With our introductory chapter we have tried to set the frame for both, not least by reflecting on why canonical economics has difficulties recognizing and coping with the evolutionary nature of the economy.

To advance the debate on the core we have suggested recognizing a methodological particularity of evolutionary theorizing. On the one hand, it sticks to the general presumption that evolution is a historical process in which recurrent patterns exist. On the other hand, evolutionary theorizing assumes that the current features and conditions of the economy are a result, and are hence explicable in terms of, the causal mechanism that produces the recurrent patterns. We therefore expect hypotheses about the causal mechanism and its many facets to make up the core of an evolutionary approach to economics. Future work may show to what extent the theories worked out in the three discussed waves of evolutionary economics can be integrated on this basis in an encompassing theory of a causal mechanism governing economic evolution.

References

Abernathy, W. J. and Utterback, J. M. (1978). Patterns of Industrial Innovation. *Technology Review*, 80, 40–47.

Aldrich, H. E., Hodgson, G. M., Hull, D. L., Knudsen, T., Mokyr, J., and Vanberg, V. J. (2008). In Defense of Generalized Darwinism. *Journal of Evolutionary Economics*, 18, 577–596.

Amendola, A. and Gaffard, J.-L. (2006). *The Market Way to Riches: Behind the Myth*. Cheltenham: Edward Elgar.

Andersen, E. S. (2009). *Schumpeter's Evolutionary Economics*. London: Anthem.

Andreoni, J. (1995). Cooperation in Public Good Experiments: Kindness or Confusion. *American Economic Review*, 85, 891–904.

Bargh, J. A., Gollwitzer, P. M., and Oettingen, G. (2010). Motivation, In: Fiske, S. T., Gilbert, D. T., and Lindzey, G. (eds.) *Handbook of Social Psychology*. New York, NY: Wiley, 268–316.

Binmore, K. (2006). The Origins of Fair Play. Papers on Economics and Evolution, #0614, Max Planck Institute of Economics Jena.

Boehm, C. (2001). *Hierarchy in the Forest: The Evolution of Egalitarian Behavior*. Cambridge, MA: Harvard University Press.

Börgers, T. and Sarin, R. (1997). Learning through Reinforcement and Replicator Dynamics. *Journal of Economic Theory*, 77, 1–14.

Bowles, S. (2008). Conflict: Altruism's Midwife. *Nature*, 456, 326–327.

Bowles, S. and Gintis, H. (2011). *A Cooperative Species: Human Reciprocity and Its Evolution*. Princeton: Princeton University Press.

Boyd, R. and Richerson, P. J. (1985). *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

Brenner, T. (1998). Can Evolutionary Algorithms Describe Learning Processes? *Journal of Evolutionary Economics*, 8, 271–283.

(2004). *Local Industrial Clusters – Existence, Emergence and Evolution*. London: Routledge.

Brown, G. R. and Richerson, P. J. (2014). Applying Evolutionary Theory to Human Behavior: Past Differences and Current Debates. *Journal of Bioeconomics*, 16, 105–128.

Buenstorf, G. and Klepper S. (2009). Heritage and Agglomeration: The Acron Tire Cluster Revisited. *Economic Journal*, 119, 705–733.

Burnham, T. C. (2016). Economics and Evolutionary Mismatch: Humans in Novel Settings Do Not Maximize. *Journal of Bioeconomics*, 18, 195–209.

Burnham, T. C., Lea, S. E. G., Bell, A., Gintis, H., Glimcher, P. W., Kurzban, R., Lades, L., McCabe, K., Panchanathan, K., Teschl, M., and Witt, U. (2016). Evolutionary Behavioral Economics. In: Wilson,

D. S. and Kirman, A. (eds.) *Complexity and Evolution – A New Synthesis for Economics*. Cambridge, MA: MIT Press, 113–144.

Buss, D. M. (2003). *Evolutionary Psychology: The New Science of the Mind*. Boston, MA: Allyn and Bacon.

Camerer, C. F. and Loewenstein, G. (2004). Behavioral Economics: Past, Presence, Future. In: Camerer, C. F., Loewenstein, G., and Rabin, M. (eds.) *Advances in Behavioral Economics*. Princeton: Princeton University Press, 3–51.

Campbell, D. T. (1965). Variation and Selective Retention in Socio-cultural Evolution. In: Barringer, H. R., Blankenstein, G. I., and Mack, R. W. (eds.) *Social Change in Developing Areas: A Reinterpretation of Evolutionary Theory*. Cambridge, MA: Schenkman, 19–49.

Cavalli-Sforza, L. and Feldman, M. (1981). *Cultural Transmission and Evolution: A Quantitative Approach*. Princeton: Princeton University Press.

