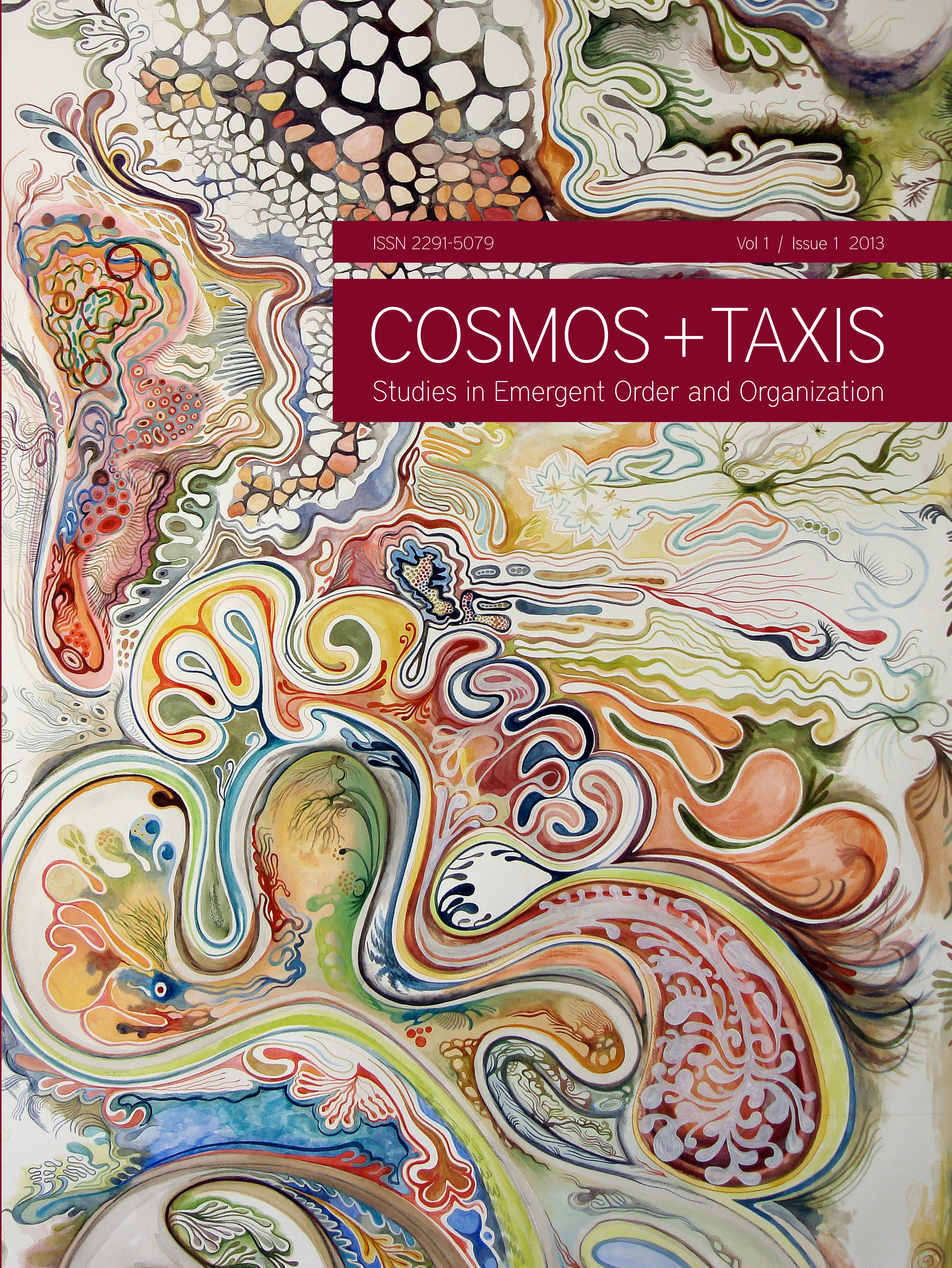

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COSMOS + TAXIS

Studies in Emergent Order and Organization

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COVER ART:
Jill Poyourow
http://www.jillpoyourow.com
Detail, *Chinese Actor*, 2007.
Watercolor, ink, pencil, gouache, acrylic and oil on paper
51.5 x 285 inches (132.1 x 723.9 cm)

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Introduction

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Bio-sketch: David Emanuel Andersson's authored books include *The Economics of Experiences, the Arts and Entertainment* (Edward Elgar, 2006) and *Property Rights, Consumption and the Market Process* (Edward Elgar, 2008). David is the Editor-in-Chief of COSMOS + TAXIS and the editor or co-editor of five books: *Gateways to the Global Economy* (Edward Elgar, 2000); *Asia-Pacific Transitions* (Palgrave Macmillan, 2001); *Handbook of Creative Cities* (Edward Elgar, 2011); *The Spatial Market Process* (Emerald, 2012), and *Private Urban Planning: Opportunities and Limits* (Edward Elgar, forthcoming). His more than 30 scholarly articles have appeared in journals such as *Regional Science and Urban Economics*, *Technological Forecasting and Social Change*, and *Urban Studies* and as contributions to edited books. David's research program can be summarized as an institutional approach to urban development processes.

Abstract: The Editor-in-Chief introduces the inaugural issue of COSMOS + TAXIS.
Keywords: Cosmos; emergent order; Hayek; spontaneous order; taxis

COSMOS + TAXIS takes its inspiration from Friedrich Hayek's (1979) distinction between spontaneous and planned orders. A spontaneous order, as Gus diZerega explains in the opening article, evolves in an orderly but unplanned fashion because of the presence of shared rules, simplified feedback, and status equality among the order's participants. Though the most studied instantiation is the market order, this journal is concerned with the broad manifold of spontaneous orders. Michael Polanyi (1962) used the term "spontaneous order" to explicate the evolution of science, while diZerega (1989) extended its application to democracy as distinguished from the traditional authoritarian nation state, the largest-scale example of a *taxis*.

A *taxis* has three distinguishing features: it is brought into existence through the conscious planning of one or several people; it has—at least at the outset—a clear hierarchy of goals; and it is seen as the tool for realizing such goals. In other words, it is an organization. Authoritarian states, governments (even in democracies), profit-seeking firms, and universities are all *taxes* in this sense.

It is our belief that Hayek's and Polanyi's contributions constitute the foundation for a new research program in the social sciences. Spontaneous-order theory has the potential for clearing up a great deal of confusion about the workings of markets, democracies, and the global scientific community. It is thus of obvious relevance to economics, political science and the philosophy and sociology of science. But spontaneous orders are only a subset of a wider class of *emergent orders*. As diZerega explains, emergent orders are unplanned and exhibit orderly development trajectories, but only some of them are spontaneous orders in the sense of providing easily interpreted feedback to order participants. Examples of emergent orders that are not spontaneous in the sense of Hayek or Polanyi are civil society, the ecosystem, and human cultures. Thus emergent orders in this more general sense are relevant not only to the three aforementioned disciplines, but also to sociology and biology. It is our intent that COSMOS + TAXIS will become an arena for multidisciplinary conversations that engage scholars across all five disciplines.

diZerega's article sets the stage for such conversations by introducing a vocabulary and taxonomy that should facilitate communication among scholars in different disciplines. In this introduction, I have chosen to adhere to diZerega's choice of terminology to pave the way for a shared language within our scholarly community. A series of workshops that preceded the launch of this journal made one problem rather obvious: scholars in different disciplines do not interact much with one another because they use different terms or languages to theorize about the same or similar phenomena.

Most spontaneous-order and indeed emergent-order contributions in the social sciences have focused on markets. Insights, using a different terminology, preceded Hayek's use of the terms *cosmos* and *taxis* by several centuries. Perhaps the most important of these came from Scottish Enlightenment thinkers such as Adam Ferguson, David Hume, and Adam Smith. To take but one example, Smith's metaphor of the "invisible hand" falls squarely into this intellectual tradition. It is therefore somewhat disappointing that economists have only intermittently shown an interest in our theoretical framework, even in the schools of thought that would seem most hospitable to a spontaneous-order approach to understanding markets.

