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How to generalize Darwinism suitably to help understand both the evolution and the development of economies

by

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How to generalize Darwinism suitably to help understand both the evolution and the development of economies

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Abstract: This paper agrees that a suitably generalized Darwinism may help understand socioeconomic change, but finds the most publicized generalization by Hodgson and Knudsen unsuitable. To do better, it generalizes the extension of Neo-Darwinism into evolutionary developmental biology ("evo-devo"), which pays more attention to genomes-as-instructors than to genes-as-replicators, and to the entire process of instructed development than to fully developed organisms. The new generalization has clear connections to economics with a minimum guarantee of helpfulness: it generalizes both evo-devo and previously elaborated approaches that already helped understand specific issues of comparative economics, economic reforms, and transformation policies.

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Introduction

There is a broad agreement that no version of Darwinian evolutionary biology is directly relevant to the evolution of human economies and societies. But evolutionary economists still disagree on whether or not *some* generalization of *some* version of Darwinism might nevertheless be helpful. These disagreements perhaps most clearly appear in the recent conflict between the generalization of Darwinism elaborated by Hodgson (2002, 2004), Knudsen (2004), and Hodgson and Knudsen (2006), and the Continuity Hypothesis advocated by Witt (2003, 2004) and Cordes (2006, 2007) – let me refer to the two as HKGD and CH, respectively. While HKGD extracts from biological Darwinism certain notions and principles that its authors claim also to apply to socioeconomic evolution, CH considers Darwinism able to explain the origins of the human cognitive abilities on which this evolution builds, but insists that Darwinism has nothing to do with this evolution itself.

In a first approximation, the present paper can be situated by its agreements and disagreement with these two sides. It agrees with the authors of HKGD that biological evolution and socioeconomic evolution do follow certain common principles that can be regarded as Darwinian, but shows that these principles substantially differ from those considered by them. And it agrees with the advocates of CH that socioeconomic evolution is a continuation of the biological one, and that it is indeed not Darwinian in the sense of HKGD, but shows that it does follow certain principles that can be considered Darwinian, provided Darwinism is generalized in a more suitable way than HKGD.

But this paper aims to be more constructive than critical. Instead of engaging in extensive evaluations of, agreements with, or objections against, different existing views, its main purpose is to show how a new, for socioeconomic applications truly suitable generalization of Darwinism (SGD) can be elaborated. Its fist step is to choose another version of biological Darwinism to generalize than HKGD. Biological Darwinism now exists in three versions, which can roughly be described as follows:

(A) The original Darwinism, limited to the evolution of directly observable features of adult organisms (phenotypes).

(B) Neo-Darwinian synthesis, which takes into account genes, recognizes that many features of organisms depend on them, but is mainly concerned with their replicating and evolving, while saying little on how they instruct the forming of organisms (ontogeny), and in what precise ways their instructions mix with inputs from environments.

(C) Evolutionary developmental biology (evo-devo), which extends attention from genes to entire genomes, shifts its focus from how genomes replicate to how they instruct, in collaboration with environments, the forming and development of organisms, and considers the entire process of this forming and development, and not only the final outcomes.[1]

Version (A) is clearly unsuitable, because it ignores what causes the observable features to change and evolve. Version (B), as can be inferred from its generalization by HKGD, is not very suitable either. For social scientists, its focus on genes-as-replicators is misplaced, because replicating is only a special method of retaining valuable information over time, used much more over generations of organisms than in economies and societies. These only rarely replicate, but most often arise, evolve, develop and possibly fall as childless singles. To retain their basic information, they typically use other ways. The only kind of genomic replicating that has a meaningful socioeconomic counterpart appears to be the one taking place within a multicellular organism, by which the organism's genomic instructions are spread across its cells. But this kind can only be seen to correspond to what CH calls "imitation," "diffusion," or "transmission," taking place among the members of one given society.

The only promising version to generalize is therefore (C). But, to avoid the pitfalls of superficial and often misleading analogies, SGD generalizes only its basic logic, while leaving all of its biology-specific aspects carefully aside. Thus, when using this logic for distinguishing between the evolution and the development of economies, SGD recognizes the great factual differences between this development and the development of organisms, and carefully ignores all the biological particularities of the latter.

Next step is to put SGD on a solid micro-basis – without which, as has been so many times demonstrated, full clarity cannot be attained. SGD joins HKGD in using the term "interactor," coined by Hull (1980), to denote the organized and functioning entities, the visible products of evolutionary processes, of which organisms are special biological cases.[2]

[1] For version (A), the basic reference is of course Darwin (1859). In spite of its high age, this version still appears popular, especially among paleontologists. Perhaps the most prominent of them, or at least the best known to non-specialists, is J.S. Gould. That he has not fully attained version (B) can be inferred from what he presents as difficult to explain evolutionary paradoxes – such as punctuated equilibria, most recently presented in Gould (2007) – that turn out to be quite easy to explain when attention is properly shifted from the evolution of forms of phenotypes to the evolution of their genes and genomes. References for version (B) are more difficult to choose, as it has been pioneered, elaborated and propagated by many authors. Let me only mention among the pioneers Huxley (1942), who is the author of the term "Neo-Darwinian synthesis," and among the elaborators and propagators, Dawkins (1976, 1982, 1996). Version (C) is the newest; to non-specialists perhaps best presented by Carroll (2005) and Carroll et al. (2008).

[2] The term "vehicle" introduced in this meaning by Dawkins (1976) is less suitable because it does not properly express how richly and variably active such entities may be. The term "system" has two other drawbacks: it is too general, currently used in many different meanings, which may cause misunderstandings and confusion; and

But it departs from HKGD by specifying for each large interactor considered a set of smaller interactors of which it can be seen to consist – such as proteins for a cell, cells for an organism, and individuals for a society. This makes SGD compatible with the methodological individualism of modern social sciences, and allows it simply to clarify, in Sections *I.6* and *III.1* below, the old and apparently still controversial issues of multilevel evolution and group selection. That HKGD lacks a clear micro-basis is another reason, in addition to its misplaced focus on replicating, why meaningful socioeconomic applications of it are so difficult to find.

Concerning such applications, SGD has an inbuilt advantage. As opposed to HKGD, which stems from the highly abstract areas of ontology and philosophy of biology (much of which now appears to need updating), SGD has its roots in more mundane approaches to issues of comparative economics, economic reforms, and transformation policies (Pelikan 1988, 1992, 2003a). It is from efforts to generalize these approaches that SGD started to emerge. SGD is thus a collection of general principles that turned out to be common both to the evo-devo version of Darwinism and to already proven ways of dealing with specific economic issues, and is therefore guaranteed applicable at least to these issues.

Emphatically, however, this paper is far from claiming that generalizing Darwinism is the only way to understand socioeconomic change. There are always two alternative strategies for addressing new problems within a scientific discipline: (i) to search for their solutions within this discipline, or (ii) to learn from another discipline where similar problems have already been solved. Both have merits and demerits. Strategy (i) makes it easy to communicate with colleagues, but may uselessly repeat difficult work that has already been done elsewhere. Strategy (ii) avoids this repetition, but requires learning the basics of another discipline. The choice is free, depending on what one hopes to find within one's discipline and how much interested and willing one is also to look elsewhere. This paper is addressed exclusively to those economists and other social scientists whose choice is strategy (ii).

To avoid misunderstandings and misdirected criticism, two early disclaimers are in order. First, despite its focus on the instructing role of genomes, SGD is not genetically deterministic. In addition to extending attention from genes to entire genomes, it does not claim that genomic instructing alone determines how organisms form, develop and function, but fully recognizes that environments may also play important roles. It only makes it clear, following the elementary logic of information processing, that however important these roles might be, the instructing remains primary: these roles are both initially defined and ultimately

its classical definition is "a collection of given parts interconnected in given ways," which makes it poorly suited for denoting developing entities, where both the parts and the interconnections are variable.

limited by it. Thus, SGD is in a sense deterministic, but not naively and only negatively: it recognizes that genomes are far from determining what specific features their organisms will actually develop, but points out that they set strict limits to what these features might, in the most ideal environments, possibly become. It thus implies for each genome a certain developmental potential, which environmental inputs can more or less actualize, but never expand. Instead of genetically deterministic, SGD may thus be called “genomically limitist” – making it clear, for instance, that the genome of a mouse will never allow it to grow into an elephant, no matter how much food it might be given, and that the genome of a monkey will never allow it to learn higher mathematics, no matter to how many schools it might be sent.

