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# The Future of Evolutionary Economics: Why Modalities Matter

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# The Future of Evolutionary Economics: Why Modalities Matter

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**Abstract**

The label "evolutionary" is currently used in economics to describe a variety of theories and topics. Far from inspiring the paradigmatic shift envisioned by some of the early proponents of evolutionary economics, the patchwork of theories and topics in this field demonstrates the need of an overarching interpretative frame. In other disciplines, the adoption of the Darwinian theory of evolution extended by hypotheses on cultural evolution has led to such a paradigm shift. This paper explores what can be accomplished by adopting that theory as an interpretative frame also for economics. Attention is directed in particular to the modalities of causal explanations that are germane to such a frame. The relevance of these modalities to the various thematic and theoretical specializations carrying the label "evolutionary" in economics is established to demonstrate the suitability as a common frame. Moreover, these modalities suggest a criterion on the basis of which evolutionary research can be distinguished from non-evolutionary research in economics. The case of institutional economics is used to outline some implications in an exemplary fashion.

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## 1. Introduction

The past century has seen an avalanche of newly emerging disciplines committed to exploring the evolution of nature and man. Evolutionary biology, evolutionary anthropology, evolutionary psychology – all of them frame the explanation of human behavior and human culture within an overarching research paradigm commonly referred to as the Darwinian paradigm. In this paradigm, the Darwinian theory of descent with variation in nature is *extended* by hypotheses on cultural evolution. These hypotheses account for the unfolding faculties of the human species to manipulate and reshape its conditions. The impact of these disciplines and, hence, the extended Darwinian theory of evolution on the human sciences can hardly be understated.

Evolutionary economics shares the attribute "evolutionary" with these disciplines, yet it is not in tune with them. Since its inception, the evolutionary brand of economics has grappled with conceptual confusion. A variety of approaches have emerged in which the common use of the attribute "evolutionary" refers to quite different and sometimes incommensurable conceptions (Hodgson 2002, 2011; Witt 1998, 2008). Moreover, the conceptual differences coincide with different specializations of the approaches regarding their topics: industrial dynamics, long-term development, institutional change, the emergence of human cooperativeness, and so on. There seems to be only one common denominator: to interpret the changes that are investigated as not only being driven by exogenous shocks but also unfolding according to endogenous forces.

Fragmented as it appears, evolutionary thought in economics is far from informing the paradigmatic shift in the discipline that some of its proponents had hoped for (e.g., Nelson and Winter 1982, Chap. 1, Hodgson 1993, Winter 2014). On the contrary, lacking the support of a common foundation, each of the isolated approaches risks being marginalized. This was indeed the fate of Veblen's (1898) naturalistic conception of "evolutionary economics" which he tried to bring to bear on his study of habits and institutions. It was soon lost out of sight by his successors in American Institutionalism, the school of thought that Veblen had founded (Hodgson 2004). A similar fate may await the Neo-Schumpeterian (non-naturalistic) conception of "evolutionary economics" initiated by Nelson and Winter (1982) that is presently en vogue. Judged by its research topics (see, e.g., Hanusch and Pyka, eds. 2007), it seems to develop ever more in the direction of an economics of innovation and industrial dynamics. The role that evolutionary reasoning plays in this is unclear (see, e.g. Dosi 2012).

Under such conditions, one may be concerned about the future of evolutionary economics. Its fate appears to depend on whether, and in what way, common ground can be found beneath the present heterogeneity of unconnected topics and theories. A comparison with the situation in biology is instructive. The biologist Theodosius Dobzhansky (1973, 129) coined the now broadly acclaimed motto: "Nothing in biology makes sense except in the light of evolution". Can it be claimed in like manner that nothing in economics makes sense except in the light of evolution? While for most economists this may be an unfamiliar way of thinking about the economy, adherents of evolutionary economics would presumably agree. But what sense-making theory is then associated with such a claim? When speaking of making sense in biology, Dobzhansky had in mind the Darwinian theory of evolution. Should this option be considered also for economics as well? This had been Veblen's plea – a

plea deemed less than promising by his successors. The profound success enjoyed by other evolutionary disciplines since then with the extended Darwinian theory of evolution theory invites the reconsideration of the naturalistic option for evolutionary economics (Witt 1999; see also Hodgson 2002, Dopfer 2011, Herrmann-Pillath 2013).

The present paper is devoted to discussing this option. More specifically, attention will be drawn to the modalities of causal explanations that correspond to a naturalistic approach. These modalities have been developed by the ethologist Tinbergen (1963) with reference to the Darwinian theory of evolution. Their relevance, however, is not affected by the extension of the theory to account for cultural influences on evolution. While Tinbergen originally suggested the modalities for analyzing animal behavior, their application has quickly been disseminated across disciplinary boundaries (Wilson and Gowdy 2013). With some modifications they can also be used as a benchmark for evolutionary analysis in economics. This will turn out to have far-reaching implications.

