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**Heterogeneous Economic Evolution:
A Different View on
Darwinizing Evolutionary Economics**

by

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HETEROGENEOUS ECONOMIC EVOLUTION: A DIFFERENT VIEW ON DARWINIZING EVOLUTIONARY ECONOMICS¹

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1. Introduction

Recently proponents declared their Generalized Darwinism to be the emerging *communis opinio* in evolutionary economics (Hodgson 2010). Given that over the last decade Generalized Darwinism has met strong resistance from within certain quarters of evolutionary economics (cf. Witt 2004, 2007; Bünstorff 2006; Cordes 2006; Schubert 2009), this (alleged) convergence on a received view on how to Darwinize evolutionary economics is remarkable. This agreement might well turn out to be a Pyrrhic victory for Generalized Darwinism's proponents, however. As I argued elsewhere (Vromen 2007, 2010), the price for gaining acceptance in the evolutionary economics community seems to be that proponents had to settle on a version of Darwinism that is so general and abstract that "Darwinism" seems to have lost its definite and discriminating contours. Indeed, the sort of Darwinism we are left with seems so diluted that it is not worth fighting for. It seems its principles are so much emptied from their content and substance that they are of little if any use in guiding further theory construction.

Fortunately there seems to be an alternative view on Darwinizing evolutionary economics in the offing that does not have this drawback. In his recent book, Peter Godfrey-Smith (2009) develops a useful taxonomy for distinguishing Darwinian from non-Darwinian processes and, within the former category, for distinguishing the degree to which processes are Darwinian. This taxonomy is developed to come to grips with the vast heterogeneity of evolutionary processes in biology. But, as Godfrey-Smith himself suggests, it can also be used to come to grips with the perhaps even greater heterogeneity in processes of cultural evolution. In this paper I first introduce Godfrey-Smith's taxonomy and contrast it with Hodgson and Knudsen's version of Generalized Darwinism. I then take a closer look at an argument proponents of Darwinizing culture (and social science) advance to counter an objection that opponents have often voiced: the Darwinist model of biological evolution is too simple to do justice to culture and cultural evolution. This "biological evolution is not simple either" counterargument is analyzed both from the perspective of Generalized Darwinism and that of Godfrey-Smith's taxonomy. After that a specific argument is critically scrutinized that Hodgson and Knudsen put forward to show the inevitability of invoking Darwinian principles in acceptable explanations of evolutionary processes in economic systems. Again, this is contrasted with Godfrey-Smith's take on the usefulness of Darwinism in both biological and cultural evolution. Finally, the issues are taken up of whether there are social replicators and of whether replicator dynamic can be applied also in the absence of social replicators. This relates to the long-standing debate between proponents and opponents of Darwinizing culture about the relevance of the observation that discrete entities such as genes, which are copied with high fidelity, seem to be rare (if not non-existent) in the cultural domain.

¹ Comments by Geoff Hodgson and Thorbjørn Knudsen are gratefully acknowledged. All remaining errors are mine.

2. The received view on Darwinizing evolutionary economics

Attempts to Darwinize evolutionary economics (cf. Aunger 2000) have met resistance from within the field of evolutionary economics (Witt 2004, 2007; Bünstorff 2006; Cordes 2006; Schubert 2009). But now it seems the field has reached an agreement about what sort of Darwinism is acceptable and perhaps even necessary (Hodgson 2010). In a nutshell, the crux of this “received view” is that the three Darwinian principles, variation, replication and selection should be given an abstract and general interpretation (cf. also Aldrich et al. 2008, Hodgson and Knudsen 2010). A Generalized Darwinism is based on a recognition of ontological communalities between the biological and the economic (or, more broadly, the cultural) domain,² while acknowledging that there are also huge differences in the (“details” of the) mechanisms that bring about variation, replication and selection in the two domains. It is acknowledged, for example, that in the cultural domain intentionality plays an important role in the production of variation and in selection, that replication is often mere retention of information and that, if there is genuine transmission of information from the one cultural interactor to the other, the fidelity typically is lower than in genetic inheritance.

By identifying variation, replication and selection as the key ingredients in Darwinism, proponents of Generalized Darwinism such as notably Hodgson and Knudsen (2006, 2010) seem to place themselves in the “classical” tradition of attempts to give generic descriptions of Darwinian evolution through natural selection (Godfrey-Smith 2009). Important forerunners in this tradition are Lewontin (1970) and Lewontin (1985). In this tradition, variation, heredity and differential fitness are seen as separately necessary and jointly sufficient conditions for evolutionary change through natural selection to occur. Hodgson and Knudsen also argue, however, that further refinements and clarifications of these Darwinian principles are needed. One such refinement is the requirement that interactors and replicators are to be identified. By imposing this requirement, Hodgson and Knudsen put themselves also in another tradition of attempts to give generic descriptions of Darwinian evolution pioneered by Dawkins (1976) and further developed by Hull (1980): the replicator approach (Godfrey-Smith 2009). The replicator approach insists that for some evolutionary process to qualify as Darwinian there must be replicators involved. Replicators are entities that induce the production of copies of themselves. The paradigm examples of replicators in biological evolution are genes. Hodgson and Knudsen argue that in the economic domain, habits (of individual persons) and routines (of organizations such as firms) are replicators. Hull defines “interactors” as cohesive entities that interact with each other, causing reproduction to be differential. Individual organisms are paradigm examples of interactors in Darwinian biological evolution. Hodgson and Knudsen argue that firms are interactors in the economic domain.

Hodgson (2002, 2004) rightly argues that Darwinism is thoroughly committed to causation and to causal explanation. Darwinism forbids postulating an entity or phenomenon that enters the scene as a *deus ex machina* (or as an “uncaused cause”). For each entity or phenomenon postulated, it must be possible (at least in principle) to show that it has been produced in earlier causal processes. In Dennett’s (1995) felicitous wording, whereas it is admissible to invoke cranes in evolutionary explanations, referring to skyhooks is inadmissible. Thus, contrary to a common and tenacious misunderstanding, Darwinism does not rule out intentional (or purposeful) action. Darwinism does insist, though, that the capacity for

² Implicitly, it is assumed that the economic domain is a subdomain of the cultural domain and that the biological and cultural domain can be carved up “horizontally” as two adjacent, non-overlapping domains. The implications of the fact that the biological domain can be seen as part of the economic domain (brains, neurons and genes can be seen as constituent parts of the economic domain at different levels of organization, for example) are given scant attention (cf. Vromen 2004). In this paper I accept the implicit assumption for the sake of argument.

intentional action must have been produced in earlier evolutionary processes (Vromen 2001). In the same spirit, natural selection itself is to be conceived of as a causal mechanism. Or, to be more precise, natural selection is to be conceived of as a recurring cycle of three mechanisms: one that produces (and replenishes) variation, one that does the selecting and one that takes care of the replication (Darden and Cain, 1989). Similarly, Hull argues that natural selection is not one causal process, but two: one of interaction (in which interactors are put to the test of environmental selection) and one of replication (in which replicators are transmitted).

Hodgson and Knudsen hold that the three Darwinian principles must necessarily be invoked in any adequate causal explanation of evolution in complex population systems.³ But they also argue that invoking the three Darwinian principles is insufficient for providing adequate causal explanations. Taken together the three Darwinian principles form a meta-theory. To arrive at empirically meaningful middle-range theories auxiliary hypotheses will have to be added to the three Darwinian principles. And the auxiliary hypotheses added will have to do justice to the peculiarities of the phenomena in the domain at issue. The contribution of the Darwinian meta-theory in constructing middle-range theories is an heuristic one: it directs theorists to look specifically at the details of how the mechanisms of variation, replication and selection (or, alternatively, those of interaction and replication) are implemented in some particular domain.