Second, despite its building on a clear micro-basis, SGD is not naively reductionist. It does not reduce an interactor to a “simple sum” of smaller interactors – as would do the naive reductionist that holists are so fond of criticizing (and who appears to be an easy-to-beat straw man of their own imagination). SGD fully recognizes that what an interactor is and does also depends on how its smaller interactors are organized, and allows all kinds of feedback through which their organization may in return influence their own features – although only to the extent to which they are intrinsically able to let their features be influenced. SGD only insists that no complex interactor can fall as a holistic mystery from the sky, but each must start with some small interactors forming its initial organization. Only then can the organization begin to influence, within the limits of their intrinsic malleability, their features, while they may respond by helping the organization, some more than others, to develop and evolve.

Note that this simple clarification suffices to settle the old controversy of whether it is individuals who form society or whether it is society that forms individuals: the clarification makes it obvious that some prehistoric individuals, based on their genomic potential for socializing, must have first formed some initial society, before the interplay of feedback influences of societies on individuals and of individuals on societies, under the ever present constraint of the individuals’ genomic potential, could start unfolding.

The rest of the paper consists of three parts and a concluding comment. SGD is briefly presented in Part I. Part II derives from it a conceptual model of economic change. Part III consists of examples of applications: a simple clarification of the issue of group selection, new questions for three fields of economic research that may help bring them together, and a few pieces of advice for dealing with issues of reform policies and economic development. The concluding comment briefly considers the possibilities of SGD to help other social scientists understand other issues of socioeconomic change.

I Suitably Generalized Darwinism

I.1 Instructions and their interactors

In a first approximation, SGD conceptualizes evolution as a kind of trial-and-error experimenting, which can be structured, following the early generalization of Darwinism by Campbel (1965), into variation, selection, and retention.[3]

In a closer view, the variation is seen to consist of the actually attempted, more or less randomly (irrelevantly) chosen trials from a set of potentially feasible trials. The trials consist of *instructions* for the forming, functioning and developing of *interactors*.

The interactors are tested for their performance in more or less adverse environments. In general, the success criteria of the tests may, but need not, be those of natural selection, and the environments may, but need not, include competition and/or cooperation with other interactors. Performance success of interactors imply evolutionary success of their instructions. These remain retained in certain evolutionary memories, from where they can continue to instruct the forming, functioning and developing of their interactors. Possibly, but not necessarily, successful instructions may be transmitted to other interactors – inherited by offspring, or copied by neighbors.

Note that this simple distinction between interactors and instructions suffices to clarify the still controversial issue of the units of selection in Darwinian evolution: such units, as the evolution's final longest-lasting products, may only consist of instructions. It is the rare instructions able to guide the forming and the developing of successfully performing interactors that are what the evolution produces, selects and retains in some lasting memories. In contrast, interactors are only units of testing, which may be, and often are, short-lived.[4]

In biology, where the main examples of interactors are proteins, cells, and organisms, the relevant instructions are contained in genomes. The trials with them – such as mutations and recombinations – are considered random, as no use of information relevant to their eventual success has been found.

In the social sciences, where interactors may be exemplified by different social and

[3] That Campbel wisely keeps his generalization free from the biologically-loaded notions of "inheritance" and "replication" is worth emphasis. This makes it particularly difficult to understand why Hodgson and Knudsen insist on building on these notions, and even distort their references to Campbell by giving the impression that he also used them. Hodgson (2004), for instance, offers two such distortions: "variation, inheritance, and selection" and "replication, selection, and variety-creation." In private correspondence, Professor Hodgson admitted that Campbell did not use these notions, but was reluctant to abandon them because of their widespread uses in the current philosophy of biology literature.

[4] This agrees with Dawkins (1976, 1982) that units of selection can be neither organisms nor groups or societies, but disagrees with his limiting them to single genes. Some of them may consist of several interrelated genes and moreover include non-genic segments of DNA whose RNA transcriptions act as important regulators by themselves, without prescribing, as genes are defined to do, the synthesis of any protein (cf., e.g., Mattick, 2004).

economic organizations – from small groups to entire economies and societies – the relevant instructions are contained, as explained in more detail below, in institutional rules. The trials with their changes need not be entirely random: some information on their eventual effects may be acquired from practice and/or theory, and used in making these trials. But as this information is, and for a foreseeable future appears to remain, far from perfect, even these trials must at least partly be random, made with the help of some irrelevant inputs. Many of them are therefore also likely to be errors, requiring what may labeled as Darwinian selection before a successful variant of institutional rules can be found and retained.

But this raises the question of labels: should an evolution in which trials employ some relevant information, and are thus only partially random, be labeled "Darwinian" or "Lamarckian"? Although the answer is largely a matter of personal taste, there are good reasons for keeping the Darwinian one. Namely, Darwin himself did not exclude the possibility of informed mutations, and the only reason why modern biology excludes them (by the Weismann barrier) is that they have not been found to exist. Biological Lamarckism has failed simply because of its inability to show in what biochemically feasible ways the relevant information could be produced and allowed effectively to direct genomic change. But in socioeconomic evolution, as mentioned above and convincingly argued by Nelson and Winter (1982), corresponding information channels demonstrably do exist. To comprehend also this evolution, SGD thus cannot reject them – with the somewhat curious, but perfectly logical implication that biological evolution is a special, handicapped case of a general Darwinian evolution, admirable for doing so marvelously well without them.[5]

I.2 Environments

Each interactor faces certain environments: nature and possibly other interactors, which may be its competitors and/or collaborators, either independent or fellow agents of a higher-level interactor. The environments contain the resources – materials, energy, and information – which the interactor needs in order to form, develop and function according to its instructions.

The conditions for obtaining the needed resources imply the success criteria for testing interactors' performance. In generous environments the conditions are easy to meet and the tests are easy to pass: a wide variety of interactors can succeed and thus allow a wide variety of instructions to be selected and retained. But in hard environments, where the needed resources are difficult to obtain, the variety of successful interactors is narrow. Successful

[5] The radical rejection of Lamarckism by Hodgson and Knudsen (2006), which must be understood to exclude such channels, is thus a third reason why socioeconomic applications of HKGD are so difficult to find.

instructions – among all the feasible instructions that the more or less random evolutionary experimenting can try – are there rare (if they exist at all), and may require long experimenting before any of them is found.

All this brings to light the important point that in general, Darwinian evolution is only satisficing – and not, as it is sometimes wrongly claimed, optimizing. It does not seek maximum efficiency, only eliminates what the environmental success criteria evaluate as excessive inefficiencies. In hard environments, where even small inefficiencies are excessive, satisficing of course does converge to optimizing. But if the environments are more generous, instructions may prescribe and their interactors exhibit many useless and wasteful ornaments, and yet both be approved of as successful.

Why an interactor needs materials and energy significantly differs from why it needs information: the former, to have a range of possibilities to act, and the latter, to know which of these possibilities to choose. This implies two success conditions: (A) the materials and energy that it possesses and/or is able to obtain must allow at least one of the possibilities to lead to success; (B) the information that it possess and/or is able to obtain must allow at least one of the successful possibilities to be found. Condition (A) is harder: if it is not met, no success is possible. But if (B) is not met, success is only unlikely: the interactor may still go ahead and try its chance with the help of some random or otherwise irrelevant inputs. Of course, the more of the relevant information is missing, the less likely it is to succeed.

But there is a more fundamental precondition: to obtain from environments and effectively use any resources, each interactor must already be equipped with a minimum of corresponding resources, including tools, energy, and information. Its effective uses of resources are thus doubly constrained: by their availability in its environments, and by its equipment for finding them, obtaining them, and using them.