Coase, R. H. (1960). The Problem of Social Cost. *Journal of Law & Economics*, 3, 1–44.

Cross, J. G. and Guyer, M. J. (1980). *Social Traps*. Ann Arbor, MI: University of Michigan Press.

Currie, T. E., Greenhill, S. J., Gray, R. D., Hasegawa, T., and Mace, R. (2010). Rise and Fall of Political Complexity in Island South-East Asia and the Pacific. *Nature*, 467, 801–804.

Cutler, D. M., Glaeser E. L., and Shapiro J. M. (2003). Why Have Americans Become More Obese? *Journal of Economic Perspectives*, 17, 93–118.

Cyert, R. M. and March, J. G. (1963). *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice Hall.

Dawkins, R. (1976). *The Selfish Gene*. Oxford: Oxford University Press.

Day, R. H. (1982). Irregular Growth Cycles. *American Economic Review*, 72, 406–414.

Day, R. H. and Cigno, A. (1978). *Modelling Economic Change – The Recursive Programming Approach*. Amsterdam: North-Holland.

Dopfer, K. (2005). Evolutionary Economics: A Theoretical Framework. In Dopfer, K. (ed.) *The Evolutionary Foundations of Economics*. Cambridge: Cambridge University Press, 3–55.

Dupré, J., ed. (1987). *The Latest on the Best: Essays on Evolution and Optimality*. Cambridge, MA: MIT Press.

Eibl-Eibesfeldt, I. (2004). *Die Biologie des menschlichen Verhaltens*. 5th edn. Vierkirchen: Buchvertrieb Blank.

Elsner, W., Heinrich, T., and Schwardt, H. (2014). *The Microeconomics of Complex Economies*. New York, NY: Elsevier.

Fagerberg, J., Srholec, M., and Knell, M. (2007). The Competitiveness of Nations: Why Some Countries Prosper While Others Fall Behind. *World Development*, 35, 1595–1620.

Fewell, J. H. (2015). Social Biomimicry: What Do Ants and Bees Tell Us About Organization in the Natural World? *Journal of Bioeconomics*, 17, 207–216.

Fisher, F. M. (1983). *Disequilibrium Foundations of Equilibrium Economics*. Cambridge: Cambridge University Press.

Gauthier, J. A. and Padian, K. (1989). The Origin of Birds and the Evolution of Flight. *Short Courses in Paleontology*, 2, 121–133.

Ghiselin, M. T. (1974). *The Economy of Nature and the Evolution of Sex*. Berkeley, CA: University of California Press.

Gilbert, S. F. and Epel, D. (2009). *Ecological Developmental Biology*. Sunderland, MA: Sinauer Associates.

Gintis, H. (2007). A Framework for the Unification of the Behavioral Sciences. *Behavioral and Brain Sciences*, 30, 1–61.

Gintis, H. and Helbing, D. (2015). Homo Socialis: An Analytical Core for Sociological Theory. *Review of Behavioral Economics*, 2, 1–59.

Güth, W., Schmittberger, R., and Schwarze, B. (1982). An Experimental Analysis of Ultimatum Bargaining. *Journal of Economic Behavior and Organization*, 3, 367–388.

Hamilton, W. D. (1964). The Evolution of Altruistic Behavior. *American Naturalist*, 97, 354–356.

Hannan, M. T. and Freeman, J. (1977). The Population Ecology of Organizations. *American Journal of Sociology*, 82, 929–964.

Hanusch, H. and Pyka, A. (2007). *Elgar Companion to Neo-Schumpeterian Economics*. Cheltenham: Edward Elgar.

Henrich, J. P., Boyd, R., Bowles, S., Camerer, C., Fehr, E., and Gintis, H. (eds.) (2004). *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-scale Societies*. Oxford: Oxford University Press.

Hodgson, G. M. (2002). Darwinism in Economics: From Analogy to Ontology. *Journal of Evolutionary Economics*, 12, 259–281.

(2004). *The Evolution of Institutional Economics*. London: Routledge.

Hodgson, G. M. and Knudsen, T. (2010). *Darwin's Conjecture – The Search for General Principles of Social and Economic Evolution*. Chicago: University of Chicago Press.

Hodgson, G. M., Järvinen, J., and Lamberg, J.-A. (2014). The Structure and Evolution of Evolutionary Research: A Bibliometric Analysis of the "Evolutionary" Literature in Management, Economics, and Sociology. Paper presented at the Annual Meeting of the European Association for Evolutionary Political Economy, Paris, 2014.

Hofbauer, J. and Sigmund, K. (1988). *The Theory of Evolution and Dynamical Systems*. Cambridge: Cambridge University Press.

