

## Social systems evolving—reviewing Leydesdorff’s the knowledge-based economy

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Is the biological metaphor the proper one for evolutionary economics to pursue, given that it leads one to incorporate more from biology as an academic discipline than would be called for? Is the economy, the subject of analysis for economists, not fundamentally different from a biological or a natural system? These are the topics of ongoing discussion within the field of Evolutionary Economics that I will address only indirectly here, reviewing Loet Leydesdorff’s (2006a) recent book. They do linger in the background, however, needless to say.

Leydesdorff’s book offers significant theoretical insights and counter-points to the strand in evolutionary economics that aims to stay close to Darwin’s thinking (Hodgson and Knudsen 2006; special issues of the Witt 2006, and the Klaes 2004). Rather than addressing this body of literature head on, dismantling it first before presenting his own views, Leydesdorff develops an alternative perspective of how social systems evolve, largely without extensive reference to this literature. And as well he might, as there is a long history of thought in the social sciences that he draws on besides the field of evolutionary economics.

In many respects, this book is the culmination of thinking in systems’ theory, science studies, scientometrics and related fields. It is unfortunate that these lines of research have not reached evolutionary economics. In addition to a

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profound theoretical discussion in seven of the 11 chapters, empirical work in the field of evolutionary economics is presented. The three chapters that discuss empirical work offer a new direction for analysis. Empirical research in the field of evolutionary economics has been restricted to some degree to simulations, case studies, or to work that is not tightly connected to an evolutionary model.

The book is the culmination of several years of very intensive and groundbreaking work that is deserving of being noticed outside of the fields of science studies and scientometrics, where it has received a lot of attention. As with any incursion of relatively new ideas into a field, there are bound to be misunderstandings. Leydesdorff's own idiosyncratic vocabulary will not improve that much. Still, perseverance, both on the part of the reader digging into this kind of work, as well as on the part of Leydesdorff seeking to add meaning to his work for relative outsiders (cf. also Leydesdorff 2006b), will bear fruit. This book review, then, is partly meant to bridge the two life worlds of evolutionary economics, on the one hand, and systems theory and science studies, on the other.

## 1 Are social systems different?

For Loet Leydesdorff, the Knowledge-based Economy is not equated to that part of the economy involved with ICT or technology. It is not about innovation and technical development per se, or the role of knowledge workers. Rather, Leydesdorff makes a more general theoretical point. He looks at the economy as a complex system that may endogenously evolve coordination systems in addition to the market mechanism whereby action, expectations, and meanings are aligned with each other. Rather akin to the polyphonic kind of singing, most notably from the Italian island of Sardinia, whereby a group of singers cooperate such that a new voice seems to appear, Leydesdorff argues that when three or more subsystems interact, an 'overlay' can emerge that autonomously but not purposefully coordinates the subsystems, much like an invisible hand.

While at the level of systems one may not speak of actors purposefully pursuing a goal, anticipation of future states of affairs emerging in the systems do help constitute stable meanings, communication and outcomes, retaining some elements and not others. In this respect, too, the selection mechanism is endogenized. This meets a fundamental critique leveled at evolutionary economics also by Andersen (1994), not addressed till now: variation and selection are not completely separate, and the selection environment is not undifferentiated. This is not to deny the physical or biological nature of agents (individuals) in a system, but does suggest that they are not limited by these dimensions of their existence. Social systems and biological systems are different because, in the former, meanings are created as effects of and preconditions for communicative behavior (p. 180). This line of argument

does raise some serious questions about issues that are rather central to evolutionary theory. For instance, the idea that (anticipations of) future states of the world can affect the present seems to be incompatible with the 'arrow of time' and so touches on the conception of causality—not an uncommon position in the current state of affairs in physics (van Fraassen 1985).

The existence and workings of such a knowledge-based economy needs to be explained and cannot be alluded to, as especially many policy makers are wont to do, to figure as explanans. For reasons of theoretical and empirical tractability, Leydesdorff discusses how three subdynamics interact and mutually shape one another. Especially where subdynamics interface, disturbances (innovations) may be expected—a theoretical generalization of the critique of the linear model of innovation that does not and has never worked (Dolfsma 2008). The potentially different selection mechanisms in the different systems (profit seeking in the economy, technological excellence in technology, political clout in the political or geographical spheres) may interact to produce a non-linear dynamics. In simulation, the circumstances under which such a dynamics may stabilize locally or even globally are investigated. Thus, for instance, the question whether or not a country or a region is a stable innovation system may be investigated.