There is much to be admired and recommended in Hodgson and Knudsen's treatment of Generalized Darwinism. They rightly stress that Darwinism is firmly committed to population thinking (Mayr 1976, Metcalfe 1988). Rather than thinking in terms of fixed types and immutable essences, as in typological and essentialist thinking (modes of thinking, it can be said, that we are more accustomed to), Darwinism takes changes in populations of heterogeneous entities as its starting-point. Among the many other merits of Hodgson and Knudsen's treatment is also a thoughtful analysis of how social structure, which arguably is important in economic systems, can be fitted into the Darwinian meta-theory. Hodgson and Knudsen also argue convincingly that their Generalized Darwinism steers clear from justifying optimality claims and also from genetic determinism and biological reductionism. It is indeed one of the attractive features of Generalized Darwinism that it allows for the possibility that processes of cultural evolution can go against biological imperatives. Generalized Darwinism grants that there can be more or less autonomous processes of economic evolution in their own right, leading to outcomes that run against the "interests" of our "selfish genes". Hodgson and Knudsen also seem to recognize the many significant disanalogies between phenomena and processes in the biological and economic domain. They rightly sense that any rendering of "Darwinism" that tries to deny or conceal the profound differences between those domains is bound to fail.

The latter comes at a price, however. To accommodate legitimate concerns about significant differences between biological and cultural evolution (at the level of detail, Hodgson and Knudsen assure us), Hodgson and Knudsen are compelled to give a very general and abstract rendering of Darwinism. It seems their Generalized Darwinism does not rule out "selection" understood as conscious, deliberate choice, for example, and "replication" as mere retention or as systematically biased transmission. Indeed, it seems their rendering becomes so general and abstract that the Darwinian principles are bereft of much if not all of their substance. We are left, it seems, with a diluted (or watered down) version of Darwinism. The problem with this is that it not only tends to lose its discriminating power (the set of non-Darwinian dynamic processes tends to be empty). It also seems to put all the explanatory

³ Complex population systems are systems that are populated by a great variety of different entities (Mayr 1976) that interact with each other in non-trivial ways.

work on the auxiliary domain-specific hypotheses that have yet to be added to the three Darwinian principles. The devil is in the details, as the saying goes (Vromen 2007, 2010). And since the principles are emptied from almost all of their substance, it also seems that the three Darwinian principles are not able to give much (“heuristic”) guidance in the search for the auxiliary domain-specific principles. Of course, all this does not show that attempts to base further theory construction in evolutionary economics on the three abstract Darwinian principles are doomed to fail. What it rather shows is that the three abstract Darwinian are not of much use as a basis for further theory construction.⁴

3. A different view: Godfrey-Smith’s taxonomy

Godfrey-Smith (2009) presents a different view on Darwinism.⁵ Like Hodgson and Knudsen, Godfrey-Smith also takes Lewontin’s (1970, 1985) classical descriptions of Darwinism, in terms of the three conditions (or principles) of variation, inheritance and differential fitness,⁶ as his point of departure. But he works this out in a way that deviates from Hodgson and Knudsen’s at two critical points. First, while Godfrey-Smith takes Lewontin’s classical approach to describe the key tenets of Darwinian evolution through natural selection as a useful starting-point for further distinctions and refinements, he criticizes and ultimately rejects Dawkins’s and Hull’s replicator approach. Second, he argues that additional requirements have to be added to Lewontin’s “minimal” description to arrive at a more substantive form of Darwinism that is able to explain cumulative evolution of novel structures.

Godfrey-Smith criticizes and ultimately rejects Dawkins’s and Hull’s replicator approach for various reasons. One is that it provides an “agential” view on evolutionary processes, with hidden “selfish” interests and machinations, which is often misleading. The most important reason, though, is that it suggests that Darwinian evolutionary change through natural selection is impossible without replicators. Godfrey-Smith (2000) points out that this suggestion is false. All that is needed for evolutionary change through natural selection to occur is that offspring resemble their parents to a greater degree than that they resemble non-related individuals from the population.

One might be tempted to conclude from this that this plays in the hands of Hodgson and Knudsen. After all, Hodgson and Knudsen argue that the by itself correct observation that replication tends to be less faithful in cultural evolution than in biological evolution does not undermine their project of Darwinizing social science. Isn’t this exactly what we can conclude from Godfrey-Smith’s main objection against the replicator approach (cf. Kincaid 2009)? It is true that the mere (alleged) fact that the fidelity in social transmission tends to be lower than that in genetic inheritance does not by itself vitiate the classical Darwinian approach in the social sciences (in terms of variation, replication and differential fitness). But in Godfrey-Smith’s view this fact does undermine the replicator approach. Following Dawkins (1976),

⁴ Generalized Darwinism might still be useful for other purposes, for example for facilitating cross-disciplinary communication (as it seems to provide a common “language”) and for unifying different theories. Since Hodgson and Knudsen themselves stress the heuristic function of Darwinism in further theory development, however, I confine my attention in this paper to that function.

⁵ In my discussion, I shall refrain from making critical remarks. On the back-cover of the book Elisabeth Lloyd calls Godfrey-Smith’s book “a gem”. A gem it is: it is full of illuminating insights. But not many of the insights are worked out in great detail.

⁶ Note that Godfrey-Smith replaces Hodgson and Knudsen’s third principle, selection, by differential fitness. I think Godfrey-Smith’s is more accurate (as “selection” does not appear then in both the *analysans* – evolution through natural selection – and the *analysandum* – variation, replication and differential fitness), but henceforth I will use both formulations interchangeably.

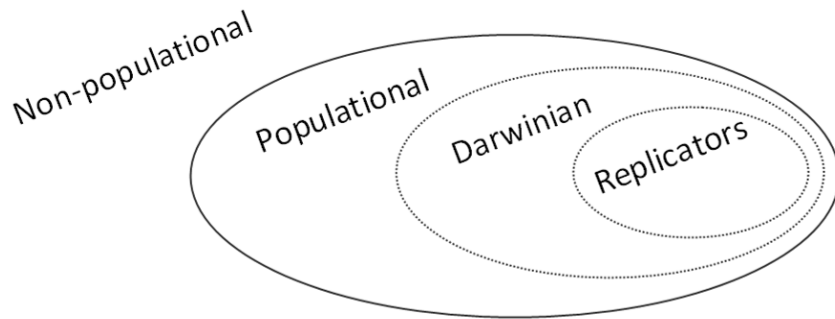
Godfrey-Smith insists that the notion of replicator implies a process of high-fidelity copying. If high-fidelity copying is lacking, there are no replicators. And then the replicator approach does not apply. More importantly, Godfrey-Smith argues that Darwinism imposes rather stringent requirements on the sorts of processes in which “parents” produce their “offspring”. “Reproduction is at the center of Darwinism” (ibid., 69): a crucial presupposition in Darwinism is that parents are actively causally involved in the production of their offspring. Sexual reproduction in biology, in which the parents copulate and produce a fertilized egg, probably is the first example that comes to mind here. As Godfrey-Smith argues, the presupposition is important for distinguishing Darwinian evolutionary processes from other processes, such as processes of growth. Mere retention or persistence of traits in individuals is also a different sort of process. Godfrey-Smith argues that when there is retention instead of genuine reproduction, the minimal requirements of Darwinism are not met. In Godfrey-Smith’s vocabulary, minimal Darwinian populations then shade into marginal (or partial) Darwinian populations.

According to Godfrey-Smith, the minimal requirements of Darwinism are not met either when the primary causal action in “reproduction” is not with the parents but with the offspring. He argues that the latter is often the case in social transmission. Thus, in imitating (or “socially learning” from) others, the primary causal action is with the “offspring”. The imitators rather than the ones that are imitated do the “copying”. Often imitators do not only (consciously or unconsciously) decide what trait to “copy”, but also whom to “copy”. It is possible that imitators put together their own behavioral traits by selectively copying traits from various role models. In such a case, the imitator (as “offspring”) blends traits from various “parents”. This differs from genetic inheritance, in which genes of parents are passed on their offspring as discrete units. What is more, the cultural “parents” selected need not stand out in terms of social prestige or reputation. Imitators might be inclined to safely stay “in the middle” by choosing “average” role models (that is, in Boyd and Richerson 1985’s vocabulary, there might be a conformism-based bias in social transmission).