Sufficiently sophisticated interactors may have the ability, due to sophisticated instruction in their information equipment, to use parts of the obtained resources for developing their equipments, and thus allowing more of the available resources to be obtained and used in the future. Importantly, however, this process can never start from zero. At any moment, the actual equipment constrains all uses of resource, including those for its own development. Hence, as can be deduced by simple recursive reasoning, no interactor can start as an empty box – a blank slate, or tabula rasa – that environments might equip at their will. Each must begin with some intrinsically own initial equipment, which determines how the obtaining and using of resources from environments may start, and sets ultimate limits to how far, in the most generous environments, its may potentially continue.

In biology, as noted, the key initial equipment of an organism resides in its genome, which determines how the organism can start using environmental inputs for its development, and sets limits to what extent, in the most favorable environments, it could potentially develop.[6]

What is the initial equipment of an economy, and how it limits the economy's development potential, will considered in more detail in Section II. Now it suffices to note that concerning problems with equipments in materials and energy, they are easy to interpret in terms of standard theories of capital and investment. And many problems with information equipments are easy to understand by all the users of personal computers, who know that every information processing needs pre-existing information equipment in the form of suitable hardware and software.[7] But one information problem is less easy: how can any information equipment form and develop by itself, without some pre-existing information equipment of an intelligent designer? It is this problem that only some form of Darwinism appears able to solve. To get a handle on it, it is necessary to adopt a very broad perspective on information and carefully clarify all the terms used.

I.3 Information, data, and instructions

Information problems are of prime importance for social scientists simply because different humans and their different societies differ much less in the materials of which they are made and in the energy they need for living than in the ways in which the materials and the uses of energy are shaped. All existing individuals and all existing societies can thus be seen as outcomes of choices from wide ranges of alternatives that the materials and energy available make equally feasible. What determines which specific individuals and which specific societies will form and how they will develop – and indeed that they will be human individuals and human societies, and not individuals and societies of other species – is therefore above all the information used for guiding these choices.

To comprehend information problems in their entirety, the notion of "information" must first be given a sufficiently broad meaning to include both the information that

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[6] In addition to its genome, as is sometimes emphasized, an organism also needs equipment for reading the genomic instructions and putting them to proper uses. But, considering the information needed for guiding the development of a specific organism, this equipment is secondary, virtually the same for all organisms of all species. Its relation to the genome may be compared to the one of proper light and good glasses to the contents of rare texts.

[7] The use of personal computers by social scientists is perhaps the main reason why most of them now drop what was not so long ago a widespread belief: that a human individual is a blank slate on which anything can be written by society. Computers made it most tangibly clear that no information can be poured into empty boxes. Without referring to computers, convincing arguments for dropping the blank slate belief are in Pinker (2001).

interactors may receive and process and the one with which they need to be equipped. It appears best to follow the main lines of the quantitative theories of information that define it in relation to choice situations (e.g., Marschak 1954, Ashby 1956, Theil 1967).[8] Here, however, it will not be necessary to quantify information exactly: this would require a number of simplifying and therefore doubtful assumptions, and might mislead attention from primary problems to secondary mathematical subtleties. The following rough definition will suffice:

Information *for an interactor* is what helps it to choose an alternative from a set of two or more feasible alternatives one that meets its internal success criterion – e.g. maximizing its objective function or satisficing its norm. The information can be carried by an event chosen by nature or other interactors from a set of two or more possible events.

Given the interactor's choice set and success criterion, the more choice alternatives there are and the fewer of them would be successful, the more information the interactor needs to find one of these. If some of this information is missing and the choice must nevertheless be made, the information deficit must be covered from irrelevant, possibly random events. The higher the deficit, the more likely the chosen alternative will fail.

Thus, importantly, what *is* information depends on the interactor considered, and not on the environments. Objectively, these only produce physical events, such as electromagnetic waves or air vibrations, which can contain information only to the extent to which the interactor is equipped, in addition to the material means needed for perceiving them, with information on how to use them. Otherwise physical states and events are nothing more than physical states and events.

To distinguish the information processed from the information equipment for processing it, it is suitable to call the former "data" and the latter "instructions." But these are only roles, not permanent properties: data in one choice problem may become instructions in another choice problem, or vice versa. Automatic computer programming and the programming of learning offer clear examples: in both cases, instructions are used for elaborating other instructions, and these thus play, while being elaborated, the roles of data.

The term "instruction" is closely related to the one of "program." SGD agrees with the increasingly accepted view that human behavior is program-based (cf., e.g., Holland 1995, Cosmides and Tooby 1997, Vanberg 2004), and thus admits that the information equipment of an interactor may also be said to consist of programs. Like in computer programming,

[8] Note that even the purely technical information theory by Shannon and Weaver (1949) can be seen to imply a choice situation: the receiver can be viewed as having to choose from a given set of symbols (an alphabet, a vocabulary), with the help of the signals received, those that were actually sent by the emitter.

instructions are seen to be elements of programs, and programs are seen to be specifically organized chains or networks of instructions.

There are two reasons why SGD focuses on instructions rather than programs. One is diplomatic: as interactors are meant also to include humans, describing these as instructed sounds better than describing them as programmed. The second reason is factual: such a detailed focus is necessary clearly to see that one program may combine instructions of different origins.

But, to include humans, both terms must be interpreted more broadly than in ordinary computer programming (although advanced computer programming can also embrace these broad interpretations). In particular, programs must be seen also to govern purposeful behaviors, learning, searching, discovering, innovating, and creating. Instructions must therefore include norms and/or objectives, feedback loops, and prescriptions for generating random or otherwise arbitrary trials and for identifying and eliminating the committed errors.

As opposed to usual computer programming, where one instruction determines just one operation, instructions must be admitted, as in ordinary languages, to be possibly less sharp, determining only a more or less large subset of feasible actions. A simple, but for social scientists important example is the choice of a move in a game: the rules of the game are more or less broad instructions telling the players which moves are permissible, and the players must then use their own internal instructions to specify which of the permissible moves they choose.

The choice of a specific action may thus be understood as a result of cooperation of several instructions. They may be viewed as gradually narrowing constraints, eliminating larger and larger parts of a given choice set, until only one choice alternative is left. Considering the total quantity of information needed to specify this alternative, each of these instruction can be seen to supply some of it, and all of them all of it. This includes even the cases when not all of the relevant information is available. Then, as noted, to obtain the total needed to proceed with the choice, some of the instructions must prescribe uses of random or otherwise irrelevant steps.[9]

All this makes it clear that the above-mentioned initial equipment, which each

[9] That interactors are defined able to take probabilistic or random steps means that they can do more than Turing machines, defined to proceed according to deterministic algorithms only. This means, among other things, that they need not stop undecided in face of two or more equally advantageous choices – as did the proverbial Buridan's ass that starved to death at an equal distance from two equally attractive heaps of hay. To cope with such choices, an interactor only needs to be equipped with instructions for a random step – such as throwing a coin – to survive. This example also illustrates that using randomness need not always diminish the probability of success – it may sometimes be the only way to it.

interactor needs to start receiving and using inputs from environments, must contain specific initial instructions telling it how to do so. The sophisticated interactor which is able to use some of these inputs for improving itself – in other words, to learn, and possibly even learn to learn – must contain specific initial instructions also for developing these abilities. The general principle behind all this is that each information processing – be it a relatively simple use of data for immediate decisions or complex learning of new instructions for future uses – requires some pre-existing instructions.

This adds clarity to why no intelligent being can be born as a tabula rasa, and helps settle the longstanding “nature vs. nurture” debates on whether it its genomes or experiences and education that determine the actual cognitive abilities (”intelligence,” ”bounds of rationality”) of an adult brain. It is now widely recognized that both matter, but how exactly they cooperate is still an open question. The need of instructions for elaborating instructions logically implies that genomic instructions must initially determine a certain development potential that experiences and education may more or less actualize, but never overstep. An individual’s cognitive abilities are therefore no arithmetic sum of “talents plus experiences and education,” where more of the latter could replace less of the former. Quite to the contrary, more of the latter, to be properly understood and used, requires more of the former.[10]

I.4 Instructions for functioning vs. instructions for associating

Instructions are in the center of SGD: they are both the key results of the evolutionary trial-and-error experimenting, and the key guides for the forming, functioning and developing of successful interactors. But how do they exactly do it?