## 2 Lock-in and break-out

A locked-in, stable configuration may also break-out from its development along a path. While the well-known model developed by Paul David of path development and lock-in explains how lock-in may occur, no satisfactory explanation of a break-out from a lock-in has yet been supplied. Leydesdorff argues that break-out will only be likely when a third system upsets the stable relation between two systems, keeping each other in a mutual deadlock. Allowing commercial, private use of communication technology by the US government has created circumstances for the Internet to develop and for IT and CT to be brought together to expand at increased speed (cf. Van den Ende and Dolfsma 2005).

Complex systems such as the economic system need to be conceptualized in terms of the interaction of a number of different sub-dynamics that may, given certain conditions, allow for a stable configuration to emerge. Systems may self-organize, as sub-systems interact at a specific moment in time, as well as over time (recursion). In addition to market coordination and alignment in the political arena, the 'systemic organization of knowledge and control' (p. 15) offers a third coordination mechanism. Three, or possibly more, sub-systems interacting can thus create institutionalized, stable structures. Subsystems cannot be observed directly, however, as that would entail that one does not realize that the institutions in existence are but one instantiation of a range of possible other instantiations that have not materialized. Systems and

their functions need to be theorized, or, in Leydesdorff's terms, hypothesized (p. 179). The position Leydesdorff (2006a, p. 103) takes might seem extreme to some:

Empirical observable phenomena inform us about cases that have occurred historically, but not about what could have occurred. The historical observables themselves cannot provide sufficient control for the quality of theorizing about meaning.

Starting from given historically emerged institutional structures would, however, entail ignoring the probabilistic nature of a system. This takes the historical development of a particular institutional furniture as the only possible development. Historians refer to this as Whig-history. By contrast, modelling, simulation and analysis of vast databases is what needs to be undertaken. In line with early suggestions of Giovanni Dosi (1991, p. 6), Leydesdorff thus takes seriously the proposition that "The world is 'full of opportunities' of which only a very small share is exploited at any one time". Hence, what is selected from is a broader set of alternatives than what actually materializes or has ever actually materialized.

If taken seriously, this position, analytically, means that one needs to adapt one's empirical analysis. The *expected* information, as in a distribution, of messages that emanate from the interaction between subsystems must be accounted for. Instead of taking any setting as given, one must try to grasp the total possible set of structures. This may be traced in terms of non-parametric statistics and mathematics. Leydesdorff in particular proposes the use of (probabilistic) entropy statistics for empirical work (Theil 1972). Probabilistic entropy offers a measure of the extent to which a system is structured such that exchange of information, within and between its subsystems, is likely to occur. In and through the exchange of information, at the level of the system, information is codified and meaning emerges. Knowledge, then, is meaning which makes a difference, a difference in stabilizing the system. Leydesdorff takes his cues here from information science and artificial intelligence, and from Shannon and McGill, in particular. Theil, of course, is an economist who used entropy as a concept, but this was not imitated much.

It is only in relation to a relatively stable system that can meaningfully organize information that such an investigation can be conducted (p. 51). For instance, the analysis in Chapter 8, where the workings of the knowledge-base of the Dutch economy is investigated in terms of the interaction between technology, economy, and geography, can only be undertaken if the system is sufficiently stable to supply information about economic units. Thus, the totality of firms registered at the Chambers of Commerce, some 1,131,688 units, allows Leydesdorff to see along which dimensions the potential for structured exchange of information is most conducive to the workings of the invisible hand in the knowledge economy.

As the interactions between subsystems are increasingly able to anticipate correctly possible future developments, the system is self-organized (p. 61), yet remains prone to failure (p. 64).

### 3 Selection

This book, then, asks some awkward questions about the current state in evolutionary economics, but is mostly an invitation for a broadly based new impetus for empirical research. Rather than a close and theoretical investigation of variation and retention, in particular the third mechanism of selection may need more investigation.