It is important to see that Godfrey-Smith is not contrasting peculiarities of cultural evolution with a straightforward and simple neo-Darwinian model of biological evolution. His point is not that whereas that simple model does fit all of biological evolution, it does not fit anything of cultural evolution. His point is rather more subtle. We can find different shades of Darwinism in both domains. Over the last decades it has become abundantly clear, he thinks, that the simple neo-Darwinian model does not fit the full complexity of biological evolution either (more on that below). Yet Godfrey-Smith does maintain that there are good reasons (such as the ones alluded to above) to believe that relatively many processes of cultural evolution do not meet the minimal requirements of Darwinism. At best these processes shade into marginal Darwinian ones. Sometimes, however, processes of cultural change are not even populational in character.⁷ Members of organizations such as firms might lack the degree of autonomy that is characteristic of populations, for example. In general, Godfrey-Smith argues, the more networks of interaction feature role asymmetries, the less population-like they are (ibid., 149). Given the ubiquity of role asymmetries in societies, this would severely restrict the scope of Darwinism in the social sciences.

Godfrey-Smith presents the following Venn-diagrams to illustrate the relevant distinctions.

⁷ Again, Godfrey-Smith is not arguing that this is unique to cultural evolution. In biological evolution, we also find ensembles of entities (such as the atoms in hemoglobin molecules) that do not constitute populations.



Thus processes that are populational in character comprise more sorts of processes than Darwinian processes, which in turn comprise more sorts of processes than the ones in which replicators feature.

There is one more relevant category in Godfrey-Smith's view on Darwinism that deserves special mentioning: *paradigm Darwinian populations*. Paradigm Darwinian populations form a subcategory of minimal Darwinian populations in that they are populations in which key parameters in minimal Darwinian populations assume particular values. One such key parameter is the degree to which reproductive success of members of populations depends on their "intrinsic properties". The relevant contrast here is with drift. Drift is taken to be evolutionary change that occurs randomly, by chance or by accident. Being struck by lightning or by an earthquake is a paradigmatic example. To some evolutionary theorists (cf. Sober 1984) drift is an evolutionary force alongside others, such as notably natural selection. In Godfrey-Smith's view, however, drift is a situation in which the dependence of differences in reproductive success of members of a population on differences in their intrinsic properties (i.e., properties that in the absence of the accident would determine differential reproductive success) is low. Another crucial parameter is the degree to which there are bottlenecks in reproduction. A bottleneck is a narrowing that marks the divide between generations. In the extreme case this narrowing means that one single cell (such as an egg) links generations in reproduction. Yet another parameter is fidelity in copying. We saw that this degree need not be high in minimal Darwinian populations. But in paradigm Darwinian populations copying is high-fidelity. Thus paradigm Darwinian populations form a subset of the set of replicators in the Venn diagram depicted above.

Paradigm Darwinian populations are populations that not only satisfy the three requirements of minimal Darwinian populations but that in addition have high dependence of differential reproductive success on intrinsic properties, have a high degree of "bottlenecking", and have high fidelity in replication.⁸ The introduction of the notion of a paradigm Darwinian population does not serve classificatory purposes only. It does not only provide a benchmark for telling how Darwinian a population is. It also is meant to single out populations for which so-called *origin explanations* can be given. Godfrey-Smith contrasts origin explanations with distribution explanations. Distribution explanations can only explain how and why the distribution of certain, already existing variants in a population changed. Origin explanations can do more; they can also explain why some population has come to contain the variants in the first place. In particular, they can explain the cumulative evolution of novelty.

Given that natural selection is often characterized as some sort of a filtering mechanism that can only trim the set of pre-existing variants, this might come as a surprise. How can natural selection generate novel structures if all it can do is weed out "unfit" variants? Godfrey-Smith's answer is that natural

⁸ This list does not exhaust the list of crucial parameters that should have a high value for populations to qualify as paradigm Darwinian populations. But it gives the gist of the notion of a paradigm Darwinian population.

selection may change the population-level background against which new mutations appear. Consider the evolution of the human eye, for example. Let us assume that natural selection cannot increase the probabilities that the right type of mutations occur for the human eye to be produced. But what natural selection can do is to “prepare” the population so that when the right types of mutations occur they eventually result in the production of the eye. Natural selection can increase the number of independent “slots” in which mutations will give us the eye (ibid., 50). For natural selection to be able of doing that, certain requirements have to be met. Drift should play a negligible role, fidelity in copying should be high and there should be a high degree of “bottlenecking”. In short, the more populations approximate paradigm Darwinian populations, the more likely it is that origin explanations can be given.

Summing up now, Godfrey-Smith’s view implies that both biological and cultural evolution are heterogeneous.⁹ In some cases there is high-fidelity replication. Then replicators are involved. Replicators are not necessary for Darwinian evolutionary change through natural selection to take place, however. The minimal requirements of variation, replication and differential fitness can be met while replicators are non-existent. But it seems more stringent requirements have to be met for natural selection to be able to (“cumulatively”) produce novelty. High fidelity in replication seems to be one of them. Thus we have different shades or degrees of Darwinism. Sometimes populations also shade into marginal or partial Darwinian populations, or outright non-Darwinian populations. The minimal requirements of Darwinism are not met when there is no reproduction of the right causal sort, for example (if “parents” are not causally responsible for the resemblance with their “offspring”, for example, or if there is only persistence or retention). And sometimes there can be gradual change in entities (such as firms) that do not even qualify as populations, let alone as Darwinian populations.

4. The “biological evolution is not so simple either” argument

Perhaps the most common objection against attempts to Darwinize the social sciences is that Darwinism does not fit cultural phenomena and processes. The basic idea is that the processes envisaged in Darwinism are too simple to do justice to the complexities of processes in the cultural domain. Thus it is sometimes argued that in the cultural domain we do not have discrete entities like genes that act as replicators. In social learning there can be a lot of “blending”: individuals can choose to put together traits they selectively pick from different some role models. And insofar as we have replication at all in cultures, it is often of the horizontal rather than vertical type: whereas parents pass on their genes only to their biological offspring in biological evolution, in cultural evolution there is social transmission of traits also between individuals of the same generation that are genetically unrelated. Children do not learn just from their biological parents, for example, but also from their peers and other role models. These are just a few of the many dis-analogies between biological and cultural evolution that have been pointed out by critics of Darwinizing the social sciences.

This objection is sometimes answered by what can be called the “biological evolution is not so simple either” counterargument (cf. Hull 1988, Mesoudi et al. 2006, Crozier 2008, Hodgson and Knudsen 2006, Wenseleers et al. 2010). This counterargument runs as follows. Critics of a Darwinian approach in the social sciences implicitly assume that the simple (neo-Darwinian) model that they take to be Darwinian fits biological evolution. In this simple model variants are traits of individual organisms that are heritable, inheritance (via genetic transmission) is only vertical and perfectly faithful (“like begets like”), fitness differences translate perfectly into differences in reproductive success and new variants enter

⁹ For a similar argument especially with respect to cultural evolution, see Sterelny (2006).

through gene mutations that are blind or random. But this only reflects a poor, simplified understanding of Darwinism, it is argued, that does not do justice to many processes of biological evolution either. Cultural evolution might be too complex for this poor, simplified understanding of Darwinism to be fitting. But the same can be said also about biological evolution. The poor, simplified understanding of Darwinism does not fit much of biological evolution either. Especially with bacteria, for example, we now know that there is also horizontal transmission of genetic information. *Ergo*: the argument is flawed that Darwinism is to be resisted in the social sciences because cultural evolution is much more complex than biological evolution.

The logic of the counter-argument is impeccable. A crucial premise in the critics' argument is that Darwinism *as they understand it* fits biological evolution. The critics think they spot dis-analogies between biological and cultural evolution, whereas in fact they only spot dis-analogies between cultural evolution and a particular version of Darwinism that they take to be representative of biological evolution. If it is indeed the case that the premise is factually false, as proponents of Generalized Darwinism argue, the conclusion (that Darwinism *as they understand it* does not fit cultural evolution) might be false as well. *Ergo*: Generalized Darwinism cannot be discarded on the basis of alleged, but non-existing dis-analogies.