It is for this question that a clear micro-basis is most needed. To understand how an interactor under the guidance of some key instructions can form, function and develop, it is necessary to specify a set of elementary interactors – let me call them “agents” – of which it can be seen to consist and through whose actions and interactions the instructions can be seen to work.

An interactor’s behaviors are thus understood as aggregates of its agents’ behaviors. The aggregating depends on the organization into which the agents arrange themselves – or, in other words, self-organize – and is thus, as emphasized in the introduction, far from any “simple sums.” The interactor may acquire new observable properties, often called

[10] The present view largely agrees with Ridley (2003), with the exception of the title: instead of ”Nature via Nurture,” it is more logically describes as ”Nurture via Nature.”

"emergent," that differ from all observable properties of its agents. Yet none of the emergent properties falls from the sky: all can be traced to some properties of the agents, provided that all the relevant properties of theirs are properly taken into account.

For an interactor that already exists, with its agents already arranged into a certain organization, it is relatively easy to imagine how the individual functioning behaviors of its agents aggregate, according to their organization, into the global functioning behaviors of itself. This must be sufficiently clear to anyone with a minimum understanding of how the functioning of a computer results from the functioning of its elementary logical switches and their wiring diagram.

The challenging question is, as noted, how can such an organized and functioning interactor form by itself, from initially disconnected agents? Or, seen from below, how can such agents self-organize to form it? The first necessary condition is that they must be active in two dimensions: in addition to their functioning in a given organization, they must also be able to associate and dissociate, and thus form and reform organizations. It is their associative behaviors that determine which connections with each other they will establish, and which ones they will refuse, and, in consequence, which organization they will form.[11]

Note the contrast with computers: they consist of electronic components that are active only functionally but not associatively, and must therefore be wired or printed together exogenously. Note also the most fundamental difference between brains and computers that this implies: while there does not appear to be any function of an already formed and developed brain that could not at least roughly be simulated by a computer, what computers cannot do (so far?) is to form and develop by themselves, thanks to suitably instructed self-organizing of some initially disconnected elementary components.

Two-dimensional behaviors require corresponding two-dimensional instructions. To self-organize into a larger functioning interactor, the initially disconnected smaller interactors need instructions both on how to associate with each other – and thus form, and find their positions in, the interactor's organization – and on how to function as the interactor's agents

[11] To illustrate why it is important to take associative behaviors properly into account, recall the well-known argument that self-organization can somewhat miraculously create order out of disorder, and thus violate the Second Law of Thermodynamics (Prigogine and Stengers, 1984). The miracle rapidly dissolves when it is realized that this law is about interactions of chemically inert gas molecules, which are non-associating agents, often exemplified by billiard balls bouncing from each other. In contrast, the basic agents of both organisms and societies are associatively highly active and selective, to begin with the different valences of atoms and molecules. Such agents only need favorable environmental conditions – such as the right temperature and pressure – to put their associative behaviors to work and self-organize into highly ordered entities. While favorable environmental conditions are necessary, they are only auxiliary – it is not on them, but on the selective associative behaviors of the agents that the resulting order most fundamentally depends.

in these positions. The two dimensions may overlap, as some instructions for functioning may also affect the agents' associating, and vice versa. But distinguishing them is necessary for a good understanding of the long chains of effects from the instructing of individual agents to the main properties of the by them formed and developed larger interactors. To understand such chains is the main task of genomic biology, and, as will be argued below, should be the main task of institutional economics.

Note well that the initially disconnected agents must first of all to use some of their instructions for associating, and thus self-organize into some initial, possibly only rudimental organization, before they can start using their instructions for functioning as agents of organizations. Only afterword can instructions of the two dimensions take turns in influencing the course of events. Outcomes of the agents' functioning may change conditions for their further self-organizing – which may include changes of their behaviors by learning, if their instructions also tell them how to learn. This will lead them to develop or otherwise change the organization, which will modify the conditions for their functioning, and this will again change the conditions for their self-organizing, and so on, possibly many times.

What further complicates these processes is that instructions of both dimensions may be open to inputs from environments. This enormously amplifies the potential impact of these inputs: in addition to causing the functioning of a given organization to produce certain outputs, they may more fundamentally influence the form and the development of the organization, and thereby its functioning with the ways of producing outputs. Their influences may be so overwhelming that superficial observers may overlook the underlying ultimate responsibility for all that of the initial instructions.

To see this responsibility, consider an interactor that fails. This may be due to two immediate causes: (a) it has been organized so poorly that no functioning of its agents, however excellent, might save it; and/or (b) its agents function so poorly that no way of organizing them, however ingenious, might help. It is then easy to discover that the deep cause in both cases is that its instructions have failed to guide its agents – in case (a) to self-organize, with clever uses of available environmental inputs, into a potentially successful organization; and in case (b) to function, with clever uses of available environmental inputs, to make such an organization actually to succeed.

Of course, the environments might be so adverse and supply so little of needed inputs that no instructing of the agents could help. But then also no larger interactor from these agents in these environments could form and develop, and no evolution of such interactors could take place. This includes the possibility that the adversity is caused by some insufficiently cooperative or hostile other interactors, which leads the search for the ultimate responsibility to their instructions – with the conclusion that they have been better instructed how to find and obtain needed resources than the interactor that failed.

What makes the ultimate responsibility of instructions difficult to see is that many of their effects on the performance of interactors take long and for external observers difficult to follow ways. Instructions for associating have often little to do with those for functioning – so that observing how agents self-organize may not say much on how they will function, and thus make the organization function, once this is formed. It is as if the agents kept their instructions for functioning hidden in sealed envelopes that they will not open until their self-organizing has sufficiently advanced and put them into their first functioning positions.[12]

Note that this difficulty arises already in chemistry. It is relatively easy to infer how atoms will self-organize into different molecules, given their instructions for associating displayed by their valences. The difficulty is in predicting how they will function and interact within those molecules, and how the molecules will consequently behave as wholes. Yet this is only a difficulty for the observing chemists. Whether it is clear to them or not, atoms are in specific ways instructed for both associating and functioning, and, depending on environmental conditions, their instructing will guide them both to form specific molecules and to make the molecules formed behave in specific ways.

How weakly instructions for associating may be linked to those for functioning may also be seen in the possibly great differences in the extent of centralization that the two may prescribe. For instance, a highly decentralized self-organizing may result in a highly centralized control of functioning – such as the largely decentralized ontogeny that results in an organism with a central nervous system – and vice versa – such as the centrally imposed market liberalization reform by which the functioning of the economy is decentralized.

I.5 One-level evolution and development

Both the evolution of instructions and the development of interactors may possibly take place at several levels: some interactors may act as instructed agents forming and developing a larger interactor while being themselves formed and developed by smaller interactors. But first, consider just one level. This can be represented as follows:

Assume a set of agents, internally instructed for certain associative and functional

[12] Note that instructions for associating are hidden more deeply than the hidden order disclosed by Holland (1995). This only consists of instructions for functioning, comparable to programs for already made computers. In this comparison, the hidden instructions for associating can be seen to guide the very making of a programmable computer by self-organizing of its initially disconnected elementary components.

behaviors, and certain environments implying certain success criteria. The task of evolution is to find additional instructions that could guide the agents to form, develop a make function a larger interactor, able to succeed in these environments.

But evolution is sometimes impossible and sometimes unnecessary. Three cases must be distinguished: (a) the environments are so harsh and/or the agents so little able that no ways of instructing them can help; (b) the environments are so tolerant and the agents' internal instructions are so complete that they self-organize into a successful larger interactor automatically by themselves; (c) the agents are able to self-organize in a variety of alternative ways, of which only few will produce a successful larger interactor.

It is only in (c) that evolution is both needed and possible. In (a), no larger successful interactors can form at all, and in (b), all of them are automatically successful without any evolution. But (b) can be seen an extreme case of (c). In general, the instructions guiding the agents come there from two sources – inherent, and supplied by evolution. There may therefore be many variants of (c) which differ in the proportion of the two. Case (b) can then be regarded as the extreme (c) in which all the instructions are inherent and none is supplied by evolution. NB: the opposite is not possible, as some instructions must always be inherent.