Hayek is not only known as a spontaneous-order theorist. He is also—and probably more widely—known as one of the most influential members of the Austrian school of economics. But Austrian economists have only rarely explored questions of how individual actions cause emergent structures on a more aggregate level of the economy. One reason for this is an epistemological split within the Austrian school itself: Hayek's teacher Ludwig von Mises (1949) insisted on a deductive logic of choice grounded in methodological individualism. It is surely worth noting that Hayek only reluctantly abandoned the theoretical strictures of his teachers in Vienna (this also helps explain Hayek's transition from technical economics to a more interdisciplinary type of social science from the 1950s onwards).

The other obvious candidate for a spontaneous-order understanding of economics is evolutionary economics, which often uses analogies from biology and focuses on how markets interact with human learning processes. Evolutionary economics is, in many ways, closer to the perspective advocated here, but tends to miss the key distinctions between the emergent order of an ecosystem and the *spontaneous* order of a market. The simplifying and knowledge-disseminating function of market prices and the effects of the rule *of* law (as opposed to rule *by* law) are not explicitly addressed in the evolutionary classics, from Schumpeter (1934) to Nelson and Winter (1985).

Neither Austrian nor evolutionary economics has constituted the mainstream of twentieth-century economics, however. And the lack of awareness among "neoclassical" mainstream economists of spontaneous-order processes dwarfs the challenges that Austrian or evolutionary economists face. Mainstream economics has borrowed heavily from physics in its pursuit of mathematical sophistication, at the considerable expense of having to disregard some of the main causes as well as effects of markets. A partial list of mainstream neglect includes dispersed knowledge, cognitive limitations, learning, imitation, and even how *intentional* and *self-conscious* human interactions must differ from the interactions of atoms or gases. Thus students of mainstream textbooks in economics are liable to get the impression that the key components of conceiving the market as a spontaneous order – entrepreneurial actions, (static) institutional constraints, and (dynamic) institutional evolution—are peripheral to the discipline.

diZerega is a political scientist, but the three other contributors to this issue represent each of the three schools of economics mentioned above. Johanna Palmberg is an Austrian economist with a particular interest in entrepreneurship and the role of cities in facilitating economic development. Jason Potts is known as a key figure in evolutionary microeconomics. Eric Scheffel takes mainstream (Walrasian) economics as his starting point, asking himself how modelling must change in order to incorporate Hayekian insights.

The subtext of this issue could therefore be "a political scientist meets three different types of economist to discuss Hayekian *cosmoi*." Inevitably, the discussion is therefore more concerned with markets than with other spontaneous or emergent orders. This should not be taken as a portent of things to come. Future issues of COSMOS + TAXIS will focus on other disciplines and phenomena, including not only democracy and science but also language, ecology, and the worldwide web. It is my sincere hope that this journal may play a role, however minor, in creating a new paradigm that spans several—if not all—of the social sciences.

References

diZerega, G. (1989). Democracy as a Spontaneous Order. *Critical Review*, 3(2): 206-40.

Hayek, F.A. (1979). *Law, Legislation and Liberty*. Chicago: University of Chicago Press.

Mises, L. von (1949). *Human Action: A Treatise on Economics*. New Haven: Yale University Press.

Nelson, R.R., and Winter, S.G. (1985). *An Evolutionary Theory of Economic Change*. Cambridge, MA: Harvard University Press.

Polanyi, M. (1962). The Republic of Science: Its Political and Economic Theory. *Minerva*, 1: 54-74.

Schumpeter, J.A. (1934). *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.

Outlining a New Paradigm

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Abstract: Emergence is attracting growing interest in the sciences. This paper argues understanding emergence in social science requires different approaches than in the physical sciences. The argument makes use of contributions by Elizabeth Fox Keller, Thomas Kuhn, Jane Jacobs, Michael Polanyi, and F. A. Hayek. As a subset of emergent phenomena, spontaneous orders have complex relations with one another and with emergent processes in civil society and nature. This includes areas of conflict as well as the symbiosis usually discussed. Conflicts include commodification, alienation, inequalities of power, tensions with organizations within them and ecological and social degradation. This new paradigm promises to enrich the social sciences and their interrelation with the biological sciences.

Keywords: Alienation; commodification; cosmos; emergence; emergent order; Evelyn Fox Keller; Hayek; Jane Jacobs; John Kingdon; Jürgen Habermas; Michael Polanyi; Richard Cornuelle; R. J. Rummel; spontaneous order; taxis; Thomas Kuhn.

I: THE NATURE OF EMERGENCE

For some decades emergent orders have attracted growing interest across many disciplines, from physics to the social sciences. Emergent systems are nonlinear, meaning they do not arise through chains of causation. They are instead networks shaped by the back and forth influences of mutual causation. Each node in such a network influences and is influenced by other nodes through positive and negative feedback signals that, taken together, generate the order as a whole. The order is a kind of pattern in relationships rather than an arrangement of objects, which themselves might be individually mobile and transient. Objects come and go; the pattern remains.

Emergent perspectives constitute a third approach to existing scientific research strategies, which traditionally focused on what mathematician Warren Weaver (1948) described as either "simple" phenomena or those characterized by "disorganized complexity." Simple phenomena, Weaver wrote, possess two variables: changes in one are the result entirely or almost entirely of changes in the other. While other factors might also contribute, Weaver (1961, 57) states that "the behavior of the first quantity can be described with a useful degree of accuracy by taking into account only its dependence upon the second quantity, and by neglecting the minor influences of other factors." Centuries of research in the physical sciences focused on problems of this sort, leading to much of our modern technology.

Around the end of the nineteenth century this traditional approach was enriched by tools developed for analyzing disorganized complexity, phenomena with unmanageable numbers of variables interacting randomly with one another. In these cases statistical techniques could discover otherwise invisible enduring patterns. Probability theory and statistical mechanics opened up these phenomena to scientific exploration, and have generated many practical applications as well.

Successful as these approaches had proven, they did not address what Weaver termed problems of "*organized complexity*" a "middle region" of phenomena possessing too many variables to be studied by the reductive methods so successful with simple phenomena but critically different from disorganized complexity that could be analyzed statistically. In organized complexity, predictable patterns arose from relationships among many variables that possessed their own organization and mutually influenced one another. As examples Weaver referred to how an organism's genetic constitution expresses itself as an adult or how the price of wheat is determined in the market.

As commonly encountered, emergent order usually applies to two of the phenomena Weaver (ibid.) describes. In certain kinds of open physical systems involving enormous numbers of simple elements existing far from equilibrium, advances in nonlinear mathematics showed how emergent patterns can still arise. Some researchers such as Albert-Laszlo Barabasi (2007) suggest all emergent phenomena can be understood this way. Approaches such as Barabasi's have identified important phenomena within organized complex systems. For example, power laws suggest that extremes of inequality emerge from the process of network formation rather than qualities unique to the patterns' elements. Formal equality can breed enormous inequality due to systemic features (Barabasi, 2003). In addition, adaptive systems apparently require most nodes within a network to have only a very few links with other nodes—as Stuart Kauffman put it, "somewhere in the single digits"—no matter how large the network (Kelly, 1994). These are important findings, but the strong sense of this claim remains a promissory note with strong arguments against it.

An alternative perspective is taken by Evelyn Fox Keller (2009a, 26), who argues systems accessible to analysis by statistical nonlinear thermodynamics are open to energetic input but not "generally open to material or informational input or output." She elaborates:

> Stripes, rolls, whirls, eddies are all phenomena indicative of complex nonlinear dynamics; they . . . share with organisms the property of being open, far from equilibrium, dissipative. But they still lack the properties that make organisms so insistently different from physical systems . . . function, agency, and purpose (Evelyn Fox Keller, 2009a, 27; cf. Kauffman, 2008, 72-8)

Emergence within the biological world and in society are examples of Weaver's "organized complexity" because they reflexively interact with one another, unlike colliding billiard balls. But unlike non-living complex systems, change is internal to living systems as well as generated by their openness to outside disturbances. As Keller put it[1]:

> We have learned that a science of self-organized complexity will have to take into account processes of self-assembly and self-organization in multilevel systems, operating on multiple spatial and temporal scales through multilevel feedback in which the internal structure and properties of the component elements are themselves responsive to the dynamics of the system (Keller, 2009a, 30).