It should be clear by now where proponents of Generalized Darwinism believe the critics go wrong: the critics read too much in "Darwinism". The understanding of Darwinism by the critics is not general and abstract enough. On a more general and abstract understanding of Darwinism, Darwinism might fit many more (and perhaps even all) processes of biological evolution through natural selection. And indeed this is exactly what biologists and philosophers like David Hull with their abstract rendering of Darwinism have been trying to accomplish. Their claim is furthermore that their rendering of Darwinism is general and abstract enough to account also for at least some evolutionary processes outside the biological domain (such as processes of cultural evolution).

Still, for all its "impeccability", there seems to be something strange about the counter-argument. It seems critics are not really interested in whether or not some version of Darwinism can be formulated that fits all instances of biological evolution. What they are really interested in is whether or not Darwinism gives a clear and simple model to study cultural evolution. They are not really helped by being told that in order to accommodate all processes of biological evolution Darwinism should be understood in a more general and abstract way than what they took Darwinism to be. They thought (and perhaps hoped) that Darwinism gives a rather clear and simple model. But now they learn that Darwinism does not give anything of the sort. Instead of a clear and simple model, Generalized Darwinism provides them with a very general and abstract description that is explicitly aimed at covering diverse processes and phenomena.

Critics might wonder why we would like to have such a general and abstract rendering of Darwinism in the first place. What is so desirable about a formulation of Darwinism that is able to accommodate a multitude of biological evolutionary processes, if it is admitted that there are significant differences between evolutionary processes in the biological domain? Obviously, such a formulation would slide over such differences. What is the use of a formulation of Darwinism that blurs rather than highlights such differences? If proponents of Generalized Darwinism are correct in their observation that a simple model of Darwinism does not fit many processes of biological evolution either (and it seems they are

correct), why not draw the alternative conclusion that there is no clear model of Darwinism that can do justice to all processes of biological evolution through natural selection?¹⁰

It seems that is the conclusion Godfrey-Smith is drawing. Rather than searching for a watered-down version of Darwinism that is able to cover all known instances of biological evolution through natural selection (and that “flattens out” all those instances as equally Darwinian), he is looking for a clear conception of a minimal Darwinian population to distinguish Darwinian processes from not quite (marginal) Darwinian ones and within the first category for a clear conception of a paradigm Darwinian population to distinguish between populations that are more or less (paradigmatically) Darwinian. Whether or not cultural evolution harbors many paradigm Darwinian populations remains an open, as yet unresolved question. The merit of Godfrey-Smith’s approach is that we at least have a clear understanding of what paradigm Darwinian populations are. Instead of stretching “Darwinism” so as to cover as many dynamic processes as possible, we keep to a relatively simple and clear model. Just as there are some dynamic processes in the biological domain that are not Darwinian (or only marginally Darwinian at best, and some are not even populational – such as the cells in organisms), there are dynamic processes in culture (and economies) that are not populational (let alone Darwinian).

In the end this is a matter of what we want abstract formulations of Darwinism to do for us. Godfrey-Smith argues that two different desires have spurred attempts to give abstract formulations of Darwinism. One desire is to capture all genuine cases of natural selection in a summary description. The other is to describe a clear, simple and causally transparent machine. Often it has gone unnoticed that there have been these two different desires (Godfrey-Smith 2009, 4). As a consequence it has not been acknowledged either that there is a trade-off between what is required to meet the two desires: since the total set of cases of natural selection is rather messy, heterogeneous and complex, meeting the desire to cover all cases of natural selection goes at the cost of the simplicity, transparency and clarity of the resulting description: “As the summaries get sharper and function better as recipes, they start to omit cases. As they become more inclusive, they break down as recipes.” (Godfrey-Smith 2009, 27).

In their version of Generalized Darwinism, Hodgson and Knudsen seem to be led more by the first than by the second desire. In Hodgson and Knudsen (2010, 22) they describe the difference between generalizing and analogical reasoning as follows. Analogical reasoning takes phenomena and processes in one domain as reference points for the study of similar phenomena and processes in another domain. Generalizing does not prioritize analytically any domain. It rather takes a deliberately copious array of phenomena and processes (possibly in different domains) and tries to adduce shared principles. It is clear that Hodgson and Knudsen believe that they themselves are engaged in generalizing rather than analogizing. This is roughly the same, I venture, as what Godfrey-Smith calls the desire to give a summary description of all cases of natural selection. By contrast, critics who stress the dis-analogies between biological and cultural evolution are interested in whether or not analogical reasoning is apt. They conceive of Darwinism not as a summary description of all cases of evolution through natural selection, but as a description of a simple, clear and transparent mechanism; a description that was first given in evolutionary biology.

¹⁰ It would seem we need a more general model with (paradigm) Darwinism as a special, limiting case. Kerr and Godfrey-Smith’s (2009) generalization of the Price equation can be seen as exactly such an attempt. See Wenseleers et al. (2010) for an interesting further discussion with a special focus on (alleged) differences between biological and cultural evolution.

Thus it seems Hodgson and Knudsen's Generalized Darwinism does not provide what critics of Darwinism believe Darwinism (if adequate, or useful, or fruitful) ideally should provide: a clear and simple model for how to study processes of cultural (or more specifically economic) change. As an analogy for studying economic evolution, the critics find the simple model wanting. But what else could the contribution of Darwinism to economics be other than offering a clear and simple model to study processes of economic change? A summary description of ontological communalities between processes and phenomena in various domains is not what made Darwinism an interesting candidate approach or framework to look at in the first place. For all its shortcomings as an analogy, the simple model has at least the merit of being clear and substantive. That merit seems to be missing from Hodgson and Knudsen's version of Generalized Darwinism.

5. The "Darwinian principles must be invoked" argument

"... an adequate explanation of the evolution of such as system [a complex population system; JJV] *must* involve the three Darwinian principles of variation, inheritance and selection. [...] Otherwise the explanation of evolution will be inadequate." (ibid., 31; italics in the original)

Hodgson and Knudsen (2010) argue that adequate explanations of evolution of complex population systems must refer to the three Darwinian principles of variation, inheritance (or replication) and selection. Reference to the principles is said to be inevitable. Invoking the three principles is not sufficient to give complete explanations of evolution in such systems, however. To that effect, domain-specific auxiliary hypotheses have to be added. But no adequate explanation of evolution can do without invoking the three Darwinian principles.

Let us have a closer look at how Hodgson and Knudsen argue (Hodgson and Knudsen 2010, 30-31). They first make plausible that in complex population systems variation, inheritance and selection are present. "Complex population systems" are defined abstractly and loosely as systems comprised of a variety of entities that interact with each other. Thus variation is part of complex population systems by definition. Hodgson and Knudsen argue there also is selection in the sense that entities in such systems are mortal and degradable. The entities have to compete for locally scarce resources. Finally, Hodgson and Knudsen assume that the entities have the capacity to retain and pass on workable solutions (acquired in the struggle for existence) to others. In other words, there also is replication. After Hodgson and Knudsen established that variation, inheritance and selection are omnipresent in complex population systems,¹¹ they go on assuming that for each of these - variation, inheritance and selection - a distinct mechanism (or distinct sets of mechanisms) is working. Thus we have a mechanism for the creation (and replenishment) of new variation, a mechanism for replication and one for selection. Finally they present the "... crucial step in the argument": an adequate explanation of evolution in complex population systems must involve the three Darwinian principles (cf. "each principle is an explanatory requirement", ibid., 31).

