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# *Veblen, Sen, and the Formalization of Evolutionary Theory*

***Nuno Martins***

***Abstract:*** It has been suggested that economics could benefit greatly from recent developments in evolutionary game theory. In fact, key authors in the study of the role of ethical norms in economic behavior like Amartya Sen argue that evolutionary game theory could contribute much to the study of social norms and behavior. Others have suggested that evolutionary game theory could be most helpful for formalizing the work of classic authors in evolutionary and institutional economics like Thorstein Veblen. Here I discuss the behavioral assumptions of evolutionary game theory models, and Jörgen Weibull's approach in particular. I will argue that Weibull's models, and evolutionary game theory in general, pose overly strong restrictions on the explanation of human behavior, which limit the potential of evolutionary explanation. I also suggest Tony Lawson's population-variety-reproduction-selection (PVRS) model as an alternative evolutionary framework that can successfully accommodate developments in behavioral economics, while also providing a solution to important critiques of Darwinian evolutionary analysis made by Richard Nelson, among others.

***Keywords:*** evolutionary game theory, population-variety-reproduction-selection (PVRS) model, Sen, Veblen

***JEL Classification Codes:*** B41, C73, D01

Evolutionary game theory has been rapidly expanding within the economic literature, and has become an important part of mainstream economics. The expansion of this approach raises two important questions. One of them concerns the role that evolutionary game theory can play in the development of existing approaches in evolutionary economics. Mauricio Villena and Marcelo Villena (2004), for example, suggest the use of evolutionary game theory in order to formalize older traditions in evolutionary economics, such as original institutional economics, and the work of Thorstein Veblen in particular. Similar questions could be posed concerning other

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prominent traditions within evolutionary economics, such as the neo-Schumpeterian approach of Richard Nelson and Sidney Winter (1982).

Another crucial question is whether evolutionary game theory can help with developing the study of social behavior in general, and the analysis of ethical behavior and social norms. Amartya Sen (1997), for example, argues that evolutionary game theory can provide significant contributions to the study of "conventional rule-following." Other examples of this perspective are the works of Ken Binmore and Larry Samuelson (1994) and Robert Sugden (2001a, 2001b).

However, there are several problems with evolutionary game theory that must be addressed in this connection. First, many assumptions made in evolutionary game theory are inconsistent with Sen's own analysis, or with the work of central authors of evolutionary economics, including authors of the original institutional tradition like Veblen, or authors of the neo-Schumpeterian tradition like Nelson (1995). (Nelson, in fact, criticizes evolutionary game theory.)

Second, most evolutionary game theory relies upon the notion of "average" agents, or agents whose characteristics are "averaged" (see, for example, Binmore and Samuelson 1991, 1994; Selten 1991; Weibull 1995). Now, in Darwinian evolutionary analysis, variety has a crucial importance for explanation. Hence, to impose a priori restrictions on variety, such as requiring that agents engage in "average" behavior (where this average behavior is a consequence of some uniformity of the characteristics of the agents), constrains the explanatory power of any Darwinian model.

I will argue that Tony Lawson's (2003) population-variety-reproduction-selection (PVRS) model provides a solution to these problems. Furthermore, the PVRS model also provides a solution to some limitations of Darwinian evolutionary analysis identified by Richard Nelson (2006). When discussing evolutionary game theory, I will refer to Jörgen Weibull's (1995) account of evolutionary game theory that is particularly relevant for the issues addressed here.

## *Evolutionary Game Theory and Social Behavior*

Evolutionary game theory has been rapidly expanding within economic analysis, and is now widely accepted in mainstream economics. As the name indicates, this approach brings insights from evolutionary theory into game theory to provide a better understanding of the evolution of social behavior.

A first crucial distinction brought from evolutionary theory is the distinction between *phenotype* and *genotype*. Phenotypes are the individuals in competition in the environment of selection, and may differ according to their particular genotype. In biology, the term genotype refers to the genetic constitution of the individual, and consists of the individual's characteristics that are ultimately selected through the selection of phenotypes.

In social theory, the entities through which the interaction with the environment of selection occurs are often called *interactors* (following Hull 1981), and the entity that passes on its structure (i.e., is reproduced) in the evolutionary process is termed *replicator* (following Dawkins 1976, 1978). One prominent type of evolutionary model is a Darwinian model. Four elements are needed to describe a Darwinian population model: (i) a *population* of phenotypes; (ii) a *variety-generating* mechanism (that generates different genotypes in the population of phenotypes); (iii) a *reproduction* mechanism (that transmits each genotype from one phenotype to another); and (iv) a *selection* mechanism (through which the phenotype is selected in the environment of selection). Note that, even though one is ultimately analyzing which genotypes (and replicators) are selected, such selection happens through the phenotype (and the interactor) that corresponds to each genotype (and to each replicator). Following Lawson (2003, 121-123), a Darwinian PVRS model can be defined as any model that contains these four features, together with some degree of independence between variety-generating mechanisms and selection mechanisms.

Different types of evolutionary models can be found in evolutionary game theory literature. Sen's (1997) reference to evolutionary game theory as a useful tool to explain conventional rule appeared in his paper, "Maximization and the Act of Choice." In it, the most comprehensive account of evolutionary game theory that Sen references is Weibull's 1995 book, *Evolutionary Game Theory*, which will be the evolutionary game theory conception I focus on here (but see Elsner [2012] on more recent contributions not mentioned by Sen [1997] that could require a different analysis, not least in the context of institutionalist analysis).