Unlike non-living chemical phenomena such as Ilya Prigogine studied, in living cells systemic feedback serves to maintain the cellular system of which it is a part, creating a homeostatic order that does not approach equilibrium as long as life exists (Prigogine and Stengers, 1984). Prigogine's studies of nonliving dissipative structures required outside energy to continually be supplied.

In living systems Keller argues emergence takes two forms. Natural selection is the best known, but the *origin* of life cannot itself arise that way. Natural selection requires the existence of a stable cell subject to mutation. The cell must *already* exist. Keller (2009b, 9) calls the process that originates such a cell "internal selection" which "follows automatically from their contribution to the persistence of the system of which they are a part. … their existence is what lends the cell the stability for natural selection to operate." Natural selection arises out of this process as its effect, not its cause. Biological emergence can occur either through internal selection *or* from Darwinian natural selection.

Keller (2009b, 19) explains that in living organisms agency, function, and purpose, "seem clearly to require an order of complexity that goes beyond that which spontaneously emerges from complex interactions among simple elements." The study of organized complexity is the study of emergence in living systems, and apparently only in living systems.

Keller (2009b, 20-1) prefers the term "robustness" to "stability" when referring to living systems because they are always in motion. They are robust "with respect to the kinds of perturbations that are likely to be encountered."

Systems of organized complexity are adaptive. Elements internal to these systems react to changes in their environment, "interpreting" this information based on their local situation, and so reacting to feedback in positive or negative ways. This process appears to go all the way down to any form of life, as single cells have demonstrated an ability to remember and even anticipate repeated events (Saigusa *et al.*, 2008).

Another useful descriptive term is "Complex adaptive systems." They are adaptive because they maintain their pattern of organized relationships by adjusting internally to environmental changes that would otherwise disrupt them. Organisms, communities of organisms, ecosystems, evolution, and social systems are examples of such systems.

In contrast to purely statistical approaches appropriate to complex nonliving systems, Keller (2009a, 30) emphasizes that "[r]ather than trying to transcend the particularities of the system through statistical averaging and placing one's confidence in the significant emerging patterns of maximum likelihood, we may find the secrets of biological organization residing precisely in the details that have been washed away." Significantly in terms of my argument to come, Keller cites a study by David Noble of the internet that shows "the best-performing topologies are precisely those with low likelihood" (Barabasi, 2003, 70-1).

From her perspective the most central research questions become, "first, how do new ways of persisting, new stable modes of organization – come about, and second, how are they integrated into existing forms?" (Keller, 2009a, 20-1). The relevance of Keller's framework for understanding emergent processes within society should be clear. Many emergent social processes are characterized by internal rather than natural selection. How then do social emergent systems come about and how are they integrated into other such orders in society and its environment?

COSMOS + TAXIS focuses on these kinds of questions. Other emergent orders, such as ecosystems, are important to us primarily for the light they can shed on social orders. If Keller's distinction holds, nonliving complex systems will be still less useful.

Connecting threads

In contrast to those arguing for a clear distinction between the social and natural sciences, this emergent paradigm encompasses social orders within a framework that includes biology. It arises from many converging threads of research, particularly over the past several decades (Keller, 2008). What follows are brief cameos of five scholars I regard as particularly important in helping constitute this paradigm, and in explaining why it is important in the social sciences: Evelyn Fox Keller, Thomas Kuhn, Jane Jacobs, F. A. Hayek, and Michael Polanyi.

Evelyn Fox Keller

Evelyn Fox Keller is more than an insightful observer of the increasing interest in self-organization and emergent order across disciplines. She has also made important contributions to this field in biology.

Ilya Prigogine's research on self-organization in far-from-equilibrium dissipative chemical structures inspired Keller, a physicist, to investigate how biological structure could emerge out of an undifferentiated beginning. As she put it, "[a]ll cells of a complex organism derive from the same initial cell and presumably, therefore, have the same genetic material" (Keller, 1985, 150). How, then, could the enormous differentiation of functions and structures arise that exists within so many organisms? Keller (ibid.) explains that it was mathematics rather than the biology of the time that gave her the needed insight. She had come across Alan Turing's then little known 1952 paper on morphogenesis, the generation of form. Turing showed mathematically how diffusing and interacting chemicals could generate form, in other words, how self-organization and structure could arise from out of an undifferentiated beginning. Applied mathematician Lee Segel then convinced her that slime molds were a good organism with which to research this question.

Slime molds challenge our sense of what it is to be an organism. Part of the time they exist as single-celled amoeba-like individuals crawling across a forest floor. At other times, when food becomes scarce, these individuals coalesce, forming a larger multi-celled organism able to detect food sources. If the organism is broken up into individual amoebae, they come together again to form a new one. Ultimately it crawls to a higher point, stops, raises a spoor stalk, and reproduces through emitting spores that again become single-celled amoebas. As amoebae they are the single-celled organisms mentioned above that are able to anticipate future events and remember past ones. Slime molds are independent individual cells and part of a larger differentiated organism (Bonner, 1980; Keller, 1985). How do they do this?

Until Keller's research scientists assumed slime molds formed under the influence of a "pacemaker cell" that served as a kind of leader. It differed somehow from the others and triggered their collective coming together. But such cells had never been identified.

Inspired by Turing's insight, Keller guessed slime mold cells might all be equal, and when conditions were right, simple rules followed by all cells triggered the larger aggregations. No pacemaker cell was necessary. In 1969 Keller and Segel published their research showing this was the case (Keller and Segel, 1969). Simple rules followed by independent individuals could generate complex adaptive patterns far beyond their ken. The resulting organism could adapt independently to its environment.

We know today that they are hardly unique. The role of simple chemical signals in enabling social insects such as ants and termites to develop extraordinarily complex societies is now well established (Wilson, 2012). Keller's basic insights also easily translate into more complex versions of social phenomena in the human world.

Thomas Kuhn

Thomas Kuhn is not usually included in discussions of emergence, yet I think he is important in understanding how it occurs within social phenomena. In return, the concept of emergence solves a vexing difficulty many have had with Kuhn's argument.

Kuhn's (1962) *The Structure of Scientific Revolutions* challenged the popular idea that science proceeds largely through the gradual accumulation of facts, each a brick in the edifice of knowledge. Instead, major scientific advances result in new "paradigms" that are not part of the same intellectual world as the established paradigms they replace. The traditional model of science as gradually approaching Truth was mistaken.

Kuhn's argument took some time to shake up people's understanding of science, but by the 1970s it had inspired a multitude of books, collections of essays, and conferences (see Lakatos and Musgrave, 1970). Today over 1.4 million volumes of Kuhn's book have been printed, a remarkable achievement for a scholarly study of science.

Central to Kuhn's approach was his distinction between "normal" and "revolutionary" science. Under normal circumstances scientists work within an established "paradigm," but as it is applied to exploring new questions, over time unexpected problems eventually emerge. Sometimes these nonconforming findings are later resolved, and sometimes they persist as puzzling anomalies. At some point anomalies inconsistent with the reigning paradigm turn out to be clues leading some to develop an intellectual "revolution," resulting in a new paradigm. New questions open up that would have meant little or nothing under the older paradigm, and older questions are sometimes abandoned as useless or irrelevant.[2]

In a much challenged term, Kuhn (1962) argues that—strictly speaking—paradigms are "incommensurable." Consequently, science demonstrates no clear direction towards Truth. Kuhn directly challenges almost all scientists' image of scientific knowledge as a collective human effort gradually discovering Truth. As David Weinberger (2012) puts it, "if science exists within paradigms and if those paradigms can't understand one another, and if there is no Archimedean point from which to view them, then how can we tell if we're making progress?" There is obviously order and progress in science, but what kind? Kuhn himself had a difficult time explaining just what kind it was.