The paper proceeds as follows. Section 2 starts by briefly reviewing the present heterogeneity of hypotheses and thematic specializations in evolutionary economics. The purpose is to show that research done under this label interprets the attribute "evolutionary" quite differently and differs significantly in the topics addressed. Section 3 focuses on the modalities of causal explanations in a naturalistic approach, i.e. in applying the extended Darwinian theory of evolution. As will turn out, at the level of these modalities substantial commonalities exist among the diverse contributions to evolutionary economics and clear differences in relation to canonical economics. Section 4 illustrates by means of the example of institutional evolution what kind of questions follow from the use of these modalities for evolutionary analysis. Part of the exercise is to show how such an analysis differs from the now prevailing game-theoretic investigations of institutions. Section 5 offers the conclusions.

## 2. Patchwork "Evolutionary Economics"

It is beyond doubt that research conducted over the past decades under the label of "evolutionary economics" has been able to improve our understanding of our changing economies. The problem, however, is that the diverse results attained are difficult to integrate into a broader picture that presents a coherent theory of economic evolution. Rather, there is a patchwork of approaches and topics. The variation in the interpretation of what an "evolutionary" analysis is, matches the variety in the topics deemed relevant to such an analysis.

For example, the Neo-Schumpeterian approach, [1] successfully reviving Schumpeter's powerful ideas on the innovative nature of capitalism, basically keeps to the narrow agenda defined by Schumpeter. Focus resides mainly on innovation competition, R&D, technical progress, and the growth of firms, industries, and economies. This kind of economic change

[1] In these days most economists associate "evolutionary economics" with this approach (Silva and Teixeira 2009; Hodgson, Järvinen, and Lamberg (2014) going back to the seminal work by Nelson and Winter (1982).

can, but does not have to be, interpreted as evolutionary change. Indeed, a good part of the success of the Neo-Schumpeterian school is due to its close affinity to the agenda of contemporary, non-evolutionary innovation research. [2] The special, "evolutionary" connotations in this field have been provided by Nelson and Winter's (1982) seminal synthesis of Schumpeter's ideas with the behavioral theory of the firm (March and Simon 1958, Cyert and March 1963), and the critique this implies of canonical optimization-cum-equilibrium economics.

Canonical theory portrays economic change as simultaneous, optimal adaptations of economic agents to exogenous shocks. Drawing on the work of Simon (e.g., 1979), Nelson and Winter argue that bounded rationality prevents optimization, particularly at the organizational level, and leads to routinized, and therefore inert, behavior. Consequently, Nelson and Winter infer that innovative economic change cannot be conceptualized in terms of optimal individual adaptations and a notion of perfect plasticity of behavior. Instead, it has to be seen as outcome of a process that is analogous to natural selection. Over time, external market forces (and sometimes internal competition as well) winnow out the less well-adapted behavioral routines. Nelson and Winter's intention, thus, is to reinterpret the competitive adaptation process in the economy by means of an analogy to natural selection.

In Nelson and Winter's work and that of their Neo-Schumpeterian followers there is thus a shift in research focus. Instead of individual adaptations converging to a state of perfect coordination in the market equilibrium, the dominant mechanisms are the adaptation processes at the level of the population. They change the composition of the population of agents, firms, or industries (Metcalfe 2008). These adaptation processes can also result in equilibrium, albeit a population or occupancy equilibrium. This may, or may not, coincide with market equilibrium. In any case, much of what in the canonical perspective is treated as exogenous shocks disrupting market equilibria is endogenized by attributing the causes of the shocks to the fact that firms and industries incessantly seek innovations. Analogously to genetic variation, these activities cannot only disrupt market equilibria, but also the population equilibrium. The disruptive effects of innovations thus trigger new adaptation processes (Metcalfe 1998).

Nelson and Winter (2002) characterize their use of evolutionary concepts such as natural selection as "loose" analogy constructions of the Darwinian theory of evolution in biology. Neither they nor other Neo-Schumpeterian have a direct application of the Darwinian theory in mind. [3] Their strategy contrasts with the historical precedent of "evolutionary economics" proclaimed by Veblen (1898) with his naturalistic approach. Veblen indeed advocated an extension of the Darwinian theory of evolution to economic phenomena. He was no less critical of the mechanical, rational adaptation hypotheses

[2] The importance of the non-evolutionary research tradition was already apparent in the seminal paper by Dosi (1988). Something similar holds for research on the growth of firms (Coad 2009) and industries (Fagerberg 2003).

[3] The Neo-Schumpeterians' lack of interest in a naturalistic interpretation of evolutionary economics also shows up in the complete inattention to prominent pleas for blending the evolutionary perspective on the economy with a (naturalistic) ecological one such as in Georgescu-Roegen (1971) and Boulding (1978). New impulses for such a merger are now emerging within ecological economics, see Gowdy (2006) and van den Bergh (2007)

underlying the economic theory of his time. Like Nelson and Winter after him, he also called for a more "realistic" view of human behavior. But his critique of the marginal calculus did not induce him to put a selection algorithm in its place. He abandoned calculus completely and elaborated instead on the role of instinct (genetic influences) and habit (the influence of cultural learning) for economic institutions. Accordingly, he was not much, if at all, interested in technical change and industrial dynamics but rather how economic, political, and cultural habits and institutions shaped the development of the economy (Veblen 1899, 1914).