There are some advantages in Sen's referring to Weibull's account. In Sen's (1987, 2002) own view, social rules of conduct are irreducible to atomistic interaction of agents who permanently engage in utility optimization. In most game theory analyses, on the other hand, agents are assumed to permanently engage in optimizing behavior, and social rules are derived from (and ultimately reduced to) the atomistic interaction of utility optimizing agents (see Martins 2009, 2013, ch. 6).

Weibull does use utility functions when conceptualizing *evolutionary stable* strategies that could be relevant to the study of what Sen terms a conventional rule-following. But Weibull also uses other concepts, such as replicator dynamics and selection dynamics, which do not presuppose that agents necessarily engage in permanent utility optimization like other approaches in game theory do.

Robert Sugden (2001a) criticizes evolutionary game theory approaches for not going beyond the basic tenets of standard game theory. But in Weibull's models, when conceptualizing the replicator dynamics and selection dynamics (to be discussed later), agents simply follow rules that might not lead to optimal outcomes at every moment, and only review them at a constant average rate (not permanently). Hence, Weibull's framework is more compatible with Sen's view than most game theory models are.

I will not attempt a detailed explanation of Weibull's models (for details, see Weibull 1995), but, for the present purposes, my emphasis will be on what Weibull calls the "formal modeling of social evolution of behaviors in a population of strategically interacting agents" (Weibull 1995, 152). This concept contains the aspects of Weibull's perspective that are relevant to my analysis. In particular, Weibull's models of "replication by imitation" are especially relevant to understanding whether evolutionary game theory can help explain conventional rule-following, as Sen suggests. Of course, one can find a much richer variety of evolutionary models in Weibull's work, and in evolutionary game theory in general, which apply to many contexts other than the social evolution of behavior. For example, models have been developed in the study of biology (see Maynard Smith 1982; Maynard Smith and Price 1973), though, again, my emphasis here is only on the models that Weibull suggests in the context of the evolution of social behavior.

The use of evolutionary theory has a long tradition in economics, going back at least to the contributions of original institutional economists, such as Thorstein Veblen. However, the evolutionary analysis undertaken by original institutional economists differs significantly from the more formalized analysis of modern evolutionary game theorists. Nevertheless, Villena and Villena (2004) argue that even original institutionalists have much to gain by turning to evolutionary game theory, while referring to Weibull's approach in particular, especially in the way it could provide a useful formalization of Veblen's work.

It can certainly be conceded that Weibull's evolutionary game theory is more compatible with institutional economics — and with evolutionary analysis in general — than with other contributions in game theory analysis. The assumption that agents permanently optimize — as presupposed in standard game theory — and that all behavior is to be explained as the outcome of utility optimization leaves little (if any) room for notions like "habits of thought" or conventional rule-following behavior that are very common in institutional (and evolutionary) economics (for example, in the work of Veblen).

In fact, Veblen (1898a) has strongly criticized the view of human agents as being driven by the pursuit of utility, happiness, or hedonistic desires. According to Veblen, human agency cannot be understood as a reaction to subjective valuations, such as utility. In Weibull's evolutionary game theory analysis, on the other hand, there is no need to assume that agents permanently engage in such optimizing behavior (even though the utilitarian subjective valuation that Veblen rejects is still present in the payoff function). Nevertheless, Weibull's conception also raises some problematic issues that I will discuss here. Before doing so, however, I will describe Weibull's approach in more detail.

## Weibull's Evolutionary Models

In Weibull's evolutionary models, each agent is "programmed" to play a given strategy. This strategy is the replicator (which is passed from each individual to his/her offspring). In biology, the game's payoffs represent the "fitness" of the individual (measured as the number of "offspring" that are generated by the individual). This "offspring" will follow the strategies that the individual person, who has generated them, did, thereby "replicating" the strategy. Under this framework, a given strategy is said to be *evolutionary stable* if there is a share of individuals in the population following this strategy, so that the payoff these individuals get from following the strategy is higher than the payoff of some other strategy pursued by other individuals (see Weibull 1995, 36; for a general discussion of the concept of evolutionary stable strategy, see also Maynard Smith 1982; Maynard Smith and Price 1973; and for a more recent discussion, see Elsner, Heinrich and Schwardt 2015).

Evolutionary stability criteria help us understand how a given equilibrium is maintained. However, as used in standard evolutionary game theory, these criteria do not explain how strategies change through time (for an alternative approach, see Lindgren 1997). The social evolution of behavior in a population of strategically interacting agents is explained through what Weibull calls the "replicator dynamics" and the "selection dynamics." The latter are modeled as systems of differential equations, showing how population shares (which are programmed according to a given replicator, i.e., a given strategy) evolve through time and which agents are selected (and so, which corresponding replicators are selected).

Weibull defines "$x_i$" as the share of agents in the population who follow strategy "i" (that is, who are pre-programmed to play strategy "i"); "$r_i(x)$" as the average time rate at which agents that follow strategy "i" revise their strategies; and "$p_i^j(x)$" as the probability that, when revising strategies, agents will switch from strategy "i" to strategy "j." Also, Weibull argues that agents may be human individuals, firms, or other social or economic units. He then describes a population dynamics where the inflow of agents switching from some strategy "j" to strategy "i" is given by the sum:

$$\sum_{j \neq i} x_j \, r_j(x) p_j^i(x) \tag{1}$$

On the other hand, the outflow of agents switching from the share of agents that plays strategy "i" to the share that plays strategy "j" is given by the sum:

$$\sum_{j \neq i} x_i \, r_i(x) p_i^j(x) \tag{2}$$

Then, the population dynamics is given by the difference between equation (1) and equation (2).