Incommensurability and Truth: a problem solved

At first take Kuhn's argument appears too strong. Scientific knowledge is obviously cumulative in the sense that things able to be done from within a Newtonian framework remain able to be done from within a relativistic or quantum perspective, while the latter paradigms enable things to be done regarded as impossible from a Newtonian perspective. Isn't being able to reliably do new things evidence we are expanding our knowledge of truth?

Further, individual scientists are often passionately motivated by their search for truth, and this passion is necessary for good science to be done (Polanyi, 1974). How do we harmonize individual scientists' pursuit of truth within a larger context where, if Kuhn is right, we have no solid reason to argue truth is being cumulatively approached?

If science does progress towards truth, once this direction is discovered, further advance could at least in principle be planned, and so made subject to organizational criteria of efficiency. It would be a march towards a goal which, if not itself yet known, can be understood as at the end of a clear path. But if science is not of this nature, what is it?

I think the confusion arises from the assumption that scientific method, to use a shorthand term, developed to discover Truth. It did not. It developed to discover a certain kind of knowledge which scientists hoped would lead them to truth.

Physicist John Ziman (1978) calls the knowledge scientific methods seek "reliable knowledge." Scientists privilege measurement, prediction, experiment, and to a lesser degree reason as tests potential scientific propositions must pass. These methods evolved as early scientists sought standards others would accept as valid for evaluating their work, while avoiding treading in realms where theologians sought to monopolize authority (Toulmin, 1992). The relative importance of these evaluative criteria changes between scientific disciplines and within a discipline over time. Compared to chemistry experiment is unimportant in astronomy. Prediction only recently became important in the study of evolution, as when the existence and geological location of the early fish/amphibian Tiktaalik was predicted before it was discovered. "Scientific method" is flexible in its details and biased towards finding what is universally reliable.

Ludwig Wittgenstein (1974, 370) states: "Tell me *how* you seek and I will tell you *what* you are seeking." The "how" by which science seeks knowledge carries within it a model of the reality it assumes to be true. Such a reality is impersonal, material, and governed by physical "laws." The methods of science were devised to discover how knowledge of that kind could be revealed. As biologist Richard Lewontin approvingly observes:

> It is not that the methods and institutions of science somehow compel us to accept a material explanation of the phenomenal world, but, on the contrary, that we are forced by our a priori adherence to material causes to create an apparatus of investigation and a set of concepts that produce material explanations, no matter how counter-intuitive, no matter how mystifying to the uninitiated (Lewontin, 1997).

If knowledge claims cannot be tested by experiment, measurement, prediction and perhaps reason, science has nothing to say about them. For example, we are certain we are conscious and have inner subjective awareness. But consciousness has long been a problem for science because we cannot measure, predict, or experiment directly upon awareness in an inter-subjective way. Even in neuroscience we can at best find physical correlations. If awareness is basic to reality, science is ill-equipped to study it.

As a system science discovers reliable knowledge. When physics shifted from Newtonian to Quantum mechanics physics became more reliable, but that did not mean we necessarily got closer to Truth.

As individuals the best scientists seek truth. In doing so they rely on methods devised to provide reliable knowledge so that they can demonstrate their findings to others. These tools of inquiry may or may not ultimately give us truth, but they do enable scientists to acquire an ever greater fund of *reliable* knowledge.

Translating this to the present context, it implies that we are confident that our journal will contribute to humanity's fund of reliable knowledge and depend on our contributors' search for truth for this to happen.

Jane Jacobs

At a time when many believed cities could be planned and reorganized through directives chosen by experts, Jane Jacobs' studies of urban structure and the dynamics of cities, particularly within neighborhoods, raised a major challenge (Jacobs, 1961). Jacobs argues that cities are too complex to respond predictably to such planning. Focusing initially on neighborhoods (ibid.), she argues that cities constitute a kind of urban ecology, a spontaneous network of intricate relationships spanning many fields of knowledge and activity. Order emerges by residents independently adapting to one another rather than from following a master vision. Successful growth requires cultivating good initial conditions, and Jacobs argued such conditions were often the opposite of those favored by urban planners. Simultaneously these principles were being successfully applied in the development of Vancouver, BC, although at the time not attracting much attention elsewhere (diZerega and Hardwick, 2011).

Jacobs' analysis is an ecological one, emphasizing how people's networks of informal relationships generate stable patterns of urban life, without these patterns being intended by anyone and without their details being predictable or stable. For example, short blocks turn out to lessen the prevalence of crime, because by increasing valuable commercial locations, they attract more pedestrians and thereby generate more "eyes on the street." They also slow traffic. Commerce, vehicular and foot traffic, and public safety all influence one another. No one can predict what store or even what kind of store will locate where. Those decisions depend on local insight and dispersed knowledge of circumstances among urban residents. But prediction of broader patterns is possible.

Jacobs later pursued her approach farther. In *Cities and the Wealth of Nations* (Jacobs, 1984) she argues cities are spontaneous natural results of growing social complexity, whereas larger political boundaries are arbitrary with little relation to the underlying social ecology. Political power is often parasitic on the wealth and culture created by and within cities. Jacobs juxtaposes an ecological model of societal development to one based on hierarchies of rule, and argues for the greater importance of the former and the frequent unfortunate results arising out of the latter. Ultimately her research led her to consider the broad systemic issues (cf. Jacobs, 1994; 2004) to which we hope COSMOS + TAXIS will contribute.

There seems little similarity between slime molds, the history of science, and the structure of urban neighborhoods. But from an emergent order perspective there is.

In living systems emergent phenomena beyond the cellular must be due at least in part to communicative relations linking individuals. If emergent biological and social phenomena were cases of organized complexity, signals had to be passing between those involved, and those signals had to be able to go in both directions. Slime mold cells communicated chemically. So did the social insects.

Slime mold cells had no intention to form a multi-cellular organism. Ants and termites did not envision their complex colonies. Neither did humans. Despite humankind's dramatic differences from these organisms, producers and consumers in a market need no more knowledge of markets to generate one than termites need knowledge of its colony. Each need only apply simple rules to guide its use of local information to generate something far beyond individual capacities.

It is here that F. A. Hayek and Michael Polanyi enter into our discussion.

Friedrich Hayek

By the late 1920s, F. A. Hayek had become the major theoretical critic of arguments for centrally planning a complex economy. Along with his one-time teacher Ludwig von Mises, his study of market processes led him to see markets as a decentralized coordination and discovery system, where feedback through prices signal the different financial costs of various means for pursuing different economic plans. By providing a common scale among divergent resources, prices serve as signals facilitating efficient resource use, at least in terms of the values reflected in those prices. Each individual uses price information, in combination with their knowledge of local conditions and personal insight, to determine which plans they believe are worth pursuing. Price signals generated by continuing processes of exchange make the market quicker and more adaptive in facilitating and reacting to changes than any centrally planned system. They are also able to handle vastly more information than any type of deliberate planning.

While they always agreed with regard to the weaknesses of central planning, the two economists (i.e. Hayek and von Mises) increasingly diverged methodologically. Mises sought to turn economic theory into a strictly deductive "praxeology" of logical propositions derived from "human action." Hayek was skeptical. People learn, and how people learn is an empirical, not a deductive question (Caldwell, 2004). Perhaps even more fundamentally, Mises' method depends on keeping ends analytically separate from means, but *human* action, which normally integrates these elements of thinking, rarely can be understood this way. Finally, Mises always argued for a strict demarcation between the social and physical sciences whereas Hayek abandoned this distinction.

Hayek was strongly influenced by Warren Weaver's distinction between simple and complex phenomena, and the inapplicability of statistics to carry us far in the study of organized complexity (Caldwell, 2004, 302-06). He realized the theory of evolution was such a science, as was economics. Hayek understood that the social sciences were compatible with work being done in other scientific fields focusing on organized complexity, breaking down the traditional distinction between the social and natural sciences (Caldwell, 2004, 362).