As mentioned, Veblen's successors soon abandoned his naturalistic, evolutionary approach. Apparently they did not find it useful for explaining the various political, industrial, and macroeconomic topics they were interested in. However, some of Veblen's naturalistic intuitions reemerged later in works of diverse authors such as Georgescu-Roegen (1971), Hayek (1979, Epilogue), North (1997), North, Wallis and Weingast (2009), and Ostrom (2014). The subjects, methods, and political messages of these contributions differ, and yet all share three basic assumptions that separate them from canonical economics. First, they recognize that the human economy and its institutions are embedded in, and contingent on, nature, not least of which human nature (i.e. innate human proclivities). Second, they portray the institutions prevailing at a given time as the result of an ongoing evolutionary process. Finally, they emphasize the necessity of explaining in terms of a historical analysis why some institutional forms prevail while others decline. These commonalities expound why these contributions can be said to represent an evolutionary branch of a new, naturalistic institutionalism. Their common evolutionary perspective notwithstanding, Neo-institutionalists (with the exception, perhaps, of North and Ostrom) and the Neo-Schumpeterians hardly take notice of each other, not to speak of the missed chance of a cross-fertilization.

A similar mutual silence resonates in the interactions between evolutionary economics and the new field of evolutionary game theory. [4] In contrast to rational game theory, players in evolutionary games are assumed to represent, rather than to choose, mixed or pure strategies as part of their behavioral repertoire. This assumption is due to the explanatory requirements of evolutionary biology, particularly sociobiology (Trivers 1971, Maynard Smith 1982), from which evolutionary game theory originally emerged. In that literature, the behavioral repertoire of an organism is understood to be innate and the competing strategies subject to natural selection. Economists resort to that interpretation to explain apparently "irrational" features of human economic behavior such as altruism, cooperativeness, fairness, moral aggression, etc. in terms of a possible reproductive advantage (Binmore 1998, Bowles and Gintis 2011). The association with the extended Darwinian theory of evolution is straightforward (Henrich et al. 2010).

Beyond these fundamental features of human sociality it is not clear, though, how an interpretation of strategies as genetically fixed traits can contribute to explanations in the

[4] Striking examples are the contributions by Nelson and Winter (2002) and Samuelson (2002) participating in the same symposium and the volume edited by Nicita and Pagano (2001). See also the discussion in Witt (2008) and Hodgson and Huang (2012). In terms of bibliometric searches on the terms "evolutionary", "evolution", etc., evolutionary game theory now seems to have even more hits than the evolutionary economics, see Silva and Teixeira (2009).

domain of economics. For that reason, attempts have been made to re-interpret the strategies as part of a behavioral repertoire that is not innate, but emerges from reinforcement learning (see Brenner 1998). The time scale on which behavior evolves would in that case differ dramatically from the case of innate behavior. Yet, the adaptation algorithm – usually some form of replicator dynamics – and the equilibrium points of the games remain unchanged and different from those of rational game theory (see, e.g., Friedman 1998). In non-strategic settings (i.e. in "playing against nature" as game-theorists put it), reinforcement and conditioning learning are significant forms of adapting behavior with little or no cognitive participation (Herrnstein and Prelec 1991). Yet in strategic settings their relevance is less clear and the explanatory value of evolutionary game theory therefore still uncertain.

As demonstrated by this rough sketch of the uses of the attribute "evolutionary", the diverse contributions to evolutionary economics do not share a common theoretical approach. There is also no consensus on what topics are consonant with, or even require, an evolutionary analysis. Newer developments such as evolutionary game theory and relevant parts of behavioral economics have hardly been noticed by the Neo-Schumpeterians so far, let alone attempted to be integrated. A more encompassing discussion of the role of human evolution for economic behavior and economic change is also pending. That discussion is center stage in evolutionary psychology (see Buss 2003) which has overlapping research interests with behavioral economics. [5]

A precondition for facilitating an integration of the insights from behavioral economics and evolutionary psychology would be the elaboration of a theory of *individual* economic behavior. Yet this has never been high on the agenda of evolutionary economics. The reason, it may be speculated, is the dominance of the population perspective owing to the focus on selection and variation processes (Metcalfe 2008). The only aspect where a reference to individual behavior figures prominently is the bounded rationality hypothesis going back to Simon (1972). Rejecting the fiction of full rationality certainly makes much sense. However, simply claiming that behavior falls short of such a standard does nothing to clarify what standard individual behavior does meet. To avoid ad hoc specifications, an elaborate theory of human economic behavior and its underlying motivations is needed. This would amount to calling for an individualistic foundation for evolutionary economics.