Weibull suggests various forms of modeling "$r_i(x)$," the "average review rates" of agents who follow some strategy "i," and the probability "$p_i^j(x)$" of changing from some strategy "i" to strategy "j." This framework enables Weibull to formulate a wide variety of evolutionary models, whereby replication by imitation, or change of strategy due to dissatisfaction, are modeled, depending on how the parameters (that is, the "average review rate" and the "probability of changing strategies") are interpreted. The social situations with which these models are concerned are thus the cases of imitation and changes due to dissatisfaction with a given strategy.

However, all the dynamic models discussed by Weibull share the same structure — one where variations in shares of populations are given by the difference between the inflow and the outflow of agents that, in turn, depend on the share of agents, the average review rate, and the probability of changing strategy. Since the issues to be addressed here concern this general structure — and the conclusions to be obtained about it also apply to each particular model that can be set using the same structure — the more detailed analysis of each particular model should be left for another occasion.

## *The Empirical Relevance of Behavioral Assumptions of Evolutionary Game Theory*



Daniel Kahneman (2003) distinguishes between two types of processes in human cognition. He (2003, 1451) names one type of processes "automatic," characterizing them as "fast, automatic, effortless, associative, and often emotionally charged," "governed by habit," and thus "difficult to control or modify." These processes are associated with cognitive activities like perception and intuition. The other type of processes, Kahneman (2003, 1451) calls "controlled" processes, which are "slower, serial, effortful, and deliberately controlled," as well as "relatively flexible."

Weibull's models capture these two types of processes by assuming that agents typically engage in "automatic" processes and undertake "controlled" processes of rational decision-making at an "average review rate" given by "$r_i(x)$." When undertaking such "controlled" processes of rational decision-making, there will be a probability of changing strategy given by "$p_i^j$." Thus, unlike traditional game theory and traditional microecononomics, Weibull's approach — at least, when studying the replicator dynamics and selection dynamics — does not lead to a study of human behavior in terms of a single preference ordering, which can be described by a utility function that reflects the players' payoffs.

This renders Weibull's perspective on the replicator dynamics and selection dynamics immune to Sen's criticisms of mainstream economics. Sen (1982, 1987, 1997, 2002) has argued in different contexts that preferences can be (and often are) incomplete, meaning that they cannot be represented by a utility function in many cases. Sen contends that, because of the existence of a complex set of goals and values (e.g., social commitment, morality, or self-interest), one preference ordering is not sufficient to describe the outcome of the multiple motivations at play in human action.

Veblen (1898a) also criticized the neoclassical conception of the economic agent, and described the human agent as being driven by a multiplicity of instincts and habits. Some instincts Veblen (1898b, 1899, 1914) discussed are the instinct of workmanship, the instinct of self-preservation, the parental bent, and idle curiosity, each of them leading to different patterns of action.

In fact, it seems that Weibull himself disagrees with the notion of agency used in most microeconomic theory. Weibull (1995) states:

> The standard interpretation of noncooperative game theory is that the analyzed game is played exactly once by fully rational players who know all the details of the game, including each other's preferences over outcomes.

> Evolutionary game theory, instead, imagines that the game is played over and over again by biologically or socially conditioned players who are randomly drawn from large populations. (Weibull 1995, xiii)

Weibull's criticism also applies to (dynamic) repeated games, since the agents have to set a complete strategy at the beginning (on how Sen's critique of game theory also applies to repeated games, see Martins 2009).

A crucial question concerns whether the multiplicity of (biologically and social conditioned) human motivations generates any stability of the parameters used in Weibull's analysis. The existence of conflicting motivations would not preclude the possibility of describing average behavior in terms of constant parameters (such as review rates and probabilities of changing strategy), if one could estimate the relative effects of each motivation on parameters like the average review rate given by "$r_i(x)$," and the probability of changing strategy given by "$p_i^j$."

However, the interaction between the different motivations may be complex enough to undermine this prospect. In fact, Veblen (1914) himself argued that, although there are different physiological traits that could hypothetically be distinguished at a physiological level, their effects on human instincts and behavior overlap and interfere with each other to different degrees, with enough complexity to preclude any possibility of differentiating them in an exact way at the psychological level. Veblen referred to this phenomenon as the "contamination of instincts," and argued that:

> [No] instinctive disposition works out its functional content in isolation from the instinctive endowment at large. The instincts, all and several, though perhaps in varying degrees, are so intimately engaged in a play of give and take that the work of any one has its consequences for all the rest, though presumably not for all equally. It is this endless complication and contamination of instinctive elements in human conduct, taken in conjunction with the pervading and cumulative effects of habit in this domain that makes most of the difficulty and much of the interest attaching to this line of inquiry. (Veblen 1914, 28-29)

Here Veblen's reference to "cumulative effects" means also that small changes in human conduct may lead to larger changes progressively, and to further difficulties in disentangling the interplay of each instinct. If Veblen's idea of "contamination of instincts" is correct, parameters like the average review rates and probabilities of changing strategy will not have enough stability to be represented by the replicator dynamics and the selection dynamics as constants, given the existence of conflicting motivations. Also, Sen does not seem to adopt a conception where behavior must have the stability implied in a constant average review rate and a constant probability of changing strategy.