Using our terminology, market orders emerge from the independently chosen activities of all participants. These participants are linked together by feedback through changing prices, with each responding based on their local knowledge and insight, and each response perpetuating the feedback as signals to future participants. Prices signal how money—systemically defined wealth—can be most efficiently used or acquired, although it is up to individuals to determine how money relates to their other values. Hayek called the pattern that emerged a "spontaneous order."

Michael Polanyi

Around the same time the chemist Michael Polanyi (brother of Karl) developed a similar understanding of science. Polanyi argued that science is a community devoted to free inquiry about the physical world, one whose norms subjects its members' theories and arguments to powerful tests while honoring the few whose work challenging dominant views survives this demanding scrutiny.

In science people pursue research of their choosing, while remaining subject to common rules and to the free and un-coerced discipline of the community's judgment as a whole. The many decisions that ultimately generate the community's knowledge are made independently by individual scientists, but science itself is a community creation. While individual scientists master only their own field, and often only small parts of it, their knowledge overlaps that of others. Polanyi (1969, 85) contends that "an indirect consensus forms between scientists so far apart that they cannot understand more than a small part of each other's subjects." The scientific community is self-governing, but it is not a hierarchy. No one is in charge.

Using our terminology, science emerges out from scientists' independently chosen activities, linked together and coordinated by feedback from the scientific community as a whole. Within science, reputation—not money—constitutes a scientist's systemic "wealth." A scientist might not be personally motivated by reputation as a creative entrepreneur might not be motivated by profit maximization, but reputation and money are the respective means by which these systems coordinate information far too complex for anyone to grasp in detail.

Polanyi (1969, 85) describes science as a "spontaneous order." Hayek and Polanyi described different spontaneous orders and identified different communicative systems of positive and negative feedback that develop spontaneously within them. Both science and the market arose out of independently chosen and often contradictory plans made and pursued by those acting within their frameworks of procedural rules. Each also agreed the subject of the other's study was a spontaneous order.

2: SPONTANEOUS ORDER

Not all social emergence constitutes a spontaneous order such as the market or science, even though both Hayek and Polanyi sometimes employed the term to encompass emergent social orders as a whole, and even biological phenomena. But their doing so obscured what was most unique about the market and science. For example, Polanyi writes that

> [a]n aggregate of individual initiatives can lead to the establishment of spontaneous order only if each takes into account in its action what others have done in the same context before. Where large numbers are involved, such mutual adjustment must be indirect: each individual adjusts himself to a state of affairs resulting from the foregoing actions of the rest. This requires that information about the state of affairs in question be available to each member of the aggregate; as in the case of such communal states of affairs as the conditions of various markets. . . (Polanyi, 1998, 195-6).

In a similarly expansive fashion, Hayek (1973, 37) writes that "the special kind of spontaneous order we call organism." This expansive definition of spontaneous order casts the net too widely.

Polanyi's description appears to make a jazz ensemble a spontaneous order. While jazz is emergent, jazz musicians hear the performance and can adapt to it. Market or science participants see only that tiny portion of the whole that interests them, and little of the context. In jazz, musicians are "playing together" as a deliberate act; in markets or science there is no equivalent. In jazz the connection between the emergent performance and the intentions of the musicians is very close; in markets or science this need not be the case. Jazz has a beginning and an end. Neither the market nor science does.

Hayek's example of an organism is genuinely emergent, but organisms develop towards a particular goal, a development that can be described as successful or not. They are teleological in a way that markets and science are not. Participants pursuing incompatible projects constitute a central and inevitable dimension of market and scientific phenomena, with the outcome of their competition unknown. Markets and science are discovery processes. In organisms competition like this would be pathological; the ends towards which they are developing are thus defined in advance. Puppies do not occasionally develop into goldfish.

I will define a spontaneous order more rigorously than did Hayek or Polanyi. Spontaneous orders such as the market and science are a *special kind* of emergent order within society, and they are special in the same way. Emergence arises from mutual adjustment. As David Hardwick has emphasized, the spontaneous orders of science and the market arise from mutual adjustment *among independent equals* using systemically defined feedback signals as guides to their actions.

Hayek and Polanyi identified the basic processes that generate spontaneous orders. They arise from networks of independent equals whose actions generate positive and negative feedback that help guide future actors in pursuing their own independently conceived plans, thereby continuing the feedback process. Each person is a node within a network and is linked by feedback, with each node free to act on its own. The feedback they generate minimizes the knowledge anyone needs about the system as a whole in order to succeed within it.

All spontaneous orders possess certain abstract features in common. Participants are equal in status and all are equally subject to whatever rules must be followed to participate within the order. All are free to apply these rules to any project of their choosing. Anything that can be pursued without violating a rule is permitted, including pursuing mutually contradictory goals. Finally, these rules facilitate cooperation among strangers based on certain broadly shared values that are simpler than the values actually motivating many people when they participate. Compared to human beings, spontaneous orders are "value-thin."

With this foundation we can begin to answer the first of Keller's two main theoretical questions: How do "new stable modes of organization" originate? Here is an initial answer with respect to some.

Origins

Spontaneous orders developed from within societies that were growing increasingly "civil," in the sense that more and more individuals were sharing equal and secure legal status and were free to cooperate with one another along mutually acceptable terms. This development was long and drawn out, even in cultures profoundly influenced by ideas of liberal equality. For example, civil society had long existed among whites in the Antebellum South, but slaves were excluded. Today African Americans enjoy the same legal status as whites within the old Confederacy, and consequently are part of civil society.

As it developed, civil society also became increasingly differentiated. Using the terminology of ecology, with which it shares important systemic similarities, more and more niches developed where new types of organizations and activities could flourish. Systems of specialized rules and feedback developed within some subcultures such as the early scientific community

The feedback that emerged was increasingly impersonal, anonymous, and abstract. For example, in science over time standards of cooperation differentiated from those applying in society as a whole. Specialized rules facilitated scientific agreement even as they became less relevant for other kinds of cooperation. The scientific community became increasingly autonomous from the society within which it arose, and proved able to exist across many different societies, transcending local culture and custom. This process continues. Even now new and unanticipated spontaneous orders can arise, as with the Worldwide Web.

I believe this process describes a fundamental change in the nature of human relationships that, once it took enough hold, has progressively transformed society from one where hierarchy and status were taken for granted to one where hierarchy required justification and status was assumed to be equal. In a very real sense it is a social mutation from what had preceded it.

My description of how distinct spontaneous orders emerge out of a less defined context offers one broad answer to Keller's question of how new complex adaptive social systems emerge. Her next question, how they interact with existing systems, is far more complicated. I believe Polanyi's—and even more Hayek's—studies of spontaneous orders powerfully enrich our capacity to answer this second and most complicated set of questions.

Two disturbing implications

When I first read Polanyi's essay "The Republic of Science" I was a young graduate student and a relatively orthodox classical liberal who admired Hayek's work. I believed market economies reliably responded to consumers' desires and needs, and rewarded with profit those who did so most effectively. We were all consumers, so markets mirrored the values of—and responded to the choices of—free men and women. The details could get intricate, even paradoxical, but the basic principle seemed straightforward.

If, as Polanyi argued, science was also a spontaneous order this comfortable picture got more complicated. Both markets and science responded to free and un-coerced actions by participants, but they responded differently. People followed different rules. Feedback signals were different. And most importantly, the values each privileged as systems of coordination also differed. Science privileged reliable knowledge whereas the market privileged instrumental exchange. There were no truly neutral rules.

Two important insights arose from this realization. First, *different rules generate different spontaneous orders,* privileging plans reflecting different values. Once I realized that the market was not the only spontaneous order it became an open question as to how many such orders there might be. None could simply be declared the "best" for bringing people's voluntary plans into fruition. It depended on the plans.

Second, *the values underlying these rules are often distinct from the values of those acting within their purview.* A scientist's personal motivation need not be connected to the reception of his or her research. The same holds for participants in the market process, where choices impact prices regardless of the chooser's motivation. The orders succeed because—and as far as—rules and feedback are impersonal and apply to all, but the people acting within these orders are neither necessarily acting impersonally nor simply making an instrumental exchange or seeking reliable knowledge. Very importantly, the values privileged by rules are not necessarily harmonious with the values underlying people's motivations. The traditional free-market liberal argument that markets simply reflect people's values is false.