## 3. Modalities of an Evolutionary Analysis

An attempt to explain economic behavior cannot ignore the insights of research into evolutionary psychology, human behavioral ecology, human sociobiology, evolutionary anthropology – all of which are thoroughly anchored in the extended Darwinian theory of evolution (Brown and Richerson 2014). Yet, despite the fact that the explanation of individual behavior is a latent problem across all theoretical approaches and thematic

[5] In both fields, decision anomalies and other deviations of human cognitive behavior from the rationality standard are center stage (Kahneman 2003). However, unlike in evolutionary psychology, the significance of evolution for these phenomena is rarely recognized in behavioral economics, see Witt (2011) for a discussion.

specializations in evolutionary economics, there is not much interest in that particular topic and the insights of the neighboring fields. It is perhaps for that reason that the potential of the extended Darwinian theory of evolution as an overarching frame has not yet been noticed in evolutionary economics. This, in turn, may explain why the integrative potential of the modalities of evolutionary analysis corresponding to the extended Darwinian theory has not been noticed in evolutionary economics so far.

These modalities have been devised by Tinbergen (1963) who drew on distinctions that go back to Aristotle. Tinbergen singled out four types of causal explanations which he considered integral to evolutionary biology. Suppose, for instance, the object of research is a particular trait of an organism, the capacity to process acoustic signals, say. Focus may then be on

(i) proximate explanations of how the trait works;
(ii) ultimate explanations of the function of the trait and its adaptive value for survival and reproductive fitness of the organism;
(iii) explanations of the descent of the trait (i.e. of how it has evolved during phylogeny);
(iv) explanations of how the trait develops over the organism's life cycle (ontogeny).

Tinbergen's scheme proved useful for, and is now generally accepted in, biology. Given its broader relevance to evolutionary disciplines based on the extended Darwinian theory of evolution (Wilson and Gowdy 2013, Wilson et al. 2013), the scheme will be used here with slight modifications to characterize the modalities of analysis in evolutionary economics. As a result, it will be possible to clarify two important issues. The first issue concerns the question of how evolutionary economics differs from canonical economics. Is it possible to derive an answer from the modalities as to whether the evolutionary approach should be considered a replacement for, or complement to, the canonical paradigm? The second issue relates to existence or non-existence of a common ground underlying the conceptual and thematic heterogeneity in evolutionary economics. Does an inspection of the modalities reveal a common ground and, if so, what would such a finding imply?

To begin with, both evolutionary and canonical economics have a common interest in proximate type (i) explanations. As a matter of fact, this is exactly the type of explanation that is center stage in canonical economics when analyzing all sort of economic effects and the mechanisms that cause them. Familiar examples abound: How is the daily market clearing exchange rate between two currencies fixed in the money market? How does an increase in the tax rate on cigarettes affect the quantity of tobacco consumed per unit of time? By what mechanisms does a central bank influence the price level in an economy? How does the profit rate influence the growth rate of a closed economy? Whether concerning the workings of individual response patterns, of markets and other exchange mechanisms, of organizations and institutions, or of technological constraints, to answer questions like these, a proximate explanation is required.

The specific explanation given can, of course, be based on very different hypotheses, and the hypotheses themselves can be satisfactory or unsatisfactory. The fact that evolutionary economics and canonical economics share an interest in proximate type (i) explanations does not mean that they need rely on the same explanatory hypotheses. When economics is envisioned to be the science of optimization and coordination, as in the canonical approach, the rational (or optimal) choice hypothesis supplies the foundation for

all ensuing explanations. This hypothesis is, however, rejected almost *unisono* in evolutionary economics for its lack of realism (and not only evolutionary economics). Laboratory experiments designed to test the rationality hypothesis indeed demonstrate its lack of empirical support in many contexts (Kahneman 2011). [6] In evolutionary economics it is usually argued that instead of full rationality the economic agents exhibit only a more bounded version of rationality. What precisely the behavior is that bounded rationality induces in a particular setting, i.e. how the states of the environment map into individual choices, is rarely expounded, though.

The rational choice explanations of canonical economics represent a subclass of proximate explanations. The distinguishing characteristic of this subclass is the generic use of the optimization hypothesis. If economics were to only provide proximate explanations (and if the optimization hypothesis were less problematic), canonical economics could claim to be sufficient. However, proximate explanations are not enough. They take as given the mechanisms whose workings or effects they are supposed to explain. Whenever the current properties of these mechanisms depend on the mechanisms' pre-history, i.e. on how they have evolved, it is important to go beyond proximate explanations. Different types of causal explanations are required then to answer the questions of why and how the mechanisms have evolved in the first place. (Correspondingly, such explanations are also necessary to explain how it is possible that, at different times and different places, different mechanisms have evolved that serve similar purposes.) It is here that the explanatory interest and, hence, the agendas of evolutionary and canonical economics depart.

In Tinbergen's scheme, *why* something has evolved requires an ultimate explanation (type ii). In contrast, *how* something has evolved requires an explanation of phylogeny (type iii). In biology, both types of explanations draw on the Darwinian theory of evolution, but highlight different aspects of descent with variation. Their broad power and significance in the biological domain is due to the overriding importance that the shaping force of natural selection has in the long run. It is essential to note that natural selection plays a less significant role in those domains where the Darwinian theory evolution is extended to account for cultural influences. The difference can perhaps best be epitomized by what has elsewhere been called the "continuity hypothesis" (Witt 2003, Chap. 1).