Hoffman, E., McCabe, K., and Smith, V. L. (1996). Social Distance and Other-regarding Behavior in Dictator Games. *American Economic Review*, 86, 653–660.

Holm, J. R., Andersen, E. S., and Metcalfe, J. S. (2017). Confounded, Augmented and Constrained Replicator Dynamics: Complex Selection Models and Their Measurement. *Journal of Evolutionary Economics*, 26, 803–822.

Joosten, R. (2006). Walras and Darwin: An Odd Couple? *Journal of Evolutionary Economics*, 16, 561–573.

Kahneman, D. (2003). Maps of Bounded Rationality: Psychology for Behavioral Economics. *American Economic Review*, 93(5), 1449–1475.

(2013). *Thinking, Fast and Slow*. New York, NY: Farrar, Straus and Giroux.

Klepper, S. (2002). The Capabilities of New Firms and Evolution of the US Automobile Industry. *Industrial and Corporate Change*, 11, 645–666.

Klepper, S. and Simons, K. L. (2005). Industry Shakeouts and Technological Change. *International Journal of Industrial Organization*, 23, 23–43.

Kobayashi, D. (2014). Effects of Anthropology and Archaeology Upon Early Innovation Studies. Paper presented at the International Schumpeter Society Conference, Jena, 2014.

Leslie, J. C. (1996). *Principles of Behavioral Analysis*. Amsterdam: Harwood Academic Publishers.

Levit, G. S., Hossfeld, U., and Witt, U. (2011). Can Darwinism Be "Generalized" and of What Use Would This Be? *Journal of Evolutionary Economics*, 21, 545–562.

Lloyd, E. A. and Gould, S. J. (2017). Exaptation Revisited: Changes Imposed by Evolutionary Psychologists and Behavioral Biologists. *Biological Theory*, 12, 50–65.

Los, B. and Verspagen, B. (2006). The Evolution of Productivity Gaps and Specialization Patterns. *Metroeconomica*, 57, 464–493.

Lumsden, C. J. and Wilson, E. O. (1981). *Genes, Mind and Culture: The Coevolutionary Process*. Cambridge, MA: Harvard University Press.

Lundvall, B.-Å. (ed.) (1992) *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.

March, J. G. and Simon, H. A. (1958). *Organizations*. New York, NY: Wiley.

Mas-Colell, A., Whinston, M. D., and Green, J. R. (1995). *Microeconomic Theory*. Oxford: Oxford University Press.

Maynard Smith, J. (1982). *Evolution and the Theory of Games*. Cambridge: Cambridge University Press.

Menger, C. (1985)[1883]. Investigations into the Method of the Social Sciences with Special Reference to Economics (Untersuchungen ueber die Methode der Socialwissenschaften, first published 1883), English translation by F. J. Nock, New York University Press.

Metcalfe, J. S. (1994). Competition, Fisher's Principle and Increasing Returns in the Selection Process. *Journal of Evolutionary Economics*, 4, 327–346.

(2002). On the Optimality of the Competitive Process: Kimura's Theorem and Market Dynamics. *Journal of Bioeconomics*, 4, 109–133.

(2008). Accounting for Economic Evolution: Fitness and the Population Method. *Journal of Bioeconomics*, 10, 23–50.

Metcalfe, J. S., Foster, J., and Ramlogan, R. (2006). Adaptive Economic Growth. *Cambridge Journal of Economics*, 30, 7–32.

Mirowski, P. (1983). An Evolutionary Theory of Economics Change: A Review Article. *Journal of Economic Issues*, 17, 757–768.

Mokyr, J. (1990). *The Lever of Riches – Technological Creativity and Economic Progress*. Oxford: Oxford University Press.

(2002). *The Gifts of Athena – Historical Origins of the Knowledge Economy*. Princeton: Princeton University Press.

Murmann, J. P. (2003). *Knowledge and Competitive Advantage – The Coevolution of Firms, Technology, and National Institutions*. Cambridge: Cambridge University Press.

Nelson, R. R. and Winter, S. G. (1974). Neoclassical vs. Evolutionary Theories of Economic Growth: Critique and Prospectus. *Economic Journal*, 84, 886–905.

(1975). Factor Price Changes and Factor Substitution in an Evolutionary Model. *Bell Journal of Economics*, 6, 466–486.

(1977). Simulation of Schumpeterian Competition. *American Economic Review*, 67 (Papers and Proceedings), 271–276.

(1978). Forces Generating and Limiting Concentration under Schumpeterian Competition. *Bell Journal of Economics*, 9, 524–548.