Thus, it seems that while Weibull's approach does not suffer from many of the constraints of traditional game theory and traditional microeconomics, which would render the latter incompatible with Veblen and Sen's analysis, it also suffers from some limitations. Note that the problem of lack of stability resulting from the process through which changes in strategy take place cannot be solved in general by resorting to multi-population models that share the general structure presented above (which Weibull [1995, 186-190] also describes in detail). It is true that multi-population models introduce heterogeneity and variety *between* agents. However, the existence of multiple psychological processes *within* each individual agent, which is in line with Veblen and Sen's own conceptions, is not addressed by multi-population models.

Multi-population models take into account the different review rates and probabilities of changing strategies of several agents (each belonging to a different population), but each agent is assumed to have constant parameters just like in a single population model. A further difficulty lies in the fact that, as the number of populations increases, multi-population models become progressively less tractable.

Furthermore, one should be reminded of the possibility of small effects that cumulatively lead to a radically different social conduct, which is central to Veblen's own understanding of socio-economic reality as an evolutionary process of cumulative change. Veblen's notion of cumulative effects in this context means that if the choice of strategies depends on the strategies of others, a small change of strategy of one agent, leading to changes in the strategies of other agents, may have cumulative effects that generate a completely different evolutionary stable strategy from the ones conceived a priori.

Effectively, as a central author of the neo-Schumpeterian tradition (that, together with institutional economics, is one of the most prominent traditions in evolutionary economics), Richard Nelson notes how,

> for the most part (there are exceptions) evolutionary game theory continues an older tradition in game theory of thinking of a given finite set of (basic) strategies, with equilibrium being defined in terms of these or mixes of these. In contrast, in the more general formulation an equilibrium, if there is any such, is seen as emerging out of the dynamic process, and often involves patterns of behavior and activities that were absent early in the process. The number and nature of possible equilibria thus often cannot be specified ex ante. (Nelson 1995, 52)

Robert Sugden (2001a) goes further in arguing that evolutionary game theory, like standard game theory, remains essentially an a priori endeavor that does not actually explain processes of replication.

Of course, multi-population models are nevertheless more realistic because they allow for heterogeneity between competing populations. Moreover, the concept of an evolutionary stable strategy is a polymorphism that can accommodate a wide diversity of strategies, including mixed ones. Using mixed strategies, it would be possible to formalize conflicting preferences. This procedure would be possible in situations where the vector of probabilities attached to each pure strategy is stable enough to enable this prospect.

But the concept of an evolutionary stable strategy does not include a dynamic dimension, which is introduced only in the specification of the replicator dynamics and the selection dynamics. This, in turn, leads to the difficulties mentioned above in specifying its parameters, and denying the possibility of the emergence of new strategies and replicators, as Nelson (1995) notes. On the other hand, the social evolution of strategies, which is modeled through the replicator dynamics and the selection dynamics, requires very strong assumptions, such as the constancy of parameters like the average review rate and the probability of changing strategy.



## *Identifying Evolutionary Causation*

The concepts of replicator dynamics and selection dynamics used in evolutionary game theory provide models that are very useful whenever Veblen's "cumulative effects," "contamination of instincts," or the existence of (what in neuropsychology is termed) "modularity" do not affect the stability of parameters like the average review rate and the probability of changing strategy. Likewise, evolutionary stability criteria can explain evolutionary stability when the vector of probabilities attached to each pure strategy is at least approximately constant.

But the stability of motivations required in evolutionary game theory is a strong condition that cannot be guaranteed in general. When such a condition does not exist, what alternative is there for evolutionary theorizing in economics to achieve a general model of social evolution that takes into account the "cumulative effects," "contamination of instincts," or "modularity"? I will refer now to three conditions that a Darwinian evolutionary model of human action should satisfy in order to have an explanatory power. I will then argue that Lawson's PVRS model meets all of these conditions, whereas Weibull's evolutionary game theory conception does not.

A first — I will term it — condition (a) is that, when using evolutionary models as explanatory frameworks, there must be a stable relationship between the replicator and either the phenotype or the interactor, so that the replicator can be identified. Because, if the replicator was not stable and it was changing because of other exogenous factors, evolutionary causation could not be separated from those exogenous factors and identified. This condition is essential for the identification of replicators in a Darwinian model.

A second condition (b) is that no artificial restrictions are placed on the existence of variety. That is, no restrictions on the existence of variety should be placed in addition to those that might already exist in a given sphere of reality. A Darwinian evolutionary population model of the sort advanced by original institutionalists like Veblen can have much stronger explanatory power when one uses models with a wide heterogeneity of individuals — meaning, when phenotypes are *diverse*, i.e., contain different genotypes. Sen (1999) also stresses how diversity is a fundamental aspect of reality, not an additional complication that can be temporarily ignored. So, assumptions that artificially constrain the existing variety should be avoided.

In Weibull's models, there are no differences between agents of a population because all agents in each population revise strategies at the same "average review rate," and, when so doing, all agents in such a population change strategies with the same probability. In fact, the dynamics of Weibull's models would be very hard (if not impossible) to model if this hypothesis of homogeneity of agents was not assumed. In other words, one would need a multi-population model with an extremely large number of parameters and simulations of a wide range of scenarios that may not cover all the relevant issues at stake. Thus, instead of a population of heterogeneous agents, in Weibull's models, one has a population of homogeneous agents. Thus, by positing a priori a situation of restricted variety, Weibull's models artificially constrain the explanatory power of Darwinian analysis.

A third condition (c) is that a realistic model of human action, in which the latter have the possibility of choice, must allow for the fact that each human agent may revise and choose differently at *any* moment, not necessarily at constant rates and probabilities, in a context where these constant rates and probabilities do not change within agents of the same population. Weibull assumes that the revision of strategies, when occurring at all, is exercised at a given constant rate that is the same for all individuals of the same population. Weibull also posits that, when revising strategies, the probability of changing strategies is also a constant parameter. But, as I argue earlier, this is an unrealistic assumption that places strong limitations on human behavior and restricts the possibility of conceptualizing variety.