That hypothesis submits that, for the economic domain for instance, the natural selection hypothesis continues to be relevant in a special and rather limited sense. It basically only explains the adaptive value that genetic dispositions in human behavior once had when they initially emerged. [7] However, human behavior not only depends on innate

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[6] In addition, rational choice explanations face long standing methodological objections. In empirical applications of the utility maximization hypothesis, preferences and constraints are usually specified ad hoc by "situational logic" (Popper). As a consequence, the maximization hypotheses can then neither be empirically confirmed nor rejected (Boland 1981). Furthermore, individual choices and collective outcomes are two different things. To explain the collective outcome of simultaneously chosen actions, additional assumptions about the institutional context in which individual choices interact are necessary, assumptions that cannot be derived from a rational choice model.

[7] In view of the extremely slow pace of biological evolution, the genetic dispositions of modern humans can be expected to have much in common with those of humans in ancestral times when the genetic fixation took place under selection pressure. Since modern environments can differ

proclivities. The human faculties of observational learning, inference, inventiveness, and intentionality also give rise to culturally conditioned behavior dispositions. The latter dispositions are shaped by their own adaptation processes which often occur within just one generation, i.e. on much shorter time scales than natural selection. What are the criteria for adaptation governing these processes? They are established by what the agents follow when making their choices: innate preferences *and* their learned preferences and cognitively constructed intentions. As such these adaptation criteria do not necessarily enhance individual fitness in terms of survival and reproduction, i.e. the number of surviving offspring. The influence of these criteria is greater, the weaker is the selection pressure at the species level. As a consequence it is possible that the influence might even be detrimental to survival and/or reproduction chances, causing an enduring conflict between the different criteria for adaptation.

Concerning ultimate type (ii) explanations of economic phenomena and processes this means the following. Unlike in biology, it is no longer possible to rely on the argument of functional or adaptive value in terms of survival and reproduction alone. Adaptation processes may be governed not only by the criterion of reproductive fitness, but by other criteria as well, particularly in the short run. For the economic domain, a broader set of criteria of adaptation thus needs to be accounted for in type (ii) explanations. As a consequence, ultimate explanations are more complex and less general in economics than in biology. No one who has already tried to explain economic change and its driving forces will be surprised by this implication.

Biology and economics also differ with respect to type (iii) explanations. Again, as the influence of the additional, culturally conditioned criteria of adaptation criteria increases, the more complex the explanations get. Where the criterion of reproductive fitness plays little part (except via the inherited dispositions of human behavior), the learned preferences and more or less idiosyncratic intentions and ideas of agents take over as criteria of adaption. In the limiting case, type (iii) explanations may then resemble what Menger [1883] (1985) long ago had in mind with his "causal-genetic" explanations, explicitly accounting for a multiplicity of causal factors *not* including reproductive fitness. Economic change is then still explicable in terms of an adaptation process. But the explanatory hypotheses now refer to rather specific criteria such as culturally contingent goals or even idiosyncratic motivations to expound why certain the adaptations occur. [8]

Despite these reservations, type (ii) and type (iii) explanations add substance and scope to economic theorizing. The reconstruction of how presently observable mechanisms have evolved often uncovers significant, contingent features of these mechanisms by which their functioning (or reasons for their mismatch) can better be understood. This can be shown for each of the examples mentioned above. For instance, daily fixing of the exchange rate between two currencies in the money market has evolved from quotation rules

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dramatically from those of the ancestral times, the inherited dispositions that once had adaptive value may cause forms of mismatch today (see e.g., Lloyd, Wilson, and Sober 2011).

[8] In biology, the further type (iv) developmental or ontogenetic explanations can interact in significant ways with type (iii) explanations as the so-called Evo-Devo debate has shown (Hall 1999, see also Sánchez 2012). Since, in economic evolution, generative reproduction has no particular significance, such interactions are usually negligible.

originally well adapted by trial and error to the rather slow process of oral face-to-face trade. High-speed computerized currency trade taking advantage of minimal fluctuation lasting for seconds has created new conditions. The market clearing exchange rates now vary by the second, while many transactions are still settled only once a day. As a result, the currency trade mechanism is in these days not only less transparent and encouraging additional speculation. Since computer programs still follow the logic of oral face-to-face trade, the mechanism is also vulnerable to the risks of uncontrolled, cumulative volatility.

Turning now to the second of the issues to be clarified – the question of what common ground there is in evolutionary economics beneath the heterogeneity of topics and theories – the preceding reflections suggest a simple conclusion. As to the topics explored, despite their heterogeneity, they can be integrated in a coherent agenda by virtue of their unique modalities of causal explanations. Obviously, resorting to proximate explanations alone is insufficient to establish an evolutionary agenda. However, when the pre-history of a topic turns out to be significant for its full understanding, the connection to the evolutionary agenda is established. Why and how the details of its evolution matter can only be uncovered by seeking to provide type (ii) and (iii) explanations. [9] Thus, their heterogeneity notwithstanding, the topics in evolutionary economics share common ground by the way in which they are defined that necessitates also an analysis of the relevant pre-history.