Conceptually, the existence of such a proportion is clear. But empirically, it is difficult to measure it, so that opinions may differ on what it is. Thus, concerning the evolution of life, traditional Darwinians belittle, if not entirely neglect, the inherent instructions and believe that only those supplied by evolution are significant. In contrast, many studies of biological self-organization, such as Camazine et al. (2001), do the very opposite – and thus may be seen to believe in case (b). An interesting compromise is in Kauffman (1993), where both sources are accorded a positive weight – although the one accorded to evolution may appear too small even to the most tolerant Darwinians.

Considering (c) as the only case in which a Darwinian evolution may work, there are three more conditions that must be met to allow this evolution actually to work and eventually to succeed. First, there must be a feasible variety of sets of tentative instructions with which trials can be made and which contains, possibly as a very small sub-variety, some successful ones. Second, the agents' internal instructing must enable them to receive and actually follow such instructions. Third, there must be some evolutionary memories in which successful instructions can be retained.

If all these conditions met, one-level evolution and development can be understood to unfold as follows: (1) Without full information about the consequences, the evolution tentatively picks a combination of instructions and supplies it to the agents. (2) With the help of their internal instructions, the agents receive this combination, join it to their internal instructions, and, guided by both, try to form, make function, and develop a larger interactor. (3a) If no functioning interactor forms, the evolution returns to step (1). (3b) If such an interactor forms and develops, its functioning is tested by the environments. (4a) If it fails, the evolution returns to step (1). (4b) If it succeeds, the instructions picked by the evolution are retained in some of the memories.

If out of all possible combinations of instructions, only very few are successful, it may take a long time, with many repetitions of these steps, before the evolution happens to pick one of them. The time is possible to shorten if many parallel experiments can be conducted simultaneously. But extensive uses of this possibility appear limited to the biochemical experimenting in the evolution of life. In socioeconomic evolution, considered in more detail below, the number of parallel experiments is much more limited. This evolution must therefore proceed mainly by series of successive experiments.

I.6 Multilevel evolution and development

To show how evolution and development can work at more than one level, it suffices to clarify two neighboring levels, (I) and (II). More levels will then be possible to clarify by simple recursive reasoning.

At level (I), assume again a set of agents, internally instructed for certain associative and functional behaviors, and environments implying certain success criteria. Consider again case (c), in which the agents, to be able to form and develop successful larger interactors, need to complement their internal instructions with additional instructions supplied by evolution. But now the environments are more adverse: the larger interactors can succeed only if they are able further to self-organize at level (II) into an even larger successful interactor – possibly called "group" or "society." Let me refer to the three levels of interactors as "small," "mid-sized" and "large."

This makes the task of the evolution more difficult. Its instructions must now enable the small interactors to form and develop mid-sized interactors that will not only succeed as individuals, but will moreover be able to form and develop large successful interactors.

The key to understanding multilevel evolution is to realize that that level (I) evolution, to attain such a double success, can employ two alternative strategies, for which suitable names are "complete instructing" and "instructing for a higher-level evolution."

Complete instructing means that the evolution must endow the small interactors with all the instructions that they need to form and develop mid-sized interactors so precisely that these from the beginning contain all the instructions needed for the forming and developing of a large successful interactor. This strategy turns level (II) into case (b): the mid-sized interactors can self-organize into a successful large interactors by themselves, so that no level (II) evolution need, nor can, take place. This strategy may also be described as "one level of evolution with two levels of development."

Note that this is the strategy of virtually all biological evolution, where it is extended to "one level of evolution with many levels of development." The evolution produces genomes which may completely instruct the forming and developing of a high hierarchy of completely instructed interactors – from proteins and cells to organisms and virtually all of societies of organisms. For instance, even the forming of an ant society is completely instructed by the ants' genomes. Not to be confused by the possible adaptability and flexibility of such societies, it is important to keep in mind that complete instructing need not be, and usually is not, closed deterministic programming: it may allow or even require environments more or less to contribute to the development at all levels.

Instructing for a higher-level evolution means that the mid-sized interactors do not receive from the small ones all the instructions they need to form and develop a large successful interactor. Instead, they receive instructions for seeking the missing instructions themselves, by own trial-and-error experimenting – in other words, by conducting level (II) evolution. This strategy repeats case (c) at level (II) and may also be described as "two levels of evolution with two levels of development."

Note that not to endow the mid-sized interactors with all the need instructions for the forming and developing of a successful large interactor, and make them instead search for the missing instructions themselves, does not diminish the amount of instructions they need. On the contrary, this amount is larger. This apparent paradox is immediately clear to all the computer programmers who know that programming a computer for performing a certain task needs a shorter program than programming it for finding out how to perform this task by itself. Compare also the complete genomic instructing of ants with the human genomic instructing for a higher-level evolution, which must include instructions for the forming and developing of a sophisticated brain, without which no such evolution could take place.

II From general Darwinism to a conceptual model of economic change

II.1 Interactors and instructions in economics

Like in all social sciences, the smallest interactors in economics are human individuals, but attention is narrowed to their behaviors as economic agents – meaning, as usual, their ways of using scarce resources. But it must be kept in mind that this includes the forming, running and developing of economic organizations, and making these organizations evolve.

Economic organizations of different sizes and tightness – from small and tightly organized households, workshops, and bureaus to large and more loosely organized national economies and supranational economic unions – are the larger interactors. For most of present purposes, it will suffice to consider two of their levels: (I) firms and government agencies, and (II) national economies.

That a market economy is regarded as an organization may need to be explained, as organizations are often defined as entities pursuing objectives, while markets are often viewed as orders which do not do so. The point is that markets do not indeed pursue the objectives of any of their participants, but they are automatic regulation devices with feedback loops that make them aim at certain states, and may thus be regarded "as if" they had objectives of their own. That these objectives may differ from those of their participants is precisely what raises problems for policy – for instance, a market economy may stubbornly aim at maintaining a lower growth and a higher unemployment than what all of its agents would wish it to do.

The instructions of an economic organization are its "institutional rules," possible to visualize as the rules of a game.[13] Each institutional rule constrains and thus shapes, but typically does not fully determine, the behaviors of the organization's members, and through these behaviors influences the organization's form, development and performance. According to their origins, institutional rules fall into *formal*, designed and imposed by certain top agent(s) – such as legislators in economies, or owners of firms – and *informal*, spread from anonymous innovators by spontaneous imitations – such as perhaps first clearly described by Hayek (1967). The effective institutional rules of most of economic organizations are mixtures of both.

While each organization has its own institutional rules, the same rules may be used in different organizations – for instance, different firms may use the same rules of corporate

[13] The term "institutional rules" thus has the same meaning as what North (1990) defined as "institutions." I used the former term in Pelikan (1988, 1992), but in my subsequent papers I followed North. Why I now return to my previous terminology is that North's definition has not been widely accepted: even leading economists still speak of banks and government agencies as "institutions," and not "organizations." The word "institution" may thus leave readers uncertain about its precise meaning, and cause confusion.

governance, or different national economies may use the same property rights. The rules of a higher level constrain the variety of permissible rules of the subordinate levels – for instance, the corporate law of a national economy constrains the variety of permissible rules of corporate governance within its firms.

The behaviors of individuals of constrained by the rules of all organizations of which they are members – for instance, the behaviors of a firm's owners and employees are constrained both by the in internal rules of the firm and by the overall rules of the entire economy. Under these constraints, their actual behaviors are determined in detail by their internal idiosyncratic instructions. They may respect an institutional rule voluntarily, if it coincides with some of their internal rules – such as a law that coincides with some of their moral norms – and/or because its violations are sanctioned.

Important constraints also work in the opposite direction. The internal instructions of individuals imply in part their motivations (utility, values) and in part their cognitive abilities, including abilities to learn (more or less bounded rationality, talents). Both impose constraints on what institutional rules they may be able to understand and willing to respect. While the constraint of will may be softened by increased incentives and/or sanctions, the constraint of understanding is harder. This appears to be why individuals of exceptionally bounded rationality may have difficulties with respecting even simple rules, while some highly intricate rules could not be properly understood by anyone.