What Hodgson and Knudsen seem to do here is to infer the necessity of invoking the three Darwinian principles in explanations of processes in complex population systems from the (alleged) ubiquitous

¹¹ Strictly speaking, Hodgson and Knudsen do not prove that besides variation, replication and selection are always ("necessarily") present in complex population systems. They rather trust on it that readers will recognize that in many different systems there is selection and replication (if "selection" and "replication" are understood sufficiently generally and abstractly).

existence of variation, replication and selection in those systems. This inference is dubious if not fallacious, however. The mere presence of certain things in some system does not ensure the importance (or relevance) of these things in explanations of phenomena and processes in the system. Take atoms, for example. Assuming that complex population systems always consist of matter and that the presence of matter always involve the presence of atoms, atoms are always necessarily present in such systems. Yet it is clear that adequate explanations of the evolution of such systems need not refer to atoms. If anything, adequate explanations are likely *not* to refer to atoms. Or consider another example closer to the subject matter of economics. Hedström (2005) argues that adequate explanations of social phenomena must refer to individual persons and their (inter)actions (rather than to institutions and social structure) because individual persons and their (inter)actions are always necessarily involved in the production of social phenomena. Sperber (2010) rightly observes that this is a *non sequitur*. There are many other things involved (at different levels of description) in social phenomena than individual persons and their interactions; their mere presence does not grant any of them explanatory primacy. Indeed, given their emphasis on the importance of social structure, I am pretty sure Hodgson and Knudsen would readily agree that even though individual persons are always necessarily present whenever there are social phenomena, often not individual persons and their interactions but social positions, roles and institutions are the adequate level of analysis in explanations of social phenomena.

Note also that the claim at stake here, that in systems in which the three principles are present, adequate explanations must involve the three principles, is a stronger claim than that, taken together, the three principles are a sufficient condition for evolution through natural selection. The latter weaker claim can be rephrased as follows: in any system in which the three conditions are met, evolution through natural selection necessarily occurs (cf. Lewontin 1970, 1985; Dennett 1995). Thus the three principles are often seen as a recipe for Darwinian evolution (Godfrey-Smith 2009).¹² This latter claim is weaker than Hodgson and Knudsen's claim that adequate explanations must involve the three principles because it does not imply that natural selection is the only mechanism working in complex population systems. There might be other mechanisms working in complex population systems than (paradigmatic) Darwinian natural selection, such as drift and migration. The weaker claim that the presence of the three principles is a recipe for Darwinian evolution does not imply either that natural selection dominates or overrides the possible working of other "forces". Indeed, other forces might override the working of natural selection.

A simple economic ("toy") example shows why in such a case explanations in terms of the three Darwinian principles would not be adequate. Suppose that firms in, say, the automobile industry differ in profitability. Suppose also that the conditions of variation, replication and selection are all met. Imagine that the firms vary with respect to the traits that are selected for. The traits are perfectly heritable. Firms are of the same size and the number of spinoff firms that "parent" firms found is proportional to their profitability. Then, *ceteris paribus*, "natural selection" will see to it that the market share of more profitable firms increase at the cost of that of less profitable firms (this is an example of what Hodgson and Knudsen call "successor selection"). Now suppose that the more profitable firms are geographically concentrated in a particular area and that that area is hit by an earthquake. The earthquake causes fatal losses for the hitherto more profitable firms, which in turn increases the market share of the hitherto less profitable firms (or, to be strict, of their traits). It seems evolution in such a system is clearly not adequately explained in terms of variation, inheritance and selection. The effects of

¹² Godfrey-Smith gives a simple example to show that this need not be true, though: it is possible that the differential fitness effects are exactly nullified by the systematically biased transmission effects (cf. the two terms in the Price equation exactly add up to zero) so that there is no net evolutionary change.

“natural selection” are overridden here those by drift (assuming that events such as earthquakes are paradigm examples of drift).

Thus adequate explanations of evolution in complex population systems need not, and perhaps sometimes should not, involve the three Darwinian principles. But it might still be that the three principles must be invoked to explain particular sorts of evolutionary processes. Perhaps the *explananda* of Darwinian explanations should be delineated more precisely (Stoelhorst 2008). Perhaps explanations of the evolution of adaptive complexity must involve the three Darwinian principles. Sometimes it seems Hodgson and Knudsen have something like this in mind. They argue, for example, that for the evolution of (ordered and adapted) complexity, and for important transitions in the mode of replication (esp. social organization: social structures, rules, positions and institutions), we need the existence of replicators and interactors. Without social replicators, social evolution would be less sophisticated than biological evolution, and would have a more limited potential for the evolution of a more complex phenomena. (Hodgson and Knudsen 2010, 71). Given that we continuously witness the evolution of more complex phenomena in economic systems, they argue, there must be “economic” replicators.

I think that there are several issues at stake here that should be distinguished carefully. One is whether adequate explanations of the evolution of adaptive complexity must involve variation, replication and selection. This does not seem to be the case. To see this let’s return to the automobile industry example. In the absence of drift and other confounding factors, Darwinian evolution through “natural selection” led to a particular outcome in our simple toy example. Here, in this specific example, it can be perhaps maintained that an adequate explanation must involve variation, replication and selection.¹³ But it is easy to see that the same outcome can result via very different sorts of causal processes. Instead of “parent” firms founding spinoff firms with exactly the same traits, firms now simply retain their traits over time. The growth of firms is proportional to their profitability. Then again the traits of the most profitable firms will eventually come to prevail in the industry. Thus we have the same particular outcome, but this time without any replication (this is an instance of what Hodgson and Knudsen call subset selection).

It can be argued that the deviation from the Darwinian variation – replication – selection framework in this second example is only minor. The only thing that has to be replaced, it seems, is “replication” by “retention”. But now consider a third example: all firms in the industry imitate the superior traits of the most profitable firms (and assume, for the sake of argument, that they can perfectly copy and implement the traits). Again the outcome will be that only the superior traits will come to prevail in the industry. But now all the relevant causal action is with the offspring firms, rather than with the parent firms. And it seems “replication” (or social transmission) is doing all the causal work here. Unlike in the first two examples, there is no active causal role here for selection, at least not in the sense of the test of environmental selection. This rendering seems to be square well with how Hodgson and Knudsen would render this third example. Hodgson and Knudsen would probably classify such a causal process as diffusion. In their classification, diffusion is a subcategory not of selection but of replication, since the traits transmitted are not (yet) subjected to the test of environmental selection.¹⁴ (this can be said to be

¹³ It should be noted, though, that the causal processes envisaged in this simple example can be described at other levels (e.g. at the level of individual persons and their interactions in particular social situations) in ways that do not refer (at least explicitly) to variation, replication and selection.

¹⁴ In this specific case it might be argued, though, that there is a subsequent stage of selection. It is just that in this specific case (as all firms are assumed to copy the superior traits flawlessly) the causal efficacy of selection is pre-empted. But below we will see examples of cultural evolution in which there is no subsequent stage of selection.

pre-empted in this particular case). We can think of many more causal routes via which the same outcome may be produced. Thus all firms might individually learn (that is, unlike the social learning in the third example, independently of each other) that the traits of the most profitable firms are the superior ones. Or firms from other industries might found new firms with the superior traits in the automobile industry (which would be an example of migration, not natural selection).¹⁵ In sum, contrary to what Hodgson and Knudsen argue, adequate explanations of the evolution of adaptive complexity need not involve variation, replication and selection. There seem to be other causal pathways via which adaptive complexity can be produced than the one involving variation, replication and selection.

Social replicators?

It might be objected that the outcome in all these examples is not an instance of adaptive complexity: the outcome for sure is adaptive, but it is not complex. And it might be added that it is exactly for the cumulative evolution of increased complexity that we need replication and replicators. Without replication and replicators, Hodgson and Knudsen seem to suggest, what is momentarily gained in previous evolutionary processes (in terms of increased complexity) is subsequently lost. This seems to be similar to Godfrey-Smith's argument that we need more than minimal Darwinian populations, namely ideally paradigm Darwinian populations with high-fidelity replication, for the cumulative evolution of novel phenomena. But Godfrey-Smith reserves this argument for biological evolution. He questions the relevance of the argument for explaining adaptive complexity in cultural systems. It seems one of the central messages of Williams (1966), that Darwinian natural selection is the only mechanism in biology that we know of that can produce adaptive complexity, still stands. But for cultural evolution things might well be different. As Godfrey-Smith rightly argues, in a cultural context we are dealing with intelligent agents who can accumulate skills and information by a variety of means (Godfrey-Smith 2009, 163). "Replication" and "replicators" in a substantive sense, implying that "parents" are actively causally involved in the material reproduction of "offspring" that almost perfectly resemble their parent with respect to the relevant traits, do not seem to be required. In cultural evolution, skills and information might not only be retained in various memory systems in individual persons, but also in artifacts and various systems of social organization (cf. Hutchins 1995, Clark 1998), for example.