This issue becomes even more pressing for authors like Sen (2002), who support evolutionary game theory models, but simultaneously place freedom of choice and the irreducibility of human behavior to exact regularities at the center of their analysis. If one assumes that each individual person is "pre-programmed" to play a given predefined strategy (revising it at some constant "average review rate"), as Weibull does, this conception would be inconsistent with most of Sen's writings.

Sen (2002) defends a different conception of rationality to the one often assumed in game theory. He takes rationality to be the (not permanently exercised) discipline of scrutinizing goals and values, whereby human agents have the capacity of engaging in reasoned scrutiny and choosing differently at any time. In Sen's view, reasoned scrutiny (which may lead to changes in behavior) does not occur at a constant "average review rate," with the persistent probability of changing rules when reviewing them. Rather, it is essential to Sen's thinking that reasoned scrutiny, as constant need, can occur at *any* time (even though it does not permanently occur).

This inconsistency springs from simultaneously recognizing the possibility that freedom of choice can be exercised at any moment, while also assuming that the exact regularities of actual behavior, demanded by evolutionary game theory analysis, also occurs when attempting to combine evolutionary game theory models with other evolutionary economics approaches (like the original institutional perspective). Even though original institutional contributions emphasize the role of institutions and "habits of thought" in human behavior, it does not follow from this emphasis that either these social forces determine human behavior, or that social forces and "habits of thought" manifest themselves in a constant and predictable way.

Furthermore, since human agency may be a source of variety (which adds to the variety that may already exist in reality), limitations to condition (c) also pose limitations to condition (b) above. In what follows, I try to provide an evolutionary model of human action that fulfils conditions (a), (b), and (c), arguing that the PVRS model offers a more promising starting point for such an endeavor than Weibull's models (and evolutionary game theory in general).

## *The PVRS Model*

Weibull's assumption of constant (average) review rates and a constant probability of changing strategies enables him to verify condition (a) — the stability of the replicator. In Weibull's models, each replicator corresponds to the same agent, and if the former changes (when agents revise strategies), a revision can be exactly modeled and predicted since it occurs at a constant rate and with a constant probability of change (and these constant parameters are known and are the same within individuals of the same (sub-)population). This guarantees that evolutionary causation can be exactly modeled, identified, and isolated from exogenous factors.

Even though Weibull's models satisfy condition (a), the way in which these models achieve such a result prevents them from fulfilling conditions (b) and (c). The problem is that, because the replicator must be stable (condition (a)), then agents (human individuals, firms, or other social or economic units) must either engage in the same strategy over time, or, if they decide to change strategy, agents' decision must be exactly modeled based on a constant (average) review rate and a constant probability of changing strategies. Otherwise, it would be difficult to separate such decisions from evolutionary causation.

This emphasis on exact modeling of agents can also be found in most (if not all) evolutionary game theory contributions — for example, in the work of some of the most prominent theorists in the field, such as Ken Binmore and Larry Samuelson (1991, 1994) and Reinhard Selten (1991). However, this is an unnecessary limitation to an evolutionary account of human behavior along the lines of authors like Veblen, or even authors who are supportive of evolutionary game theory like Sen.

Now, a solution to this problem would be to identify some stable relationship not between the replicator and the agents, but between the replicator and another entity — for example, a different interactor. In such a case, the agents (human individuals, firms, or other social or economic units) need neither have their characteristics averaged, nor be subject to uniform regularities of behavior. The stability of the replicator will be ensured at another level — through its correspondence to another interactor.

The question is: What entity will this interactor be, and how can it be related to the replicator in a stable way without imposing unnecessary constraints on the characteristics or behavior of the agents? Tony Lawson (2003) argues that *social practices* are the most promising feature of the social realm to be used as a social interactor. "[I]t seems to me that a certain category of social phenomena does stand out more than others as a promising candidate for the set of social interactors we are looking for here. I refer to *social practices*" (Lawson 2003, 127, emphasis original).

So, instead of using a framework where individuals (or firms, or other social or economic units that Weibull suggests) are the entities that are selected (or not), Lawson suggests investigating whether the *social practices* of these persons qualify. As

Lawson notes, "it is specific practices … that are the individuals in competition here, not the human individuals *per se*" (Lawson 2003, 127, emphasis in original). Lawson also chooses social rules as the social replicators that are selected (or not) through the competition of social interactors. "What sort of thing or aspect might be interpreted as a social replicator, the entity that passes on its structure in replication? The answer … is social structure, and especially social rules including norms and conventions" (Lawson 2003, 128).

Lawson makes this suggestion in the context of his PVRS model. Note that, in general, a PVRS model contains five essential features: (i) a *population* of interactors; (ii) the existence of a *variety* of replicators (which depends on an underlying variety-generating mechanism); (iii) a *replication* mechanism through which replicators are reproduced; (iv) a *selection* mechanism through which the interactor is selected in the environment; and (v) some degree of *independence* between variety-generating mechanisms and selection mechanisms.

Lawson's PVRS model is a specific instance of this general formulation, in which social rules are the social replicators and social practices are the social interactors. In Lawson's specification, one neither has to assume that human agents always follow the same strategies, nor that they revise these strategies at a constant frequency. In Lawson's PVRS model, social rules are the (stable) replicator that corresponds to social practices — condition (a) is achieved — but human agents themselves can always choose a different rule of behavior at any moment and undertake a different social practice. The existence of a variety of rules that different agents might follow helps to verify condition (b), while the freedom these agents possess means that condition (c) is also satisfied. Thus, the variety of replicators (social rules) is enhanced by the diversity of active human individuals.