Like interactors in general, economic organizations also form, function, develop and evolve – although most economists, with the exception of economic historians, usually assume that national economies are already formed, and consider initial forming only for smaller organizations within them.

The main point of applying SGD to economics is to put institutional rules in the center, and use them to split the processes of economic change into development and evolution. The development of an organization consists of entry and exit of its agents and changes in their positions, relationships and behaviors – which leads in an economy to the forming and developing of markets, firms, and government agencies – all of this under the constraints of its actual institutional rules. The evolution consists of changes of these rules.

In principle, this split is simple, but in detail, it may cause difficulties that need to be clarified. First, it is only relative to the organization considered. An typical example is the *evolution* of rules of firms that is part of the *development* of the economy under its constant rules – such as the evolution of corporate governance of specific firms taking place under the constraints of a constant corporate law of the economy.

Second, the distinction is more difficult to see in economics than in biology. There, evolution and development proceed at very different speeds, which makes it easy to distinguish one from the other: an organism can usually fully develop with a virtually constant genome, while the evolution of genomes is much slower, spanning over many generations of fully developed organisms. In contrast, the development of an economic organization and the evolution of its institutional rules often proceed at more comparable speeds, and may even be closely interwoven.

The closeness of the two speeds also increases the difficulties of judging the effects of different institutional rules on their organization. Some institutional rules may not have enough time to demonstrate their full development potential, as they may be changed before the development under their guidance comes anywhere close to maturity. And newly evolved institutional rules may not be given the opportunity to start with a new organization, but must do with the already formed and more or less developed organization left to them by their predecessors. This may prolong the time they need to show what they can achieve, as much of the previous development may has to be undone before the development under their guidance may start taking off.

But none of these difficulties refutes the logic of the distinction. They only require careful attention to fine points in order to get the distinction right in concrete situations.

II.2 The development of an economic organization

An organization forms and develops by self-organizing of its members, which is based on their associative behaviors, instructed by its institutional rules. Some individuals may, and usually do, play more important roles than others – such as industrial entrepreneurs creating firms, or politicians organizing government agencies. But the roles of others are never entirely negligible: virtually all members more or less importantly contribute, positively or negatively, to how the self-organizing will unfold and the organization thus develop.

To avoid all superficial analogies with the development of organisms, it is important to realize the differences, which mainly stem from differences between their respective basic agents – molecules in organisms and human individuals in economic organization. Most important are two: the former are internally instructed for more complex behaviors, and are more heterogeneous (less standardized), than the latter.

The higher complexity of human behaviors limits the possibilities of institutional rules to help: they cannot guide individuals as precisely as genomic instructions can guide molecules. Just like the rules of a game, they may only set more or less broad limits and leave individuals free to choose their behaviors within these limits. But then, the individuals are also less informed on how to behave, and must therefore use more of trial-and-error experimenting to find this out, than the molecules.

Moreover, as this complexity includes abilities to learn and adapt, the development of human organizations is complicated by additional feedback loops – such as the often discussed path-dependence – that change individual behaviors in function of the development, and this then changes its speed and/or direction in function of the behavioral changes.

The heterogeneity implies that the development of an economic organization must solve more problems than the development of an organism. There, thanks to the highly standardized molecules, it is relatively easy for genomic instructions to make it sure – possibly with some minor trial-and-error experimenting – that molecules of guaranteed qualities will play the right roles within cells, and cells of guaranteed qualities will occupy the right positions within the organism. In contrast, the individuals who are to form and develop the organization may be of very different and in advance unknown talents, which raises the problems of recognizing their talents, designing their positions, selecting the right individuals for the right positions, and keeping the positions and the individuals adjusted to each other over time. All these problems must be solved, under the guidance of the organization's institutional rules, by the individuals' self-organizing, which must therefore involve much more of trial-and-error experimenting than the development of an organism.

Examples of the developmental errors are the tried designs and the tried assignments of positions within the organization that turn out to cause serious inefficiencies undermining the organization's success – such as a too difficult job assigned to an insufficiently talented individual. The such errors may and do happen makes the success of the development strongly depend on the organization's internal selection – how precise, severe, and fast this selection is in detecting them and eliminating them – which in turn depends on the organization's institutional rules.

But note well what is often overlooked: such an internal development selection, shaped by the organization's institutional rules differs from the external evolutionary selection imposed by environments – such as nature, competing organization, or a higher-level organization of which the organization may be a member – on which more below.

II.3 The evolution of economic organizations

An economic organization evolves, as noted, by changing its institutional rules – and thus changing its ways of functioning and developing, including its development potential. To see why the right actors for this central evolutionary role are institutional rules, consider the two main alternative views of socioeconomic change in which this role is given to other notions: to routines by Nelson and Winter (1982), and to memes by Dawkins (1976, 1982). Institutional rules turn out to occupy an advantageous middle ground between the two. They form a subset of memes, as only some memes, in addition to replicating from mind to mind, also instruct the minds on how to form, develop and make function organizations. Routines form a subset of theirs, as only some institutional rules may be so constraining that they prescribe individual behaviors step by step.

Why the middle ground is best can be explained as follows. The notion of memes is too broad, possibly corresponding to the entire genome of a multicellular organism, including the non-instructing "junk," but not to genes, which, in addition to replicating, instruct the protein synthesis, and thus crucially contribute to the organism's forming, functioning and developing.[14] The notion of routines is too narrow, as routines do not really correspond to what the members of an organization have in common: many parts of many routines are specific to individuals, hidden in their idiosyncratic tacit knowledge. Moreover, both have the disadvantage of being less tangible than institutional rules. Memes are more difficult to identify because of the enormous variety and heterogeneity of the ideas that may spread from mind to mind. Routines are more difficult to identify because so many parts of them are tacit. In contrast, many institutional rules are clearly written laws, regulations, or charters. As demonstrated by ethnologists and organizational theorists, even the unwritten rules, such as informal social and cultural norms, can often be clearly identified and mapped.

The evolution of institutional rules, like the biological evolution of genomes, is also a kind of trial-and-error experimenting, structured according to Campbell (1965) into variety, selection, and retention (NB: here definitely not "replication"!). But it differs from biological evolution in several important respects. One is that the variety originates in two types of sources – formal and informal – corresponding to the two types of institutional rules. Another difference is that the tentative picking of the institutional rules to be tried – as, for instance, in the design of an economic reform – need not be, as noted, entirely random. Although far from perfectly informed, it may be helped by relevant learning, or hindered by false religious

[14] It is surprising that this obvious fundamental difference between genes and memes has escaped both Dawkins and all the social scientists who have tried to develop a meme-based theory of societal evolution.

or ideological beliefs.

Another important difference is that the performance tests of economic organizations, which determine the fate of their institutional rules, involve an extra success criterion. In addition to being tested for their coping with environments, as organisms are, economic organizations are moreover tested for their coping with their own members.

A comparison with an ant society may again illustrate. For the evolutionary success of the ants' genomes, this society only needs to be efficient enough to obtain all the needed resources from its environments, but they run no risk of being rejected by dissatisfied ants. In contrast, the institutional rules of an organization, to succeed in their evolution, must moreover make themselves and the outcomes to which they lead sufficiently acceptable, possibly with the help of feasible enforcement, to its members.

Because of this extra success criterion, the evolution of institutional rules can be retarded by repetitions of cycles of political and economic crises: institutional rules that lead to economic efficiency, and thus allow their organization successfully to cope with its environments, may be disliked and politically rejected by the members, while the politically preferred institutional rules may cause inefficiencies that throw the organization into a deep economic crisis, and be thus made unsustainable by the environments. What appears to be the only way to prevent an unhappy end, in which some of the crises would grow into a catastrophe, is double learning: humans must learn which institutional rules can make their organizations efficient enough not to cause too deep economic crises, and then learn to like, or at least tolerate and respect, such rules, not to cause too deep political crises.