Here is where the difference between Godfrey-Smith's view and Hodgson and Knudsen's "received view" seems to have real bite. We saw that Godfrey-Smith emphasizes that there is huge heterogeneity in both biological and cultural evolution. Hodgson and Knudsen agree. The difference between the two seems to be that whereas Hodgson and Knudsen tend to call all of these Darwinian, Godfrey-Smith reserves "Darwinian" for a subset only (and allows – with his notions of minimal and paradigm Darwinian populations - for distinguishing different degrees of Darwinism within the subset). When it comes to explaining a particular *explanandum* – cumulative evolution of novelty and adaptive complexity, however, it seems that Hodgson and Knudsen agree with Godfrey-Smith that something like paradigm Darwinian populations (and surely more than just minimal Darwinian populations) are required. But Godfrey-Smith confines this argument to biological evolution only. In cultural evolution cumulative evolution of novelty and adaptive complexity might occur through completely different sorts

¹⁵ Hodgson and Knudsen (2010a) treat Klepper's (2002, 2007) insightful analyses of spinoff firms in the automobile industry as an example of organization-level replication of routines. But what Klepper rather wants to explain is that new (*de novo*) car manufacturing firms that are founded by dissatisfied members of "old" firms tend to do better than old diversifying firms and also why firms tend to be spatially clustered. More importantly, Klepper is not at all assuming that there is high-fidelity replication of routines from parent firms to spinoff firms.

of causal pathways (pathways not involving replicators in any meaningful sense, in particular). By contrast, Hodgson and Knudsen seem to assume that the argument also applies across the board to cultural evolution.

Evolutionary economists in the tradition of Nelson and Winter (1982) have always been keen to criticize “orthodox” (or mainstream) economics for its assumptions of “hyper-rationality”. And rightly so. But they should not make the opposite failure of downplaying the cognitive powers of human beings. They should not and need not deny that individual persons (and sometimes also collectives of individuals) are at least sometimes capable of anticipating future contingencies and of making reasonable plans. Likewise they need not deny that there are many more ways for people to accumulate knowledge and wisdom than to instruct and teach their “offspring”. Arguably, assuming the evolution of adaptive complexity requires faithful copying also in cultural evolution is to fall into the trap of relying on unfounded analogies between biological and cultural evolution. Godfrey-Smith does not fall into this trap. But it is not so clear in this specific case that Hodgson and Knudsen also evade the trap.

Hodgson and Knudsen do acknowledge vast differences between biological and cultural evolution (like the ones just indicated). This makes it all the more remarkable that at places they seem to insist on the existence of “faithful social replicators” (ibid., 70). Copying error is said to have a cumulative destructive effect on the evolution of complexity (ibid., 102; see also Hodgson and Knudsen 2010b). What is more, they seem to impose severe requirements on things to qualify as replicators. They build upon previous conceptual work done by Sterelny et al. (1996), Godfrey-Smith (2000) and Sperber (2000). From this work they derive three conditions that replicators have to meet: causal implication (the source must be causally involved in the production of the copy), similarity (the replicated entity must be or contain a replicator) and information transfer (the copy must inherit from the source the properties that make it relevantly similar to the source). To this, they add a fourth condition: conditional generative mechanisms (to make sure replicators play the required instructive role in the ontogenetic development of the interactor; ibid., 96-97).

What is striking here is that Hodgson and Knudsen apparently believe that with the addition of the fourth condition they are able to salvage the replicator notion from recurrent objections voiced by critics. Godfrey-Smith and Sperber are such critics. They spell out the three conditions mainly to show how demanding and restrictive they are. Godfrey-Smith and Sperber want to point out that social replicators are rare, if not non-existent especially in cultural evolution. By contrast, Hodgson and Knudsen want to show that the social (or cultural) domain is rife with replicators. But by adding a fourth condition that has to be met, it seems that they further reduce the chances that social replicators exist. By doing so, it seems that they make their Generalized Darwinism a subset of Godfrey-Smith’s set of replicators (which, recall, is for Godfrey-Smith a subset of Darwinism). Let us call this “strict” interpretation of their Generalized Darwinism GD_S . This raises a problem of interpretation, however. Above I argued that viewed from the perspective of Godfrey-Smith’s categorization, Hodgson and Knudsen’s version of Generalized Darwinism is closer to what Godfrey-Smith calls the populational set (which, recall, comprises Darwinism as a subset) than to its subset of Darwinian populations. Let’s call this broad interpretation of their Generalized Darwinism GD_B . Now which of these interpretations is the correct one?

There is textual evidence in Hodgson and Knudsen’s writings for either interpretation. But GD_B seems to be the dominant one. A first indication for this is how Hodgson and Knudsen interpret the first condition for replicators, that of causation. This condition states that the source is causally implied in the production of the copy. A natural interpretation of this is that the parents materially reproduce the

offspring. The causal action is with the parents. Above we saw that Godfrey-Smith insists that this is one of the hallmarks of Darwinism. And it is easy to think of possible examples of this in the cultural realm: biological parents trying to instill certain values in their children and teachers trying to instruct their pupils. As Godfrey-Smith observes, however, it seems that in most of cultural evolution the causal roles are reversed: the causal action is with the “receiving” party. They decide whom and what to imitate (or whom and what to socially learn from). Thus in a sense, cultural children choose their own cultural parents. In such cases, the first condition, if given the natural interpretation, is not met.

But it seems Hodgson and Knudsen want to give a very broad interpretation of this first condition. Stating that the source must be causally involved in the production of the copy is interpreted as demanding no more than that the source must serve as a model in the production of the copy. Without the existence of the source the copy could not have been produced. Thus understood the condition does not state that the sources must be causally responsible for the production of the copy (as is the case in genetic inheritance). Hodgson and Knudsen seem to interpret the second and third condition in a similarly loose way. They acknowledge that in the process of transmission, organizational routines are likely to undergo considerable modifications, for example. This does not prevent them from claiming that organizational routines are social replicators. Thus in Hodgson and Knudsen’s interpretation of the second and third condition, apparently copies need not be very similar to their sources.¹⁶ Yet other indications that Hodgson and Knudsen in the end opt for GD_B rather than GD_S can be readily given. For example, drift (understood as fitness-unrelated reproductive success of variants) is treated by them as part of Darwinian evolutionary processes (26). Apparently, in their view “Darwinism” does not entail a strong correlation between fitness and reproductive success.

Therefore it seems fair to say that the dominant theme in all the things that Hodgson and Knudsen say about the Darwinian principles (and especially about replicators) is that they should be understood in a highly abstract, general and broad way. Above I gave several examples of different causal processes in the automobile industry.¹⁷ My point was that there might be various different causal processes leading to the same adaptive outcome and that in only one of them all three Darwinian principles seem to be operating. This seemed to refute Hodgson and Knudsen’s claim that adequate explanations of the evolution of adaptive complexity in complex population systems must involve the three Darwinian principles. But this presumed a somewhat strict reading of variation, replication and selection. On a more abstract, general and broader reading of the principles, it can be maintained that the three Darwinian principles are operating in all causal processes envisioned. Differences between the causal processes are then relegated to the domain of details. Only on such a broad reading, Hodgson and Knudsen’s claim can be substantiated that adequate explanations of evolution of adaptive complexity in complex population systems must involve the three Darwinian principles. The claim then boils down to stating no more than that on a sufficiently abstract, general and broad interpretation of the three

¹⁶ Hodgson and Knudsen (2010b) distinguish between copying fidelity and reading (and development) fidelity. They argue that whereas copying errors are absolutely fatal for the evolution of complexity, development errors (in the reading of the generative instructions) are not. As Hodgson and Knudsen seem to concede, however, copying fidelity seem to characterize the creation of new units by (and in) the same firm better than the (“real”) social learning by the one firm from another firm.