Systemic values

A distinction exists between individual values and what I call "*systemic values.*" No necessary identity exists between the values of those acting within an order and values privileged by the order itself, values that strengthen as orders develop. In any given instance, systemic and individual values might be in harmony but they also might not.

This journal—COSMOS + TAXIS—is a response to just such an issue. In systemic terms, publishing scholarly research is not intended to make money through royalties, but rather to gain authors recognition as having made valuable contributions within their field. With enough recognition they are rewarded by the scholarly community with better positions, research funding, and so on.

Increasingly today academic journals are published by corporations seeking to make a profit. Profit arises from scarcity relative to demand. Corporations want to maximize their profit by limiting access, whereas scholars want to make access to their work as easy as possible.

The values of corporate publishers and scholars published by them are rooted in different kinds of spontaneous orders valuing different systemic resources and privileging organizations whose needs are in harmony with those resources. By contrast, online open source creative commons journals such as this one are in harmony with scholarly values but not with market values. The Internet's "gift economy" is in harmony with the "gift economy" that characterizes science (Benkler, 2006, 455-6; see also Hyde, 1969, 77-83).[3]

Levels of concreteness

Certain common qualities are unique to *all* spontaneous orders. Their rules have to be *procedural*, facilitate *cooperation*, and in a formal sense apply to all *equally*. With such rules people may engage in contradictory projects and in the process contribute to a larger order, facilitating successful pursuit of an unknown number of future plans. People are therefore free to act entirely on their own insights. These abstract propositions apply to all spontaneous orders.

But any given set of rules, such as those generating market or scientific relations, must be more concrete than simply facilitating cooperation. They facilitate certain kinds of cooperation. Prediction, measurement, experiment, and to a lesser degree rational explanation generate science, but not markets. Contract and property rights generate a market but not science. One privileges discovering reliable knowledge, the other privileges instrumental exchanges.

Even more concretely, different property rights and rules of contract generate different patterns of market phenomena. Markets exist when child labor is allowed and when it is not, when slavery is legal and when it is not, when workers give up their freedom while on the job, and when they do not. This same principle holds for virtually the entire gamut of property rights that is usually simply assumed to exist, their concrete details ignored. What does it mean to "own land?" It is different in the market economies of Norway or England than in the market economy of the United States.

The same observation holds for science. The details of the so-called "scientific method" manifest differently within different sciences. They also change over time within a science, depending on the development of leading theories and the discovery of new means of measurement and experimentation.

Consequently we need to distinguish which level of abstraction (among many) is being used in a study. This is particularly true when comparing spontaneous orders or how they interact, which is Evelyn Fox Keller's second big question. An abstract market order can only coherently be compared to an equally abstract alternative. There are several levels of concretization before we can compare actual historical instances of market and alternative phenomena (diZerega, 2008). This important area has only begun to be explored.

An abundance of spontaneous orders: Democracy

Ultimately I realized the principles underlying liberal democracy were also based on formal equality and the freedom of citizens to pursue different and even contradictory insights, subject only to following democratic procedures formally neutral as to their use. One person one vote, freedom of speech, freedom of organization, and common electoral rules that apply regardless of the party or issue provide a framework of rules enabling people to pursue any plan of their choosing compatible with the rules. Feedback through votes is both positive and negative (diZerega, 2000; 2011).

Whereas science seeks to discover reliable knowledge and markets seek to facilitate the discovery and coordination of private plans through making instrumental exchanges easier, democracies seek what I term "public values," which are the values citizens of a community want manifested within the community as a whole.

Consider contractual property rights, which define the sphere of voluntary relationships into which right holders may enter. Markets cannot exist without such a sphere, yet the details of what should constitute such a right are by no means obvious or objective. For example, what counts as pollution and what does not, and do the criteria change over time with advances in knowledge or intensified concentrations of what was considered negligible at one time? These are public values that cannot be discovered by markets, which depend on their having already been determined. Another example of how public values are distinct from those served by the market is the current controversy over private prisons, where few believe profitability is a sufficient measure of their value to society. Democracies enable all participants within a society to have, at one point at least, formally equal input into such decisions.

In *The Constitution of Liberty*, Hayek (1960, 109) comes very close to grasping that democracies are spontaneous orders, writing that it:

> is in the dynamic, rather than in its static, aspects that the value of democracy proves itself. As is true of liberty, the benefits of democracy will show themselves only in the long run, while its more immediate achievements may well be inferior to those of other forms of government (Hayek (1960,109).

He was describing a discovery process where no one oversees the whole, as contrasted to an instrumental organization. The same point could be made with regard to markets and central planning.

It is a puzzle to me why Hayek did not make the final connection, thereby uniting the three dominant institutions of liberal equality and making clear just how the principle of equal status transforms a society. But he did not, adhering instead to the old state model of describing democracy and referring to the rarely existing "will" of the majority as its "sovereign" (ibid., 403).[4]

In this failure Hayek missed the true significance of liberal social principles and the profound social mutation they made possible. Based on the ideal of equal status of all, Western liberalism replaced societies based on aristocratic and monarchical hierarchies with ones based on equal legal status. In the absence of emergent phenomena, liberal principles would have had seriously chaotic results beyond the institutional level of a small town. Instead, liberal societies flourished economically, advanced scientifically, and—as democracy established itself—generally became more peaceful internally and externally.

I think Hayek missed this connecting theme because of the context within which he developed his ideas. Common law was the other emergent order Hayek principally discussed, and in crucial respects it differed from the market order and science. Common law is not a spontaneous order in the sense that markets, science, and democracy are (Vasconcelos Vilaca, 2010).

Legal rulings are inherently hierarchical. Coercive decisions are rendered over those unable to influence its content by others who are. Law might define and refine what constitutes a voluntary contract, a procedural rule necessary for the market to arise, but law itself requires a hierarchy of power in order to enforce its decisions. Judges are the key participants in a common-law "discovery process" (Burczak, 2006, 45-57). The general public is not. Perhaps his focus on the law, despite realizing that sometimes it needed to be changed from the outside by legislative action, prevented Hayek from seeing this final connection.

Around the time I developed my insights about democracy as a spontaneous order R. J. Rummel was discovering how these characteristics explained why democracies behaved differently from undemocratic states internationally as well as their greater internal peacefulness (see Rummel, 1997). Soon afterwards, John Kingdon (1995, 222-230) came to similar insights while researching how American democracy responded to unpredictable issues, how it "learned" and adapted very quickly compared to undemocratic states. Rummel was aware of the complementarity of his analysis with Hayek's of spontaneous orders as well as my own of democracy.[5] Kingdon apparently was not.

Earlier writers had sometimes appreciated the discovery-oriented characteristics of democratic politics that distinguished them from more traditional forms of government, but lacked the concept of emergent order that would enable them to fundamentally distinguish democracy from these same forms. Bernard Crick (1962, 61) in particular came close with his conception of politics as rejecting the entire concept of sovereignty, even sovereignty of the people. Crick also emphasized that politics was eternal discovery, where no single policy is sacrosanct and all must be subject to political decisions. It depends on societies not being dependent "on a single skill, a single crop, or a single resource" (ibid, 141).

James Madison, the earliest serious thinker to explore this perspective, may have come closest to an understanding of democracies as spontaneous orders, but lacked the term. Madison's emphasis on democratic republics as being most secure when possessing many "factions," none of whom constituted a majority, as well as his argument that differently elected kinds of bodies, such as the House and Senate, are needed for discovering effective policies desirable for the community as a whole, led to this insight. He explicitly rejected majority rule and argued no unified will or plan was needed or desirable. Madison knew he was exploring new territory and argued that established ways of thinking about politics could not grasp what was happening in America (Madison, 1981, 361-62; see also diZerega, 2000, 57-132). But his warning was largely ignored, his path-breaking insights not followed up.