II.4 Multilevel evolution and development in economics

Much about several levels of economic evolution and development can be understood by interpreting Section *I.6* in economic terms. The small interactors can be interpreted as individuals, the large interactor as their national economy, and the mid-sized interactors as their smaller organizations – such as firms and government agencies. The instructions involved are in the individuals' genomes, in the internal institutional rules of their organizations, and in the overall institutional rules of the entire economy. But there are three special points that should be noted.

First, to avoid confusion, it is important to keep in mind that the processes involved may switch names from evolution to development, and vice versa, depending on the level considered. The already noted example is the evolution of the institutional rules of firms that is part of the development of the economy.

Second, compared to the "two levels of evolution with two levels of development" considered in Section *I.6*, there is now one more level of development. Level zero, which has again no evolution, as human genomes are assumed constant, now involves the important development of human behaviors by extensive learning and adapting, for which these genomes provide rich initial instructing. It was already noted that human learning and adapting may complicate the development of economic organizations by feedback loops already at one level. It is rather obvious that many more such loops may complicate their development and evolution at several levels. Here, however, it is only possible to note that the present conceptual framework can recognize them and make room for them, without examining them in detail.

Third, the inter-level relationships that appear to require most attention in economic practice are those involving performance tests, success criteria, and selection. The main principle is that the institutional rules of an organization whose performance is severely tested by environments must transmit, to remain selected and retained, much of this severity to the internal performance tests and selection criteria for its members. Thus, for example, the institutional rules of an economy whose performance is tested in severe international competition must transmit much of this severity, together with its selection consequences, to the performance testing of its firms, and their internal institutional rules must transmit much of that severity, together with its selection consequences, to the performance testing of their employees, to begin with their managers. In details, this principle may require qualifications due to well-known aspects of human psychology – such as the existence of limits to the pressure that can make individuals perform better rather than worse – but here also these details must be left aside.

III Examples of applications

III.1 Group selection

The issue of group selection is perhaps the clearest example of how the framework of SGD can help: this issue is still highly controversial and reputed for being difficult to understand, while the framework can explain it quite easily.

First, the framework makes the simple but essential point that groups are interactors, and cannot therefore be units of selection. It points out that groups are formed, developed and made function by their individual members who share and respect what are for each group its specific institutional rules, and that it is only these rules that can be selected and lastingly retained in some evolutionary memory. Group themselves may keep changing in many ways – their members may come and go, and they may even voluntarily dissolve. They can therefore be only units of testing of their institutional rules: their performance is tested according to certain success criteria, and if they succeed, it is their rules that are selected and lastingly retained – e.g., written down or remembered by some of its former members. They may then be used by similar individuals for the forming and developing of similar, similarly successful groups.

A complication is that the institutional rules of a group can only be a limited part of all the instructions that govern individual behaviors. To recall, the members must first of all possess some internal instructions that enable them to form groups in general, and according to the institutional rules of a specific group in particular.

In consequence, there are several types of group selection, which differ in the proportion and the origins of the initial instructions, and in the variety of the institutional rules that these instructions allow the members to adopt. To avoid confusion, at least three types of groups must be distinguished: (i) groups formed instinctively by animals without social learning – such as the earlier considered ant society; (ii) independent groups of humans – such as a tribe living in the wilderness; (iii) groups of humans within a larger society.

In a type (i) group, all its institutional rules are part of their members' genomes, which leave no room for any alternatives. Whatever might be called "group selection" must therefore be an inseparable part of the biological evolution of these genomes.

In a type (ii) group, all the initial instructions of its members are also part of their genomes. But, being humans, the genomes enable them extensively to learn and adapt, so that the variety of institutional rules that they are able to adopt is consequently large (although not unlimited). The responsibility for the performance of such a group is shared by its institutional rules and the genomes of its members, both of which thus also are, at their respective evolutionary levels, the targets of the selection.

In a type (iii) group, the initial instructions of its members, in addition to those contained in their genomes, moreover include the institutional rules of the larger society – such as its cultural (including religious) norms, and its legal framework. These rules may crowd out much of the variety of institutional rules of groups that the members of the society can possibly adopt. This shifts some of the responsibility for groups' performance to the institutional rules of the society, which thus become a third target of the selection. That these rules are indeed co-responsible can be seen by considering that the forming of groups is easier, and they have more chances to succeed, in some cultures and under some laws than in other cultures and under other laws.

That human genomes are co-responsible for the performance of human groups and societies may not be immediately clear and calls therefore for explanation. The point is that the genomes may indeed matter only little for how humans actually behave, but they are fully responsible for the variety of behaviors that their bearers, when instructed by different institutional rules, might possibly learn. This responsibility becomes critical if the success of a group or a society requires individual behaviors that do not belong to this variety – such as behaviors that are more altruistic or more rational than what the genomes allow their bearers to learn.

III.2 New questions that help bring together different fields of economics

There are three relatively new fields of economics to which the framework of SGD is most closely related, although so far they have themselves kept rather separated from each other: cognitive economics, institutional economics,[15] and evolutionary economics. In addition to accommodating most of their actual questions and answers, the framework raises for them a few new questions that may help bring them together.

For cognitive economics, the main new questions are: (1) What is reasonable to assume about the genomically given abilities of humans to learn and adopt different institutional rules, and thus adapt to different types of economies and societies? (2) What is reasonable to assume about the bounds of human rationality and about the inequalities of their distribution in society?

Question (1) inquires into the limits of what may be called "universal social grammar," a sister notion to the genomically given universal grammar that determines and limits the abilities of humans to learn languages, compellingly argued to exist by Chomsky (see, e.g., Chomsky 1976). Its answer is important for questions about the evolution of institutional rules and about the possibilities of influencing this evolution by reform policies.

The answer to question (2) is important for two questions about the development of an economy: (a) To how high complexity may its top jobs be allowed to develop without overtaxing the cognitive abilities of its even most talented individuals? (b) How sharp selection must be institutionalized to find for the top jobs the most talented individuals, or at least protect these jobs from incapable ones? The point here is that the smaller the rationality

[15] This term refers here to what is now often called "new institutional economics." This differs from the traditional one, which mainly consists of critical essays where the term "institutions" is rarely well-defined, by defining this term with operational clarity and analyzing the effects of different institutional rules, formal and/or informal, on economies. For present purposes the best introduction to it is North (1990).

inequalities, the less sharp selection is needed, and vice versa.

Institutional economics is directly concerned with the questions about the evolution of institutional rules and the possibilities of their reforms, which have been explored from its side by several authors (e.g., Hayek 1967, Vanberg 1992, North 2005). The new question for this economics is: What are the effects of different institutional rules on the self-organizing of individuals, through them on the formation, the development and evolution of production organizations, and ultimately on the development of an entire economy?

This question demands institutional economics to extend attention from its usual focus on transaction costs and other incentives to the dynamics of industrial change. Incentives undoubtedly remain important, but this dynamics strongly depends also on other, by institutional economists so far less explored factors – such as the freedom of entry and the tradability of ownership of firms, needed for allowing a rich variety of entrepreneurial trials, and the effectiveness of the selection by market competition, needed for enforcing precise and rapid elimination of the committed errors. The basic idea for analysis is that the institutional rules which allow a rich variety of entrepreneurial trials while enforcing a rapid and precise elimination of errors are superior to those rules which limit the trials and let last the errors.[16]

Institutional economics is moreover demanded to pay more attention to the differences between, and interrelations of, different levels or institutional rules – such as the corporate governance of specific firms and the corporate law of the entire economy. Most institutional economists appear to deal with only one of these levels, without being very clear on how the two levels interrelate. Clarity about their differences and interrelations is important for several issues of reform policies.

Turning to evolutionary economics, the first implication of SGD is that not all the topics that economists who call themselves evolutionary study are really evolutionary. In particular, in the changes of technologies, firms, and industries within capitalist market economies, which, following the classical works of Schumpeter (1934/12) and Nelson and Winter (1982), are perhaps the most studied topics, the only evolution may be the one of the firms' institutional rules. Otherwise all of that is industrial development, implicitly assumed to take place under constant institutional rules of market capitalism.