¹⁷ It might be objected that it testifies to the explanatory (in the sense of unifying) power of Generalized Darwinism that it is so general that it can cover all these very different causal processes. But if we want Generalized Darwinism to (in the end) provide causal explanations, this does not seem to be a merit, as the relevant counterfactuals differ greatly from the one sort of causal process to the other (Godfrey-Smith 2009, 153).

principles, adequate explanations of such evolutionary processes can be (re)formulated in terms of the three principles.¹⁸

Replicator dynamics without replicators?

Thus far I discussed the adequacy and necessity of Darwinism in evolutionary economics in informal terms. Increasingly discussions about the foundations of Darwinism and evolutionary theory are carried on in formal terms. Hodgson and Knudsen invoke the Price equation (see also Andersen 2004 and Metcalfe 2008). On a standard interpretation, the Price equation partitions evolutionary change over one generation into two components: a selection effect (normally represented in the equation as a covariance term) and a “systematic transmission bias” effect (represented as an expectation term). In an economic context, “market selection” might stand for the first effect. And innovations might be instantiations of the second effect. Hodgson and Knudsen use the Price equation to arrive at a generic understanding of “selection”. They also argue that the equation can be used to empirically verify the effects of separate processes. And, as has been observed also by many other evolutionary theorists (cf. Okasha 2007), they argue that the equation lends itself naturally to account for multilevel selection.

Here, in this section, I concentrate on another standard formal representation of Darwinian evolution through natural selection: the replicator dynamic (Taylor and Jonker 1978).¹⁹ The replicator dynamic and its properties are studied extensively in evolutionary game theory. At an intuitive level it is easy to see that the replicator dynamic neatly captures an idealized version of Darwinian evolution through natural selection. The replicator dynamic basically states that the growth rates of the strategies’ frequencies in a population are a function of the strategies’ relative fitness (i.e., as compared to the population’s average fitness). Thus, if some strategy has superior fitness (independent of the prevailing frequencies in the population), then natural selection will drive that strategy to fixation (so that, in the end, only that strategy survives in the population). It seems clear that one of the crucial idealizations in the replicator dynamic is that there is perfect-fidelity replication. The reference point seems to be asexual reproduction without any mutations. The assumption is that “like begets like” (Maynard Smith 1982).²⁰

Given this standard depiction of the idealizations involved in the replicator dynamic, it is remarkable that Henrich and Boyd (2002) argue that the replicator dynamic is useful for studying population-level changes also if social transmission is biased systematically.²¹ What is more, they even argue that the stronger the systematic biases in social transmission as compared to the force of selection, the more accurate the replicator dynamic tracks population-level patterns (see also Henrich et al., 2008). If Henrich and Boyd are right, the applicability of a standard modeling tool in evolutionary theorizing is not compromised by low-fidelity social transmission. It seems their result would support the belief that Darwinism does not require high-fidelity copying. We would be entitled to maintain replicator dynamic

¹⁸ Brian Arthur (2009) argues convincingly that the Darwinian principles of variation and selection cannot explain how radically new technologies originate (in his view by combining and recombining already existing technologies). It is easy to see that on a sufficiently general, abstract and broad reading of especially “variation” and “replication” Arthur’s own explanation of combinatorial evolution can be recast in terms of the three Darwinian principles (and thus Hodgson and Knudsen’s claim can be rescued). But one wonders what is gained by doing so.

¹⁹ Page and Nowak (2002) show that if a mutation term is added to the replicator dynamic, the resulting replicator-mutator equation is mathematically equivalent to the Price equation.

²⁰ Maynard Smith’s related notion of an evolutionarily stable strategy (ESS) investigates a counterfactual situation: what would happen if a single mutant strategy were to enter the population.

²¹ Henrich and Boyd also use the Price equation to make their case.

even in the absence of replicators. Yet, as Claidière and Sperber (2007) point out convincingly, what Henrich and Boyd show falls short of drawing this, for Darwinism comforting, conclusion. What Henrich and Boyd show at most is that *under quite restrictive and arbitrary conditions* it is possible that even in the presence of systematic transmission-biases replicator dynamic nevertheless tracks population-level change accurately.

Let us have a closer look at Henrich and Boyd's argument. Claiming that replicator dynamic gets the patterns in population-level behavior right *especially when the force of systematic transmission biases prevails over that of selection* is surely counter-intuitive. So how do they go about arguing this? Claidière and Sperber (2007) correctly observe that when one looks through the math, Henrich and Boyd's results are in effect driven by two crucial assumptions:

1. There are a few strong attractors that "deterministically" and quickly pull imitated representations towards these attractors;
2. Selection subsequently favors one of these attractors over the others so that eventually the favored attractor prevails in the population.

Henrich and Boyd give the toy example of how people perceive the moon. Suppose there are different potential role models in the population whose perceptions of the moon range (in some sort of a continuum) from the one extreme belief that the moon is a self-aware, conscious entity with goals, emotions and motivations, to the opposite extreme belief that the moon is simply a big rock, lacking goals, emotions and motivations. Henrich and Boyd assume that social learners are naturally drawn to one of these opposite beliefs. Thus, when social learners imitate role models who are (on the continuum) more to the side of the former extreme belief, what they take over from their role models is not their particular beliefs but the extreme belief near to them. This is what it means to say that there are "deterministic" strong cognitive attractors (cf. Sperber 1986). The presence of such attractors imply a strong and systematic transmission-bias (often called a content-based bias). If the two attractors indicated are indeed strong, it won't last long until there are only two types left in the population: the one type holding the one extreme belief and the other one holding the opposite extreme belief. If then one type for whatever reason stands out as being the more attractive cultural model (because the bearers of it are more successful, or prestigious, for example) then selection will drive the population in the direction of that type. Thus, when (potential) cultural models holding the inanimate belief tend to be imitated more often than the (potential) cultural models holding the animistic belief, the first type will come to prevail in the population. This is precisely what the replicator dynamic predicts.

It is easy to see that Henrich and Boyd's results are quite sensitive to changes in the assumptions. And this is exactly what Claidière and Sperber (2007) set out to do. They show that the replicator dynamic fails to predict population-behavior if the type of role model with the highest (social) fitness does not coincide with an attractor, for example. They furthermore show that it also makes a difference whether "attraction" is taken to be probabilistic rather than deterministic. Claidière and Sperber also point out that assuming that there are strong attractors, as Henrich and Boyd (2002) do, amounts to postulating replicators. After all, once the strong attractors have done their work, we are left with only two types of cultural models whose beliefs are imitated with perfect fidelity. Thus, they conclude, Henrich and Boyd's results are an artifact of the peculiarities of their model. The results do not warrant the general conclusion that when the force of systematic transmission biases prevails over that of selection the replicator dynamic gets population-level behavior right.