(1980). Firm and Industry Response to Changed Market Conditions: An Evolutionary Approach. *Economic Inquiry*, 28, 179–202.

(1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.

(2002). Evolutionary Theorizing in Economics. *Journal of Economic Perspectives*, 16, 23–46.

Odling-Smee, F. J., Laland, K. N., and Feldman, M. W. (2003). *Niche Construction – The Neglected Process in Evolution*. Princeton: Princeton University Press.

Popper, K. R. (1960). *The Poverty of Historicism*, 2nd edn. London: Routledge & Kegan Paul.

Richerson, P. J. and Boyd, R. (2005). *Not by the Genes Alone: How Culture Transformed Human Evolution*. Chicago: University of Chicago Press.

Robbins, L. (1932). *An Essay on the Nature and Significance of Economic Science*. London: MacMillan.

Rosenberg, N., Birdzell, L. E. Jr. (1986). *How the West Grew Rich – The Economic Transformation of the Industrial World*. New York, NY: Basic Books.

Roy, D. (2017). Myths about Memes, *Journal of Bioeconomics*, 19, 281–305.

Saviotti, P. P. and Pyka, A. (2008). Micro and Macro Dynamics: Industry Life Cycles, Inter-sector Coordination and Aggregate Growth. *Journal of Evolutionary Economics*, 18, 167–182.

Schumpeter, J. A. (1934)[1912]. *Theory of Economic Development* (Theorie der wirtschaftlichen Entwicklung, first published 1912), Cambridge, MA: Harvard University Press.

(1955). *History of Economics Analysis*. London: Allen & Unwin.

(2002). The Economy as a Whole (seventh chapter of *Theorie der wirtschaftlichen Entwicklung*, 1912). *Industry and Innovation*. 9, 93–145.

Silva, S. T. and Teixeira, A. C. (2009). On the Divergence of Evolutionary Research Paths in the Past 50 Years: A Comprehensive Bibliometric Account. *Journal of Evolutionary Economics*, 19, 605–642.

Simon, H. A. (1955). A Behavioral Model of Rational Choice. *Quarterly Journal of Economics*, 69, 99–118.

(1979). Rational Decision Making in Business Organizations. *American Economic Review*, 69, 493–513.

Smith, V. L. (2015). Adam Smith: Homo Socialis, Yes; Social Preferences, No; Reciprocity Was to Be Explained. *Review of Behavior Economics*, 2, 183–193.

Staddon, J. E. R. (2009). *Adaptive Behavior and Learning*. Cambridge: Cambridge University Press.

Starbuck, W. H. (1963). Level of Aspiration Theory and Economic Behavior. *Behavioral Science*, 8, 128–136.

Tinbergen, N. (1963). On Aims and Methods in Ethology. *Zeitschrift fuer Tierpsychologie*, 20, 410–433.

Trivers, R. L. (1971). The Evolution of Reciprocal Altruism. *Quarterly Review of Biology*, 46, 35–57.

Veblen, T. (1898). Why Is Economics Not an Evolutionary Science? *Quarterly Journal of Economics*, 12, 373–397.

Veblen, T. B. (1899). *The Theory of the Leisure Class – An Economic Study of Institutions*. New York, NY: MacMillan.

(1914). *The Instinct of Workmanship, and the State of the Industrial Arts*. New York, NY: MacMillan.

Wilson, E. O. (2000). *Sociobiology. The New Synthesis*. 25th edn. Cambridge, MA: Belknap Press.

Wilson, D. S. and Sober, E. (1994). Reintroducing Group Selection to the Human Behavioral Sciences. *Behavioral and Brain Sciences*, 17, 585–654.

Winter, S. G. (2014). The Future of Evolutionary Economics: From Early Intuitions to a New Paradigm? *Journal of Institutional Economics*, 10, 613–644.

Witt, U. (2008a). What Is Specific about Evolutionary Economics? *Journal of Evolutionary Economics*, 18, 547–575.

(2008b). Evolutionary Economics. In: Durlauf, S. N. and Blume, L. E. (eds.) *The New Palgrave Dictionary of Economics*, 2nd edn., Vol. 3. New York, NY: Palgrave MacMillan, 67–73.

(2009). Propositions about Novelty. *Journal of Economic Behavior and Organization*, 70, 311–320.

(2017). The Evolution of Consumption and Its Welfare Effects. *Journal of Evolutionary Economics*, 27, 273–293.

Witt, U. and Beck, N. (2015). Austrian Economics and the Evolutionary Paradigm. In: Boettke, P. J. and Coyne C. (eds.), *Oxford Handbook of Austrian Economics*. Oxford: Oxford University Press, 576–593.