Similarly, the heterogeneity of concepts and hypotheses in evolutionary economics notwithstanding, the specific modalities of working with them should give rise to commonalities. As mentioned, all concepts and hypotheses are based on, or are at least compatible with, an interpretation of economic phenomena as being subject to systematic innovative change. More specifically, that change is assumed to be driven not only by exogenous shocks but also by endogenously emerging novelty. Accordingly, the diverse concepts and hypotheses can all be reinterpreted as dealing with some form of adaption processes. Because of the endogenously emerging novelty, these adaptation processes cannot be reduced to post-disturbance convergence processes that approach a locally or globally stable state of rest. [10] Instead, as evolutionary adaptation processes, they are incessantly unfolding and require type (ii) and (iii) explanations (which transcend the possibilities of formal modeling).

## 4. The Case of Analyzing Institutional Evolution

The analysis of institutions is a good case to illustrate what follows from focusing on the role of the modalities in evolutionary economics not least because of its century-long

[9] The situation is similar in biology. Many branches of biology, particularly molecular biology, deal exclusively with topics in which proximate explanations are paramount. In the spirit of Dobzhansky's motto, it is common understanding, though, that, in principle, the explanation of these topics is incomplete. It becomes complete only if, in relation to each topic, adaptive value, phylogeny and ontogeny are also explained – which amounts to answering the rest of Tinbergen's four questions.

[10] For mathematical convenience this is nonetheless usually done when attempts are made to model the processes, see Witt (2009) for a discussion.

evolutionary tradition from Veblen to North and Ostrom. The very notion of "institutions" is among the most ambiguous concepts in the social sciences. The variety of phenomena associated with it is enormous. Institutions seem to change with each historical epoch, and the circumstances under which this happens also seem to change. It appears only natural, therefore, to try to identify generic features by which institutions can be characterized in more general, abstract terms.

The rise of non-cooperative game theory and its method of abstraction has been a major impulse for this endeavor. In its individualistic approach, institutions have come to be interpreted as being constituted as the persistent forms of strategic interactions between players. Accordingly, the generic features of such institutions are identified with the characteristics of games supposed to reflect the particular interaction context. [11] These characteristics are: first, the rules of the games (the number and kind of players involved, interaction mode and sequence, strategies and their payoff structure); second, the – possibly multiple – equilibrium points of the games (or closed orbits in case of cycling solutions). On such a basis, different categories of institutions can be formed and their implications be investigated using a game-theoretic analysis.

A simple and frequently used example is that of coordination games epitomizing the logic of a particular institution, namely conventions. They are represented by multiple, locally stable equilibrium points in many-person coordination games (see, e.g., Schlicht 1998, Young 1998). Reaching a stable convention is in the interest of all involved players. Furthermore, (in pure coordination games) there is no conflict between the players regarding their preferences over the alternative equilibrium points of the game. For this reason, any of the conventions is self-enforcing (corresponding to one of the alternative, locally stable equilibria) once it has spontaneously emerged. However, the process of equilibrium selection is underdetermined in such coordination games, independent of whether full or bounded rationality on the part of the players is assumed. Some auxiliary hypotheses such as the focal point theory of Sugden (1995) are therefore necessary to fill the gap.

The details of the corresponding game-theoretic models of convention-institutions need not interest us here. The point to be made is that all of them provide a generic explication of institutions as a stable, self-enforcing mechanism. This is a typical example of an abstract proximate type (i) explanation. Almost all game-theoretic models of other institutions also represent such type (i) explanations. Dynamic versions like Kandori, Mailath and Rob (1993) are no exception. That a convention emerges is implied by the assumptions, not explaining as a historical process – a stability analysis of equilibrium points in games is not an analysis of the evolution of a convention. An evolutionary analysis may well include a discussion of stability criteria or other dynamic properties of games, but such a discussion accounts for, at best, only some of the aspects of evolution. As explained in the previous section, the modalities of an evolutionary analysis also require explanations of

[11] See, to provide only a sample of relevant works, Schotter (1981), Sugden (1989), Heckathorn (1996), Binmore (1998), Aoki (2001). Evidently, this strategy of abstraction does not fit with the use of the term "institutions" in everyday language for, e.g., parliaments, governments, courts, tax collection authorities, and so on. The latter are therefore sometimes called "formal" institutions and separated from the "informal" ones which are claimed to be a better fit for the game-theoretic strategy of abstraction, see the contributions in Schubert and Wangenheim (2006).

type (ii) and (iii). For an evolutionary theory of institutions, the question thus arises of why and how particular conventions evolve or have evolved.