What is perhaps more telling here, though, is that the two camps (who arguably can be taken to be the *fine fleur* of contemporary theorists about cultural evolution) agree on many substantive issues. They

agree for example on what it means to say in this context of cultural evolution that the force of selection is relatively weak as compared with the force of attraction: social learners do not have a strong preference for the same cultural model(s), whereas the content-based transmission bias in their learning is strong. Thus “selection” refers here to selective attention, the tendency for social learners to pay particular attention to some individuals more than others (Henrich et al. 2008). In short, it is the choice of the cultural model. Henrich and Boyd suggest that (weak) selective forces come into play only after the strong attractors have done their variation-reducing work. But strictly speaking this is misleading. In terms of time, selection comes first here and transmission comes second. First a cultural model is selected and then information is transmitted from the role model to the learner. Or perhaps it is even more appropriate to say that instead of two distinct processes, “selection” and transmission, we have just one process. It is not that first a cultural model is picked and that only subsequently it is decided by the learner what trait to imitate. It seems this often comes in one fell swoop. An adolescent perceives the behavior of some other adolescent as “cool”, for example, and at once starts mimicking it (often without being aware of it).²²

It seems that Claidière and Sperber are in agreement with Henrich and Boyd that this is how “selection” and transmission typically intermingle in cultural evolution. Conversely, Henrich and Boyd seem to agree with Claidière and Sperber that social transmission is characterized not only by distribution-based biases (such as the conformity- or prestige-bias, relating to *whom* are learned from) but also by content-based biases (attractors, relating to *what* is learned). Indeed, it has become received wisdom that there is a panoply of different sorts of transmission biases in cultural evolution. But if all this is symptomatic of cultural evolution, standard causal interpretations of either the classical approach or the replicator approach to generalize Darwinism do not seem to fit cultural evolution. These approaches do not seem to fit not only for the reason that “replication” (let alone “replicator”) seem to be ill-suited. The standard causal interpretation of Darwinian evolution in terms either of three distinct mechanisms (variation, replication and selection) or of two mechanisms (interaction and replication) do not seem to capture the peculiarities of cultural evolutionary processes. As argued above, insofar as it is appropriate at all to invoke the three Darwinian principles in cultural evolution, they are aspects of the same process rather than three distinct processes. In one and the same process of social learning from some cultural model, new variants might pop up, the cultural model is (*de facto*) selected and information is transmitted. Likewise the portrayal of natural selection as interaction that causes replication to be differential does not seem to fit either. The only “interaction” in social learning seems to be between role model (“parent”) and learner (“child”), not between “parents”. And the causes of differential “replication” might be due more to content-based biases than to the social fitness of potential role models. In sum, it might be quite arbitrary and artificial to distinguish two or three mechanisms in processes of cultural evolution. That also implies that in its intended role as a heuristic device Darwinism might lead researchers seriously astray. It invites social theorists to look for two or three processes (or mechanisms) whereas there in fact there might only be one.

Henrich et al. suggest that many of their critics are simply mathematically illiterate (Henrich et al. 2008, footnote 1). That might well be true. They are also right in arguing that mathematical modeling might be very helpful in fleshing out the implications of particular assumptions; implications we fail to see without the modeling. In particular, it needs some formal modeling to see that the presence of considerable systematic biases in “micro”-transmission does not rule out that patterns in population-level behavior are fairly accurately tracked by replicator dynamic. But it seems we really do not learn much from Henrich and Boyd’s formal model about the scope of applicability of the replicator dynamic. It seems

²² Of course, this is just one possible way in which social learning can work. There are many others.

that with their model Henrich and Boyd draw attention to a logical possibility rather than to an empirically confirmed behavioral regularity. This is reminiscent of a lot of what has been going on in mathematical economics. Especially in the heydays of general equilibrium theory and social choice theory, mathematical economists excelled in proving yet another existence or (im)possibility theorem (or in proving the same theorem under less restrictive conditions). Much less attention was paid to how all this sophisticated formal work related to the real world. Do we in evolutionary economics want to go in the same direction?

Another aspect to the use of the Price equation and of the replicator dynamic should not go unnoticed. As Gardner (2009) argues, the Price equation can be used (and is actually used) to bolster rationality (i.e. optimization or constrained maximization) based models (cf. Grafen 2002). Similarly, the replicator dynamic has done a lot to justify the centrality of the Nash equilibrium as the solution concept in game theory (Mailath 1998, Vromen 2009). Khalil and Marciano (2010) argue that evolutionary economists who turn to (neo-Darwinian) evolutionary biology in order to get away from mechanistic Walrasian general equilibrium theory will not find what they are looking for. In fact, neo-Darwinism and Walrasian equilibrium rest on the same formal model (Joosten 2006). Given all these conceptual and mathematical links between neo-Darwinian models and equilibrium-based standard economic models, it seems neo-Darwinian models are of very little use for coming to grips with processes of cumulative evolution resulting in increased adaptive complexity and in novelty. Thus, if we seek an evolutionary economics that is able to come to grips with the latter, and friends and foes of Generalized Darwinism seem to agree that we should seek such models, the equations mentioned might steer us in the wrong direction.

Precisely because the equations are so general and multi-interpretable they might be used also in many other ways. For very different causal processes they might accurately track population-level behavior. If we insist that our explanations should get the actual causal processes at least roughly right, however, it seems that the equations have limited applicability. This seems to hold especially (but not only) for cultural evolution. Their applicability in cultural evolution seems to be severely limited by the pervasiveness of asymmetries in social roles, for example.

Conclusions

On closer inspection, it is not so clear that the “biological evolution is not simple either” argument can be used to unnerve the objection that Darwinian models are too simple to do justice to the complexity of culture. The argument could as well be turned against proponents of Darwinizing culture: if Darwinian models are also too simple to do justice to the complexity of biology, then it seems we need more complex models than Darwinian ones to come to grips with cultural and biological evolution alike. We saw that instead of coming up with a more satisfactory model, Hodgson and Knudsen seem to be looking for a summary description of Darwinian evolution through natural selection that is general and abstract enough to cover almost all possible processes of change in both domains. Thus it is not just that in their hands “Darwinism” tends to become a “catch-all” term. Generalized Darwinism does not offer a clear simple and substantive model for how to start studying economic evolution either.

Similar doubts arose with respect to Hodgson and Knudsen’s “The three Darwinian principles must be invoked” argument. The argument can only be defended on a sufficiently general, abstract and broad understanding of the three Darwinian principles. If the principles are understood in a stricter sense, then at most the claim can be defended that the three principles must be invoked to explain particular sorts of processes in complex population systems: those in which novelty and adaptive complexity

cumulatively evolve. Sometimes it seems that Hodgson and Knudsen insist on high-fidelity copying in replication for exactly this reason: without high-fidelity copying such processes would be impossible. It seems Godfrey-Smith develops a similar argument. But he confines the scope of the validity of this argument to biological evolution only. In cultural evolution, he suggests, novelty and adaptive complexity can be produced also in other, distinctly non-Darwinian sorts of processes.

There seems to emerge a consensus among theorists of cultural evolution that social transmission is typically characterized by various systematic biases. Not only is what social learners take over from their role models mostly at best an imperfect copy of what they imitate, whom they select as their role models tends to be systematically biased as well. We saw that even in such cases of clear absence of replicators, replicator dynamic might be able to predict population-level behavior pretty well. We also saw, however, that this seems to a “possibility result” at best that only obtains when rather peculiar conditions are met. What is more, the actual causal mechanisms involved in such processes of cultural evolution seem to be markedly different than the ones in biological evolution. It is not just that we find different instantiations (or implementations) of mechanisms of variation, replication and selection (or of interaction and replication) in cultural evolution, it is not even clear that we find distinct mechanisms of variation, replication and selection (or of interaction and replication) in cultural evolution at all. If so, following the (“heuristic”) lead of Generalized Darwinism (that is, look out for such distinct mechanisms in cultural evolution), would steer researchers in counter-productive directions.

Compared with the diluted concept of Generalized Darwinism, Godfrey-Smith’s concept of Darwinism has a definite shape and is discriminating. Godfrey-Smith’s distinctions between populations and non-populations, between minimal Darwinian populations and marginal (or partial) Darwinian populations, which are not quite Darwinian, and between minimal Darwinian populations and paradigm Darwinian populations are useful to classify different cases of change in both biological and cultural evolution. They give us at least a rough and ready idea in what sorts of cases application of Darwinian principles makes sense. The other side of the coin is that Godfrey-Smith’s distinctions suggest in what sorts of cases we are advised to look for non-Darwinian principles. But Godfrey-Smith’s taxonomy does not give full-proof directions and they do not make for a full-fledged theory. Here the situation is the same as with Generalized Darwinism: much domain-specific substance is yet to be added and success is not guaranteed. As before, the devil is in the details and the proof of the pudding is in the eating.

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