The Worldwide Web

During the same period that Kingdon, Rummel, and I were developing complementary insights on democracy as a spontaneous order, the Worldwide Web was coming into existence. The web is the first spontaneous order to arise entirely from within the contemporary world. In doing so it enriched the gift economy which had long remained vital to science and scholarship in general, but otherwise had largely dropped from sight. The "gift economy" had long characterized many materially simpler human societies. Now it appeared at the leading edges of applied technology and on an enormous scale (Benkler, 2006; Barabasi, 2003). As in other spontaneous orders, the web generates useful order without anyone being in charge. The worldwide web reflects liberal values of equal access and status, while information is coordinated by feedback from within an almost unimaginably complex network community.

Wikipedia is an example of how the web enables up-to-date knowledge to become widely available more rapidly than with older more centralized equivalents such as encyclopedias, even online ones. Further, it is accomplished entirely through voluntary contributions of time and expertise.

Language

Jürgen Habermas argues that equal status is inherent in the inner logic of language. Habermas argues that *at its core* every speech action claims to speak truthfully about the external world, appropriately within its social context, and be truthfully intended on the part of the speaker. Language that violates these principles is distorted communication parasitic on these principles (Habermas, 1979, 1-68; see also Adelstein, 1996, 229). If Habermas is correct, as I believe he is, language—which in any event is clearly emergent—would also qualify as a spontaneous order that in practice, as with the others, can be distorted by power and other forces.

In their pure form, each set of rules generating a spontaneous order is a more narrowly focused example of speech and communication among equals. Each comprises an analytically distinct sub-dimension of Habermas' ideal speech situation, which constitutes the most abstract universal description of the normative structure of speech relationships. I think democracy, science, the market, and the web can be considered as specialized communicative subsets immersed within language, which itself makes civil society possible.

Studying many spontaneous orders helps us understand them more deeply than is possible from focusing on only one, which is usually the market. Each spontaneous order arises from following rules biased towards certain values, and as systems each is to some degree separated from the purposes and values of the people whose actions generate them (through poetry language can even take us to where words cannot explicitly go). Through comparative study we can see what these orders share in common and what differentiates them. We can also explore conflict-laden and symbiotic relations between these orders, and how their principles interact with the place and time wherein they arose and continue to persist. Because any actual order exists enmeshed within a larger social, historical, and physical context, this field cries out for comparative studies. We hope this journal will attract such studies.

3: CIVIL SOCIETY

Jane Jacobs was not a theorist of spontaneous order; her focus was on civil society. Her work on cities, and especially urban neighborhoods, provide a perceptive study of the intricate human networks that comprise urban civil society. Her urban communities respond to a wide range of values that are woven together to create a complex urban culture, one that may differ importantly from city to city (Plaut *et al.*, 2012).

Unlike spontaneous orders, civil society is not coordinated by any single system of feedback signals, but incorporates many, including all we have discussed as coordinating spontaneous orders. This abundance of feedback means that no single standard of success or failure is defined within civil society. Individuals have wide latitude as to which kinds of feedback to attend to, and how much.

Civil society comprises the field of relations among status equals, most of whom are relative strangers or unknown to one another. It is not defined by procedural rules, as are spontaneous orders, but by equal status alone. Agreement is its coin of the realm, enabling independent equals to enter into open-ended cooperation with others. In other words, civil society constitutes the realm of freedom within society. Spontaneous orders such as the market contribute to this freedom only insofar as they remain immersed within civil society, and when they free themselves from it, problems arise.

Civil society is limited by how easily status equals can cooperate across a wide range of values. From this perspective, and for most purposes, the world consists of many civil societies, each of which honors equal status among its members, but do not necessarily see one another's members as belonging to the same civil society.

I think we can draw a distinction based on often tacit customary practices and beliefs as well as those that are more explicit. As a rule of thumb, different people will tend to feel more or less "at home" in different civil societies, which are differentiated at different scales (example: I feel more at home in America than in Italy, and more at home in Northern California than in the Midwest, and more at home in Sebastopol than in Eureka). People will therefore feel more or less able to enter into a variety of cooperative relations across many values.

America and Italy also demonstrate how different examples of civil society have indistinct boundaries. Not only do spontaneous orders such as science and the market include many members from within both the United States and Italy, many kinds of associations and interests share members across them as well. But to be at home in a civil society requires a kind of cultural "fluency" that can take years, to attain, and in some cases it can never be attained.

Economic and scientific relations cross these boundaries most easily because their feedback is standardized and impersonal, speaking to basic human interests shared by many worldwide. Other more subtle social relations translate across boundaries far less easily.

Social Ecosystems

In this respect civil society is analogous to an ecosystem. Both are theoretical constructs defined by the issue to be studied, their boundaries described by the kinds of relationships on which the investigator is focused. We can look at the ecosystem of a pond that exists within the ecosystem of the Adirondacks that exists within the ecosystem of the northern forest and so on. Short of the biosphere as a whole, the boundaries are permeable with respect both to life forms and material resources, some expanding beyond it, and new members arriving from outside. It turns out the Amazonian rainforest receives important nutrients in the form of dust from a part of the Sahara, but for most purposes we would not include both in a study of the Amazon. Planet earth is the ultimate ecosystem, as a (at this time hypothetical) world wide society of status equals is the ultimate civil society. But for most purposes more defined cases are more useful and easier to understand.

Historically civil society appears first as an urban phenomenon. Only in cities were populations large enough that in some instances complex orders could arise based upon relationships between equals. The city may well be the womb of civil society as civil society is the womb of spontaneous orders.[6]

David Hume, Adam Ferguson, and Adam Smith provided the first serious studies of how civil society could be understood as an emergent order. To my mind the next major thinker was Alexis de Tocqueville (1835/1961), whose book *Democracy in America* is the first extended study of civil society. "Democracy," as he used the term, refers to the unprecedented equality of status among most in nineteenth-century American society, and how it manifested itself socially as well as in government. Tocqueville (ibid., 90) emphasizes that in America the "appearance of disorder which prevails on the surface, leads [the foreign observer] at first to imagine that society is in a state of anarchy; nor does he perceive his mistake until he has gone deeper into the subject." Tocqueville's emphasis on subtle unplanned spontaneous order has not been much pursued, but now that civil society has become a subject of considerable interest, perhaps scholars will be more open to appreciating his insights.

Much more recently, the late Richard Cornuelle grasped the importance of what he called the "independent sector"—as distinct from both the market and government—as a vital sphere of social creativity and individual freedom. But the very diversity of feedback signals—and the freedom to respond to them in a variety of ways—prevents the larger patterns so prevalent in spontaneous order processes from emerging. As Cornuelle (1993, 102) observes:

> Look at Saul Alinsky's conquest of America's worst slum, at Henry Viscardi's success in putting the handicapped to work, at Cleo Blackburn's work in rebuilding slums, at the Menninger's work in mental health, at Millard Roberts' work in education. These operations rarely reach far beyond what these gifted and strong-willed men can do themselves."

Yet their cumulative impact is enormous.

Civil society is the most complex human emergent order, because order grows out of so many seemingly disparate elements. Perceiving it, as Tocqueville explained, calls for prolonged immersion. There is no equivalent to prices, professional reputation, or votes. No single feedback signal coordinates all of Cornuelle's examples. Yet each sends ripples of influence out to others with similar interests. As with emergent orders in general, the resulting order is too complex to lend itself to deliberate construction. Cornuelle emphasized this point, and more recently and from a different political perspective, James C. Scott (1998) makes a similar argument.

Both Scott and Cornuelle see themselves as working in harmony with lines of inquiry Jane Jacobs had done much to illuminate. Both emphasize that their analyses should not be subsumed within the market model so many of their admirers find attractive. Scott (2001) went so far as to write a long critique of such attempts to reduce civil society to market relations.

This observation sets the stage for one more theorist of civil society who—while coming from a very different intellectual tradition—helps provide a more encompassing framework within which to explore the role of spontaneous orders in society. Jürgen Habermas began his intellectual career as a leading second-generation member of the Marxist-rooted Frankfurt School, and many Marxists have been among the most intense critics of civil society. Habermas, however, developed his thinking in a different direction. I believe this happened because of his interest in language as containing within it values of equality and un-coerced communication. I think Habermas' work provides one of the best overviews of civil society from an emergent perspective, as well as substantially enlarging the universe of questions opening themselves up for exploration.