There may be more selection mechanisms for firms than bankruptcy as the quintessential selection mechanism for evolutionary economists. Not being able to tap into (sufficient; venture) capital, because such resources are not available in the geographical vicinity, means that a firm is unable to grow, or may not reach a minimum efficient scale, and so a possible future development is selected out. The diversity of bankruptcy law (Efrat 2001), the different outcomes for the firm filing for bankruptcy and the possibility of sequential entrepreneurship, provide evidence for the less-than-obviously objective selection mechanism implied. This casts some doubt on the causal claims that can be linked to this (cf. Hodgson 2006). Anticipation of the likely effects of bankruptcy will have an effect on entrepreneurial behavior now, even before the man-made law is applied. Governments, in re-drafting the law, as the US government has in 2005, will anticipate what effects it will have on bankruptcy filings. In doing so, the motives agents have will feature, too—motives ranging between self-interested utility maximization to the wish to avoid the shame of going bankrupt (Dolfsma and McMaster 2007).

Curiously, then, by ignoring agency through a focus on the level of systems and the structures that allow for communication and knowledge exchange, Leydesdorff allows for agency to play a role. In the perspective developed, the crucial role that introduces agency, through the backdoor, almost, is that of anticipation. For systems and agents in a system to be able to anticipate a future, they must have a model of their system and its interactions with the environment (p. 81). This provides meaning for the systems—thus making social systems distinct from biological systems, and making a system reflective. Indeed, a social system cannot be defined without specifying its boundaries and its environment (p. 150). Anticipations can then also select or play a role in selection processes (p. 128). Bankruptcy may thus be prevented, depending on the reasons behind it. If incompetent or culpable behavior by management was involved but if the fundamentals of the firm or the industry look promising, Venture Capitalists or the State can, for example, step in to avert it from going out of business.

### 4 So what?

Does all of this matter? Will it allow for insights that would not be otherwise obtainable? I believe it does. Theoretically, the analysis of interactions between three or more dimensions (systems) allows one to address the possible non-linear dynamics of a knowledge economy head-on. Significantly, from the

perspective of evolutionary economics, it provides insights into the question when paradigmatic development is likely to occur, both technologically and economically.

What may be more persuasive to some are the empirical findings presented. Interaction structures between the dimensions of University, Industry and Government, for instance, are investigated in Chapter 8, using different data sources. Using citation patterns in journal articles in the sciences, it is found that Japan is much more networked than other countries. University–Government relations are much more established than University–Industry relations in Europe. Might this be implicated in the failure of the EU to meet the Lisbon goals? Cooperation across national boundaries is least developed in France and Russia.

Using data for all firms in a country, hypothesizing that the interactions between Geography, Technology and Organization dimensions are of importance, Chapters 9 and 10 offer a way to operationalize the Innovation Systems of the Netherlands and Germany. The literature on regional and national innovation systems has been in need of an impetus (Balzat and Hanusch 2004), and Leydesdorff might provide just this. So, at the national level, the Netherlands can be considered an innovation system, but this is not true for Germany. Also, interestingly, it is specifically medium-tech manufacturing industries, rather than high-tech ones, that contribute to the knowledge economy.

These findings, based on a theoretical perspective that is foreign to some extent for many economists, can be made understandable to them and to policy makers, too, are startling and significant.

## 5 Some final and some critical notes

Before reading, one needs to be aware this is by no means an ordinary book. It is likely to have two kinds of readers. A first group of readers is relatively large and tries to read bits and pieces but will soon be scared away by the idiosyncratic use of terms (from the perspective of an economist), and by the sometimes unexpected accreditation of thoughts to particular scholars. The possibility that Leydesdorff is in the midst of developing a system of thought that is profound is what the other group of readers will have in mind when they continue to study it. The latter group will be struck by the lack of attention to the specificities of the separate subsystems: are they really that neatly separable? If theoretically relevant, is the economic system best characterized in neoclassical economic terms? Can systems be conceived of as having subsystems?—Probably yes, but does this lead to an infinite regress: is it turtles all the way down? The latter type of readers are, however, likely to bear with the author, I believe, since this book is likely to give social scientists keenly interested in the issue of what makes social systems evolve the most stimulating read they have had in years. Even if one does not buy into the argument, one cannot avoid this book.

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