The main new question here is complementary to the one raised for institutional economics: How does industrial development depend on the prevailing institutional rules? In what ways and at what speed this development would unfold under different variants of

[16] This idea was used in Pelikan (1988, 1992) to expose the critical evolutionary weaknesses of all forms of socialism and selective industrial policies.

institutional rules? The variants that now appear most important to examine are those of the rules for market economies with different degrees and forms of government regulation.

This means that to be really evolutionary at the level of national economies, evolutionary economists would have to join the institutional ones who study the evolution of national and supranational institutional rules. Note that this is a promising research strategy for both: the former could learn from the latter what they ignore about institutional rules, and the latter could learn from the former what they ignore about industrial development. Such a cooperation of evolutionary and institutional economists also appears to be the only way to a clear understanding of this evolution.[17]

III.3 Some elementary advice for policy analysis and development economics

If all the above questions were given the right answers, these could help solve many problems of economic policy and economic development. The two categories largely overlap, as the most urgent problems of development are just policy problems, especially those concerning institutional reforms. But without waiting for the answers, the framework of SGD can provide some general advice already now.

This advice is mostly limited to the framing and structuring of these problems, and getting an effective handle on them. It can be summarized in the following points: (1) indentify all the relevant institutional rules; (2) distinguish their evolution from the development of the organizations they instruct; (3) map the effects that different institutional rules may exert on the performance and the development of different organizations; (4) consider how different institutional rules may evolve.

Three more points concern policy problems: (5) ask what government could do, and what it cannot do, to help, and not harm, the development of the economy and/or the evolution of its institutional rules; (5) keep in mind that the government itself, with its motivations and abilities, is the product of certain development under certain institutional rules; (6) when estimating the effects of any policy, do not forget to consider its secondary effects on all important developmental and evolutionary processes. This last point is particularly important, as it was because of these effects that many policies which appeared successful in the short turned out to cause a deep crisis, while many of those which at first

[17] Such a cooperation is described in Pelikan (2003b), although in different terms: what is here more logically called “development” is there called “Schumpeterian evolution.” Attempts to realize such a cooperation within one person are in Pelikan (1988, 1992).

appeared hopeless later proved successful.[18]

The main general advice to development economics is to turn even more attention from the availability of resources to institutional rules. These were for a long time entirely neglected, as if the growth of an animal depended only on how much it is fed. Although in the beginning of the 1990's, development economics started to admit that institutional rules matter, they were only put on a par with many other growth factors. The framework of SGD makes clear their true importance by contrasting their effects on economic development with those of availability of resources: they determine a maximum development potential that a lack of resources may leave unfulfilled, but no surplus of resources can exceed – much like a lack of nutrition may prevent a mouse embryo from developing, but no nutrition, however abundant, can make it grow into an elephant. The lesson is simple, although still rarely realized: when a poor economy under its actual institutional rules has obtained the possibly small quantities of resources for realizing the possibly low development potential of its actual institutional rules, any additional resources will be wasted, as the binding constraints on its further development are these rules.

Institutional rules that hinder the development of an economy raise two obvious questions: (A) Which institutional rules would do better? (B) By what policies could the actual rules be reformed (transformed) into better ones?

Question (A) leads to the above mentioned common task of institutional and evolutionary economists to discover the effects of alternative institutional rules on the development of economies. While these effects are still far from fully known, discovering them appears perfectly feasible.[19]

Question (B) is much more difficult. Some institutional economists, including North (2005), have confessed that they are far from knowing the answer, and doubted that such reform policies might even exist. The main problem is that deliberate policies can only change formal institutional rules, while the binding constraints on economic development often reside in the informal ones. As these belong to the prevailing culture in the broadest sense of this word, including ethical and religious rules, the search for the answer leads to problems of multiculturalism, concerning the positive and negative effects of different

[18] These three points are elaborated in Pelikan (2003a). The first kinds of policies is there exemplified by the government driven at first successful economic development in Japan which ended in a deep structural crisis, and the second by the market reforms in Central and East European countries that began by making their bad situation even worse, but after a few years proved quite successful.

[19] In the framework of SGD, the search for these effects corresponds to the search of biologists for the effects of genes and genomes on the development and functioning of organisms, and the logic of institutional reforms corresponds to the logic of genomic engineering and genetic therapies. An interesting formal model of the effects of genomes on the development of organisms in the context of genomic engineering is in Doursat (2008).

cultures on the economy and their different openness or resistance to learning and adapting.

The framework of SGD may help here by pointing out that each culture consists of two significantly different parts: an economically relevant part, which influences the performance and development of economies, and an ornamental, economically neutral part, which may be highly valuable according to artistic, emotional, and other non-economic criteria. The former can be exemplified by respect for property rights, sense of fairness, business ethics, tolerance for corruption, truth-telling, and trust; and the latter by traditional songs, dances, costumes, food, and religious rituals.

Intuitively, the difference between the two parts can be compared to the difference between instructing and non-instructing memes, and to the one between instructing and non-instructing parts of genomes (cf. Section *II.3*). A culture may thus be visualized as a large and heterogeneous set of memes, which all replicate from mind to mind across a given economy, but of which only some are the informal institutional rules that instruct individual economic behaviors, and thus influence the economy's performance and development. The other memes appears suitable to call "ornamental."

A difficulty is that the borderline between the two parts is not always entirely clear, and may even have to be shifted in the light of new discoveries. In particular, some memes that may at first appear purely ornamental may turn out to have significant effect on economic outcomes, and thus be in fact part of informal institutional rules. For instance, some food diets may turn out to have important economic effects because of their consequences for health and longevity, and different religious rituals may differently help or disrupt production. Where precisely to draw the borderline is therefore to some extent an open question that requires more research.[20]

But independently of the precise position of this borderline, just recognizing its existence may save the debates on multiculturalism from confusion and settle many disagreements between its advocates and opponents. When it is taken into account, a wide support appears easy to obtain, both for extensive multiculturalism concerning ornamental memes, and for its severe limitations concerning informal institutional rules.

All this has an important implication for immigration policies. It modifies the usual assessment of the value for a rich country of immigration from a poor country. In addition to

[20] Continuing the intuitive comparison with the instructing and non-instructing parts of genomes, it may be interesting to note that the borderline between them is also partly unclear and the view of it has been moving. The first conjectures about it, when instructing was believed limited to genes, had to be corrected, as several non-genic DNA segments, first believed to be "junk" or "nonsense," were subsequently discovered to instruct important regulation of gene expression, and such discoveries are now expected to continue.

the usually considered positive value of the imported labor, it calls attention to the possibly negative value of the accompanying import of influences on the rich country's institutional rules. SGD joins here those institutional economists who try to enlighten the inhabitants of rich countries – of whom many still appear to be unaware of it – that it is mainly thanks to their possibly only accidentally formed institutional rules that these countries have grown rich in the first place (see, e.g., North and Thomas 1973, Rosenberg and Birdzell 1986, North 2005). The difficult policy question than is, by what civilized means to protect these rules, if some immigrants from a poor country turn out to carry with them some of the informal institutional rules that are among the major causes of that country's poverty – such as low respect for private property, rules of honor that foster wasteful conflicts rather than efficient competition, soft constraints on corruption and unethical business practices, and hard constraints on education opportunities for women, which both waste their talents and lower the quality of education of their children.

Concluding comment

All the above examples of are taken from problems that I have been seeking to understand myself, and with which the framework of SGD has actually helped me. I just hope that this framework may also help other economists with other problems – which is my justification for presenting it in this paper. As pointed out in the introduction, however, it cannot help all economists, but only some of those who are curious enough to look for inspiration also outside their own fields, and not with all of their problems, but only with those in which socioeconomic change plays a non-negligible role (although I cannot see many economic problems for which this would not be the case).

But even for the right economists with the right problems the possible help of this framework is limited. It may only very generally advise on how to approach such problems and prepare them for well-ordered analysis, but without saying much about the analysis itself. Admittedly, such highly general advising is only little, but, as some of the greatest difficulties with problems of socioeconomic change are with approaching them and getting an effective handle on them, it may nevertheless be far from useless.

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