The term "phenotype" could nevertheless be used to denote the human individual (or any other type of agent, such as firms or other social or economic units), and the term "genotype" could still be used to refer to characteristics of the individual (for example, the disposition, tendency, or propensity to engage given social rules). The correspondence that ensures the stability of the replicator is the one between replicator and interactor (social rules and social practices), not between the agent (the phenotype) and the replicator (the genotype) (the social rules or the propensity to engage on a given rule-following behavior, or to follow a given strategy, respectively).

The choice of social practices as social interactors leads to a reformulation of the selection mechanism. Referring to the selection environment, Lawson states that "the environment of selection includes all other social practices that are in some way related to or connected to that population of practices that constitutes our primary focus. Interaction with the environment just is human interaction" (Lawson 2003, 128).

There are two ways in which the selection environment — the population of competing social practices — can cause the selection of social practices: (i) by causing (or even forcing) people to keep or to change their social practices (or at least influencing them to do so); or (ii) by selecting/excluding those who engage in given social practices (and hence social practices are indirectly selected through the selection of agents that engage in such practices). The first case (when the environment of selection leads agents to change their social practices) can be termed *a direct selection of social practices*, and the second case (when agents are themselves selected) *an indirect selection of social practices*. In both cases, the replicator is being selected through the selection of the interactors, but only in the latter case the human individual (or any other phenotype) is also himself/herself selected. The case of direct selection of social practices is close to Donald Campbell's (1965) notion of *vicarious* selection, in which agents choose a given replicator before they are themselves selected through natural selection.

So, when a social rule is selected (through social practices), one can interpret this fact both as meaning that agents keep practicing the social rule and that the agents who practice the social rule are still "alive." Even though the social interactors are the social practices, the way the selection mechanism works implies that Lawson's framework can achieve the same results as a framework, whereby selection acts upon human agents themselves.

Thus, human individuals are no longer restricted to a passive role, and can have an active role. And it is through human agency that variety, reproduction, and selection occur. A particular social practice (of a human agent) is an interactor that must always correspond to a given replicator, but the human agent that engages in such social practice is not himself/herself "programmed" to always engage in a given social rule. Therefore, the conceptualization of human choice, as a result of a plurality of competing motivations, is not constrained under this view of evolutionary selection.

## Variety, Reproduction, and Selection

In fact, Lawson's PVRS model enables one to address a more general difficulty concerning the use of biological analogies. Nelson identifies three reasons why the identification of causal mechanisms of cultural evolution, as opposed to biological evolution, is not a straightforward exercise:

> First, for many areas of cultural evolution, the survival of the individuals and organizations involved simply is not at stake. Thus, there is often no clear analogy in cultural evolution to the mechanisms involving fitness of phenotypes in biological evolution. Second, the individuals, organizations, groups, that at any time hold particular beliefs or practices are not locked into them, as biological entities are to their genes, but can change them. Thus the relative importance of cultural traits can change, without any change in the population of the society to which that culture pertains. Third, while not over playing the role of conscious decision-making, in a wide range of circumstances beliefs about the value, and efficacy, of a particular cultural trait strongly influence whether that trait is adopted, retained or abandoned. And discussion, argument, persuasion, in some

> cases coercion, may be a central part of the selection process. (Nelson 2006, 501)

The difficulties Nelson points out can be found not only in Weibull's models and evolutionary game theory, but also in any evolutionary model that conceptualizes agents (such as individuals or organizations) as interactors. A stable correspondence between a replicator and an interactor is essential for any explanatory framework based on the selection principle. For if an interactor could change his/her replicator at any moment, it would become difficult to distinguish evolutionary change from other types of change, and an epistemological problem of identification of replicators would arise.

Lawson's PVRS model provides a solution to the problems identified by Nelson for several reasons. First, it does not require a stable relationship between agents (be it individuals or organizations) and replicators, while still enabling a stable relationship between interactor and replicator (thus maintaining the biological analogy). Second, the concept of direct selection of social practices takes into account the case when the survival of agents (either individuals or organizations) is not at stake, and includes conscious decision-making (be it in the form of discussion, argument, persuasion, or even coercion) as part of the selection process.

Lawson refers to human agency as the source of variety, reproduction, and selection in the social realm, but he does not elaborate on which particular features of human agency will constitute selection mechanisms, and which will be replication mechanisms or variety-generating mechanisms. A more concrete specification of which particular aspects of human agency enable variety, reproduction/replication, and selection is provided below. Nelson notes:

> Recognition of the purpose and thought that often go into innovation would seem to call for a view of the relevant "variation" in cultural evolution that is broader than in biological evolution. Variation in Darwinian biological evolutionary theory is variation of genes, and traits and behaviors, in an extant population at any time. This is the "stuff" on which selection works. However, in cultural evolution a good portion of the relevant variation is in human minds, and explored through calculation, discussion, and argument, rather than in actual practice. (Nelson 2006, 499)

How can one provide a broader explanation of variety, replication, and selection? Research in behavioral economics can fruitfully illuminate this matter. One needs to keep in mind Kahneman's (2003) distinction between "automatic" and "controlled" processes (like deliberate reasoning), as mentioned above. The main function of replication mechanisms is to reproduce codified information. The key role of variety-generating mechanisms, on the other hand, is to transform the existing (or generate new) codified information. From the cognitive processes described above, "automatic" processes seem to be the ultimate basis for replication mechanisms because they play the role of reproducing dispositions, habits, and social rules. Evidently, replication can also occur through "controlled" processes like deliberate reasoning, whenever a rule is consciously represented and followed. But, in social activity, for the most part, rules are followed habitually and not through deliberate reasoning.