In the particular case of convention-institutions, an ultimate (type ii) explanation starts from the question *why* a convention has evolved. The why-question can often be answered by identifying a particular function of the evolving object that enables its beneficiaries to be better adapted according to some criterion. (In biology the general answer to the why question is the beneficiaries' reproductive fitness in a given environment.) Hence, it may be asked what function with adaptive value a specific convention has in a given society, or what criterion of adaptation is improved when such a convention-institution evolves. Is it reproductive fitness? Is it the interest, in whatever form, of political and economic agents in power? Or is it everybody's utility, i.e. the phenotypic interest in the efficient saving of time and/or resources? Game-theoretic models usually remain vague on this point. Their criterion of adaptation is expressed by the payoffs associated with the strategies. When, as usually, the payoff values are interpreted in utility terms, game theory ends up with the finding that the function of convention-institutions is, well, *efficient* coordination.

Even though such an explanation is not wrong, at least according to the standards of an evolutionary analysis it is not satisfactory. It lacks a reason for why, for specific historical conventions, efficiency should have adaptive value. In the small bands that characterize early hominid societies, coordination of individual behavior most likely facilitated, for instance, joint hunting tactics, the ability to signal the threat of enemies, or ritualized inter-personal conflict resolution. With these functions, conventions had adaptive value in terms of improving survival chances and reproductive fitness. Whether or not the willingness to adopt and abide by conventions was indeed an innate behavior trait that was genetically (differentially) reproduced between generations is difficult to prove. It may also have been a culturally fostered trait, transmitted between generations through group-based communication, observational and conditioning learning, and, where necessary, the sanctioning of deviant behavior (Richerson and Boyd 2005).

Due to the tremendous technological change and concomitant growth of society since ancestral times, large, anonymous, groups have formed, and entirely new conventions have emerged. The adaptive value of many of these conventions seems to have shifted from reproductive fitness to specific (phenotypic) sources of utility. A particularly simple and common example of modern conventions is that of traffic rules, such as driving either on the left or on the right hand side of the road (see, e.g., Hodgson and Knudsen 2004). In so far as the function of this convention is the prevention of accidents, the traffic convention could be argued to still have adaptive value in terms of reproductive fitness.

However, the willingness to adopt and abide by the convention of driving on a specific side of the road is certainly not an innate behavior trait and, hence, not differentially genetically reproduced. Nor is it a culturally fostered trait that spontaneously emerges from group-based communication and observational and conditioning learning. Instead, the implementation of the convention and its transmission from one generation to the next is the result of deliberate action. The "adaption", i.e. the implementation and enforcement of the traffic convention, depends on the actions of public decision makers who, by the preceding evolution of other institutions, have the power to intervene. Accordingly,

the criterion of adaption can be conjectured to be the interest pursued by these public decision makers. They may, for instance, have a vicarious interest in saving traffic participants from suffering the disutility of injuries and pains (rather than raising their reproductive success), as well as an interest in an efficient traffic flow that saves time and resources.

An important conclusion follows from this observation. Both the function which convention-institutions serve *and* the criterion that determines their adaptive value can differ according to the particular time and place. Fundamentally, this means that type (ii) explanations cannot, like in biology, rely on the application of such a powerful, general principle as reproductive fitness. Given their importance to understanding how evolution actually takes place – which amounts here to reconstructing how both functions and criteria of adaptation are transformed over time – type (iii) explanations are particularly significant.

Consider the following comparison. Type (iii) explanations are important in biology, in two cases. First, it is necessary to explain why, even if a trait is not functional, it survives – e.g., because evolution does not offer a better variant, or because a sufficiently discriminative selection pressure is absent. Second, evolutionary mismatch needs to be explained. Why does something that was initially functional when it first emerged can become dysfunctional later and nonetheless survive? These two cases are relevant also for economic evolution and cultural evolution more generally. But, due to the potential multiplicity of the criteria of adaptation in an economic context, a third case can emerge here in addition. This is the problem of explaining why something can evolve that is not functional, or later becomes dysfunctional, because of a conflict between criteria of adaptation or because the relevant criteria have been changing over time.

It can be inferred, thus, that type (iii) explanations are substantially more complex in the domain of economics (and other cultural domains). This also applies to type (iii) explanations of how institutions evolve. With their specific demands on historical information these explanations represent a research program different from that which tries to identify generic features of institutions in abstract, game-theoretic terms. This broader research program includes type (i) explanations, but cannot be reduced to them. It has much in common, after all, with Veblen's institutionalism and the evolutionary branch of New Institutionalism. Both develop type (iii) explanations without explicitly acknowledging this.

An explanation of *how* conventions evolve – to return to the above example – is a case in point. A game-theoretic perspective can be a useful part of such an analysis. It needs to keep track, however, of potential innovations in the rules of the underlying coordination game, of changing constellation of players, and the shifting equilibrium points or, for that matter, the dynamic orbits of sequences of moves. But the game-theoretic perspective is not enough. An analysis of how the functions of these conventions change over time, and of how they possibly become dysfunctional, is also necessary. Likewise, a theoretical foundation is needed to explain the criteria of adaptation that are assumed to govern the implementation, enforcement, and change of conventions – not just a more or less plausible ad hoc specification of the payoffs and the order relation between them.