In fact, deliberate reasoning is essentially a creative activity, in which agents can attempt to transform the rules or routines they follow. Hence, deliberate reasoning (insofar as it is not significantly caused, influenced, or constrained by the environment of selection) can be seen as a key ingredient to variety-generating mechanisms, enabling agents to create, invent, and innovate through the transformation of existing rules and routines.

Note that deliberate reasoning can also lead to the decision of changing a social practice in the cases of vicarious selection, or direct selection of social practices noted above, and hence can be acting as a selection mechanism. However, deliberate reasoning will be acting as a selection mechanism *whenever it is caused, influenced, or forced by the environment of social practices*, and as a variety-generating mechanism otherwise.

It is also the case that, when a disposition to act according to a different social rule is generated by the variety-generating mechanism, it will not necessarily be manifest in an actual behavior as a social practice since it still needs to be selected by the relevant mechanism in the environment of competing social practices. When a variety of social rules is generated (for example, because a tendency or disposition to adopt new social rules arises), it will not be necessarily materialized in actual social practices since the selection mechanism might prevent that from happening.

To use Lawson's (2003) example, in an international conference there may be a great variety of people from different countries, disposed to speak their own language, but the environment of selection (in which the dominant social practice very often is to speak in English) will prevent this variety from manifesting itself. So, all speakers will engage in the social practice of speaking in English, regardless of the language in which each person is more disposed to speak. Thus, changes in variety will not lead to any change in social practices, unless the social practices that correspond to the new social rules are selected.

Another important point to bear in mind is that, very often, evolutionary processes will not be the only cause for human action. Sen (1997), for example, argues that ethical norms can be explained by evolutionary selection and also by moral reasoning. Referring to Immanuel Kant ([1788] 1949), Sen writes:

> The recent work on evolutionary game theory has thrown much light on how conventional rule-following … may emerge from evolutionary selection. Even though *ultimately* no individual may be directly concerned with the nature of the choice act, concern with the nature of the choice act may be instrumentally important in social rules of behavior that survive. This type of reasoning can be contrasted with behavioral rules being deliberately chosen by an individual through an ethical examination of

> how one "should" act ... Consciously reflexive — rather than evolutionarily selected — use of ethical rule-following was most famously explored by Immanuel Kant (1788). That approach has been pursued in different forms in modern ethical writings as well. (Sen 1997, 748-749, emphasis original)

It can be that after engaging in moral reasoning and self-reflection about human conduct, one comes to the conclusion that one must adopt a given social rule regardless of how favorable or unfavorable the selection environment is (to this social rule). In such a case, the new social rule is immediately undertaken as a social practice without any evolutionary process involved. Sen argues for the need to see evolutionary processes within a plurality of human motivations, which includes "consciously reflected use of ethical rule-following," social commitment, and moral imperatives. Evolutionary causation will, in many cases, be a power present in reality among others.

However, it can also be that some social rules are adopted only because of the evolutionary processes involved. Take, for example, the case of some new social rule that is generated by moral reasoning (in which moral reasoning acted as a variety-generating mechanism). This rule may never become manifest in social practice without the aid of favorable environmental conditions. In such a case, moral reasoning acts *in combination with* the evolutionary process. That is, moral reasoning (acting as a variety-generating mechanism) generates a disposition to engage in a new social rule, but this latter is adopted only because the environment of selection is favorable. As Sen argues,

> ["consciously reflected use of ethical rule-following" and "evolutionary selected use of ethical rule-following"] don't have to be *just* "alternatives." Even if we deliberately choose behavioral norms on ethical (or social) grounds, their long-run survival can scarcely be completely independent of their impact on each other and the evolutionary processes that might come into play. (Sen 1997, 749, emphasis original)

Sen's remark reinforces the previously mentioned point that, in many cases, social rules that emerge through the variety-generating mechanism will be manifest in social practices only through the action of the selection mechanism.

### *Lamarckian Features*

So far in my analysis, I have maintained a distinction between the environment of selection, constituted by the competing social practices, and the other aspects of human behavior that may generate some variety of social rules (such as human dispositions, moral imperatives, psychological preferences, cultural conventions, or habits of thought). However, even though some distinction between selection mechanisms and variety-generating mechanisms is necessary for a Darwinian analysis, it is also the case that these mechanisms may be interdependent. Thus, Sen argues:

> [E]volutionary processes may not only influence the *rules* of conduct that we may consciously follow, but also our psychological *preferences* about the actions involved … The same can be said about the survival of ethical norms as well. Paying reflexive ethical attention to behavior neither nullifies, nor is nullified by, the importance of evolutionary forces. (Sen 1997, 749, emphasis original)

This means that habits, dispositions, and — what Kahneman (2003) terms — "automatic" processes, identified here as the underlying mechanisms for replication, can also be affected by the environment of selection. In what Lawson (2003) calls a *strictly Darwinian* framework, the variety-generating mechanism (or the variety of traits) is regarded as independent from the selection mechanism. Thus, human dispositions, social commitment, moral imperatives, psychological preferences, cultural conventions, habits of thought, and any feature that may influence the replication and variety of social rules, are independent from the environment of selection — i.e., the competing social practices — in a strictly Darwinian model.

When the environment of selection has some sort of causal influence on the variety-generating mechanism, Lawson names the evolutionary process as a *Lamarckian* process. What Sen seems to be suggesting here is the possibility of some Lamarckian features (according to Lawson's usage of the term "Lamarckian"). That is, the selection mechanism may causally influence the variety-generating mechanism since the fact that an evolutionary process changes psychological preferences can be seen as a source of variety of social rules.

In biology, Lamarckian models represent situations where acquired traits are inherited. However, the general insight into the traditional formulation of the Lamarckian model as one, where acquired traits are inherited, is that the selection environment may influence the variety-generating mechanism, and hence impact the traits that are produced and selected (in biology, this would mean it influences the genetic features of the individual organism taken to be the phenotype, or displaying phenotypic characteristics; on this topic, see also Elsner 2012; Hédoin 2010; Pelligra 2011; Villena and Villena 2004). Thus, the reformulation of interactors as social practices leads one to define a Lamarckian model as Lawson does — as a model where the selection environment influences the variety traits.

In a Lamarckian model, the environment of selection can cause a change *indirectly* through its influence on the variety-generating mechanism, or *directly* — without causing any change in the variety-generating mechanism at all. The latter is the previously analyzed case, when the environment of selection causes, or even forces, changes in given social practices without affecting the agents' preferences (or other sources of variety of social rules). The former case, to which Sen seems to be referring here, is when the environment of selection works by first changing the underlying preferences (or other sources of variety of social rules), and then selecting social practices that reflect the modified social rules.

So, although I posit that variety-generating and selection mechanisms are independent to some degree, changes in variety-generating mechanisms might also be triggered by social practices themselves. That is, the variety-generating mechanism can be causally affected by the selection environment. Lawson argues that one of the characteristics of the social realm is that variety-generating and selection mechanisms will likely be more often interdependent or interconnected in the social realm than in the biological realm. This possibility is not contemplated in evolutionary game theory, where only strictly Darwinian processes are at play.

Nevertheless, for a Darwinian evolutionary analysis to be of some relevance, variety-generating and selection mechanisms need to be at least to some extent independent, so that one can then apply the distinction between variety-generating and selection mechanisms. It is when variety-generating and selection mechanisms are somewhat independent that Darwinian analysis in general, and the PVRS model in particular, will have a higher explanatory power.

A model, allowing for the possibility of Lamarckian processes, enables a more complete conceptualization of the diverse motivations that explain human behavior, and so it is in line with conditions (b) and (c) above. This is so because such a model emphasizes the role of variety — condition (b) — and the freedom of human agents to reason and choose differently at any moment — condition (c). At the same time, the use of Lawson's PVRS model (because of its specification that the social practices are the social interactors) assures condition (a).



## Concluding Remarks

In Weibull's models, agents do not permanently optimize utility or payoffs. Rather, agents engage in rule-following behavior, while having the possibility of revising and choosing between competing strategies or social rules. So, Weibull's analysis is closer to Sen's contribution and to original institutional economics than standard game theory analysis. However, Weibull assumes that the average rate at which revision occurs — and the probability of changing the chosen option — are constants. This assumption is needed in Weibull's models in order to assure the stability of the replicator by assuming that agents follow the same strategies or social rules (the replicators), or, if a change occurs, this change can be exactly modeled, so that evolutionary causation can be observed separately from other factors — that is, it is needed because of condition (a).

These assumptions — namely, constant average review rates and constant probabilities of changing strategies — restrict the explanatory power of evolutionary models of behavior in two important ways. First, they restrict the variety between different human beings, hence violating condition (b). Second, these assumptions neglect the possibility that human agents may review strategies and choose differently at *any* time, hence violating condition (c).

The violation of these conditions restricts the explanatory power of evolutionary game theory models, and generates inconsistencies between evolutionary game theory models and different streams of literature, such as recent developments in behavioral economics, the work of authors who are supportive of evolutionary game theory like Sen, or contributors that explicitly advocated the use of evolutionary models in economics like Veblen.

To focus on constant regularities or the "average" behavior of individuals (such as "average review rates" or constant probabilities) can be counter-productive in the context of Darwinian evolutionary processes, for it often leads one to add artificial constraints to variety. So, while Weibull's models limit the explanatory power of Darwinian evolutionary models by imposing restrictions concerning how agents might act, Lawson's PVRS model allows for exploring the diversity of characteristics of individuals as a source of variation (in addition to the variety that might already exist between different social practices).

Furthermore, since in Lawson's PVRS model, there need not be an exact correspondence between agents and their replicators, decisions to change social rules need not be exactly modeled in order to isolate evolutionary causation from other causes that may affect agents. This is the model more consistent with accounts of human agency, pointing in a direction that moves beyond the modeling of exact and predictable regularities of actual behavior (like that of Sen, but also Veblen and other original institutional economists who have emphasized evolutionary processes as explanatory tools).

Evolutionary game theory undertakes its analysis at a more specific level than authors like Veblen, Sen, or Lawson. As a consequence, its models require stronger assumptions that are needed to address more specific phenomena. This means that the models used in evolutionary game theory will be useful in the particular cases where their assumptions apply (such as, for example, when addressing specific aspects of a given situation). Furthermore, Lawson's PVRS model enables addressing Nelson's (2006) criticisms of the use of biological analogies in cultural evolution, allowing for the fact that agents (both individuals and organizations) do not have a necessarily stable relationship to replicators, and conceptualizes conscious decision-making (be it in the form of discussion, argument, persuasion, or coercion) as part of the selection mechanism.

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