In addition, causal factors in the pre-history that shape the later path of evolution have to be accounted for. Among them are genetic pre-adaptations that are relevant for how the players perceive the payoffs. Other pre-adaptations can be influential for agents spontaneously coordinate and, hence, how specific conventions emerge. An example is the unique human capacity of seeing the self in others and perceiving them as intentional agents (Tomasello 1999). Under what conditions is this capacity activated and thereby able to enhance the spontaneous formation of conventions (the question for which Sugden 1995 proposed his focal point theory). Furthermore, there are cultural pre-adaptations that have the same effect. Under certain conditions, previous experience with learning to behave in a manner that supports coordination may, for instance, facilitate spontaneously emerging conventions.

Even if all this information essential for how conventions evolve could be pressed into the Procrustean bed of abstract strategies and payoff matrices, the resulting dynamic games would be much too complex to be solved. The level of abstraction that was chosen for making progress with proximate explanations of institutions is simply not adequate for a reconstruction of the historical evolution of conventions. The analysis of institutions therefore holds different meaning for evolutionary economics and canonical economics. The latter basically confines itself to type (i) explanations of the abstract generic features of institutions developed from an elaborate game-theoretic formalism. Evolutionary economics, in contrast, acknowledges the truism that human institutions did evolve and continue to do so. The theoretical understanding of institutions cannot be complete, consequently, without integrating type (ii) and (iii) explanations, i.e. without searching answers for the why and how of institutional evolution.

A different question and matter of controversy between canonical and evolutionary economics remains: are the proximate type (i) explanations sufficient for practical purposes? Or can it be shown that policy advice and what is called “mechanism design” in canonical economics are indeed incomplete or even misleading without paying attention to how existing institutions have evolved in the first place? If so, a broad adoption of the modalities of evolutionary analysis is not unlikely to transform present day institutional economics in the future as these modalities have shaped the practices in biological research.

## 5. Conclusions

The heterogeneity of topics and theories associated with the label “evolutionary” in economics creates the impression of a fragmented research field. In its present state, evolutionary economics seems far from living up to the initial expectations of some of its proponents, namely that an evolutionary approach could mean a paradigmatic shift in economics. Such a shift has taken place in other disciplines after adopting the Darwinian theory of evolution extended by hypotheses on cultural evolution as an interpretative frame. This paper therefore set out to explore the potential that an adoption of this theory as an overarching interpretative frame holds for evolutionary economics.

It seems that the *direct* explanatory value of the extended Darwinian theory of evolution differs according to what topic presently associated with the “evolutionary” label in economics is considered. For explaining human cooperativeness, its relevance seems

straightforward. For the explanation of, for instance, industrial innovations, the relevance is less obvious. A detailed discussion of the potential explanatory power of this theory for the different topics has not been feasible here. Nor is such a discussion really necessary, if – as in the present paper – the modalities of causal explanations germane to the extended Darwinian theory are put center stage. These modalities are equally relevant across all thematic specializations and disparate hypotheses discussed in evolutionary economics, thereby neither requiring nor excluding any particular hypothesis, principle, or algorithm *per se.*

The modalities relevant for an evolutionary analysis have been developed by the biologist Tinbergen (1963). Adapted to the conditions in the domain of evolutionary economics, they imply three different types of causal explanations. These are (i) proximate, (ii) ultimate, and (iii) historical explanations of the process of evolution. The latter two are associated with the questions of why and how something has evolved, respectively. As has been discussed, the cultural extension of the Darwinian theory of evolution that is relevant for economics means that type (ii) explanations of function or adaptive value cannot be based on only one adaptive criterion such as reproductive fitness. The same holds for type (iii) explanations. Instead, several adaptive pressures – natural selection and man-made forces – are present simultaneously and operate at different time scales. For that reason, type (ii) and (iii) explanations can be expected to be more complex in economics. In the limiting case of the short run, they may even require neglecting the influence of reproductive fitness as a criterion of adaption and instead deal with human motivations and intentions. In the present paper, this approach has been discussed using the example of institutional evolution.

The modalities of evolutionary analysis imply a condition on the basis of which evolutionary research can be distinguished from non-evolutionary research and, thus, two different paradigms in economics can be identified. The condition for an evolutionary paradigm is that causal type (ii) and/or type (iii) explanations are included in addition to type (i) explanations in order to achieve a complete understanding of a particular topic. An evolutionary analysis would be unnecessary, if a topic could fully be understood on the basis of a proximate explanation. This is often claimed to be the case in canonical economics. At least for the example of institutional economics briefly discussed here, it has been argued that proximate explanations are insufficient – independent of the particular theory or narrative used for the analysis. (The question of what theory or narrative provides good explanations needs to be distinguished from the question of whether or not the analysis can be confined to proximate explanations.) Ultimately, such an assessment will have to be supported by concrete research that demonstrates the additional value that type (ii) and (iii) explanations deliver for economics. Concerning the future of the discipline it remains to be seen, therefore, whether it is really true that "nothing in economics makes sense except in the light of evolution".

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