Compared to many working within the Hayekian tradition, Habermas is more sensitive to the kinds of communicative *distortion* possible within formally voluntary frameworks. Discussing them is well beyond the scope of this paper, but I hope my analysis of systemic tension and contradiction demonstrates how these kinds of insights are central to truly understanding emergent social orders. Using a different vocabulary from my own, Habermas writes: [7]

> The lifeworld forms, as a whole, a network composed of communicative actions. Under the aspect of action coordination, its society component consists of the totality of legitimately ordered interpersonal relationships. It also encompasses collectivities, associations, and organizations socialized for specific functions. (Habermas, 1998, 354)

Habermas sees, as many working within his Neo-Marxist tradition do not, that society cannot be rationally governed by even the most enlightened citizenry. It is too complex and decentered. Democracy itself must be immersed within and subordinate to civil society. Unlike many coming from a Marxist perspective, Habermas emphasizes that any complex decentered polity is beyond the capacities of citizens to control. Administrative planning is impossible (ibid., 297-98). Decisions are always open to challenge, and at its core this process of public organization, discussion, and debate must be located within civil society, which Habermas (ibid., 307) describes as "anarchic" and "wild." Habermas (ibid.; see also Pelinka, 1999, 204) is clearly describing an emergent process:

> The institutions of public freedom stand on the shifting ground of the political communication of those who, by using them, at the same point interpret and defend them. The public sphere thus reproduces itself *self-referentially*, and in doing so reveals the place to which the expectation of the sovereign self-organization of society has withdrawn. The idea of popular sovereignty is desubstantialized. Even the notion that a network of association could replace the dismissed "body" of the people . . . is too concrete. (Habermas, 1998, 486)

In Habermas' work we see a convergent stream that brings together two traditions of modern social thought long thought of as polar opposites.

In his pioneering work Cornuelle raised the important question of to what degree the independent sector could provide what I term public values better than traditional political institutions. In Habermas' work we find a convergent stream from a very different intellectual tradition. I believe considerable cross-fertilization is possible.

And here we get, at last, into examining the more conflict-ridden and tension-filled dimensions of social emergent processes.

4: REALMS OF TENSION AND CONFLICT

Posthumous introductions: Marx, meet Hayek; Hayek, meet Marx

When we recognize a variety of emergent and spontaneous orders, questions about tensions and conflict as well as reinforcement and symbiosis arise (diZerega, 2010). Because different spontaneous orders are coordinated through different feedback systems reflecting different values, they privilege values that can be contradictory to one another. Earlier I described how the market's focus on profit, arising from scarcity relative to demand, worked at cross-purposes with those of science that rewards through recognition and reputation. There are many such possibilities.

In addition, because coordinating signals within spontaneous orders simplify the information people need to operate effectively within them, there is no guarantee that what is eliminated is unimportant from the *standpoint of the partici-*

pants. In principle systems can work to undermine the larger goals held by those acting within them, not simply because their plans were mistaken but because—given order-specific biases— their broader purposes were undermined. For example, as I write this paper Monsanto is seeking to prevent consumers in California from being informed of whether or not their food has genetically modified organism (GMO) contents. If they get their way, consumers preferring non-GMO food will have much more demanding tasks discovering the truth. Guided by price alone they might purchase cheaper GMO-containing food, thereby injuring producers of non-GMO food they would prefer to purchase if they knew the difference.

Most classical liberal and Austrian-inspired studies have paid little attention to these issues, since they consider markets to be ultimately harmonious and in most cases tending towards equilibrium unless perturbed from the outside. Hayek, Ludwig Lachmann and a few more recent scholars in this tradition are exceptions to this generalization (Hayek, 1978, 4; Lachmann, 1986, 124; High, 1986, 113-19; Caldwell, 2004, 224-30).

By contrast, the anti-capitalist tradition of the left offers insights that—while transformed in important respects when viewed from within a spontaneous order framework—nevertheless provide useful starting points for understanding this darker side of relationships between spontaneous orders. For example, Habermas writes that civil society:

> encompasses collectivities, associations, and organizations socialized for specific functions. *Some* of these functionally specialized action systems become independent vis-à-vis socially integrated spheres of action … Such systems develop their own codes, as the economy does with money and the administration does with power (Habermas, 1998, 354).

There are at least five dimensions to this issue, two closely identified with the Marxist tradition and three more universally discussed.

1. Commodification

Karl Marx began his most sophisticated analysis of capitalism by examining the commodity, an item produced entirely for sale. He saw it as exemplifying a system of social relations more complex than simple exchange and, when the primary focus of economic production, unique to capitalism (Marx, 1867/1992, 125-77). "Commodification" involved the progressive transformation of all productive activity to the creation of products valueless to their producers except for their exchange value as commodities. Marx argued that a high human cost accompanies commodification, the gradual expansion of capitalist relations to cover ever more dimensions of human life.

Little attention has been paid to Marx's concept because it has been subsumed within Marx's flawed theoretical system, especially his labor theory of value, and it has been further discredited by the appalling political consequences of using that analysis to structure a society. However, once we recognize that there is no simple correlation between personal motivations and desires and the market order, I think the *problem* Marx described becomes both theoretically interesting and practically important. I have begun to explore it myself with regard to the media and I hope others will follow, either expanding my analysis or demonstrating why my argument fails and commodification is not a problem (diZerega, 2004).

2. Alienation

Spontaneous orders become impersonal forces confronting us as a part of our environment—and their utility in social life *requires* that they do so to at least some degree. They can therefore be encountered as dominating forces. If the values they privilege are at odds with the values of those acting within them, they turn from enhancing freedom to limiting it.

Money is the systemic resource for markets, as power is for governmental organization. Power is easily understood when it manifests as physical domination. The role of the market is more complex because it arises out of relations of formal equality.

The market's systemic bias is towards instrumental values acquired through consensual instrumental action. In cases of pure market exchange, parties are resources for one another. When transactions are frequently face-to-face among resource owners, this bias is diluted by the more complex values motivating both parties as human beings. As the market becomes more impersonal this value complexity disappears. We exchange with strangers and with representatives of strangers.

At least with respect to the market, in Marxian terms a spontaneous order can become an alienating force, a product of human activity which then stands over and against individuals as a force of domination and constriction rather than empowerment and liberation. I believe this insight can also be applied to science, as illustrated by the history of eugenics. It occurs in democracies as well, with the problem often—but not always—labeled “majority tyranny” (diZerega, 2011).

Alienation is the shadow side of relations being the product of human action but not of human design. Systemic biases are not necessarily harmonious with the values and purposes of individuals who pursue their plans within that system. Spontaneous orders tend to bring ever larger fields of action, and so elements of civil society, into their domain. Alienation and commodification are related, as Marx argued.

3. Power and competition

Hayek compared competition in spontaneous orders with competition in a game. In both cases competition was necessary to discover what could not otherwise be ascertained (Hayek, 1979, 67-70). His observation is important, but the differences between these two examples are also important.

A game has a clear beginning and end, and during it the rules are constant. A spontaneous order is an ongoing field of relationships with no beginning and no end. People enter and eventually leave. There is no final move, for within such orders the basic actions are repeated across generations, indefinitely.

In addition, unlike in a game the rules are subject to change at any time and—as in a game—any change in the rules will have an impact on the “players,” assisting some and penalizing others. All those participating will have an interest in the content of the rules, but not all will be equally able to influence that content. Those currently winning within such an order have an advantage in shaping changes in the rules to keep them winning.

For example, the Disney Corporation played an important role in getting copyright laws changed to prolong their commercial control over Walt Disney’s characters. The nuclear industry has obtained special exemption from liability laws that apply to others. Costs of accidents were socialized while profits remained private. Today’s banking crisis repeats this pattern on an even larger scale. The oil industry uses eminent domain to build pipelines free from requirements for voluntary contracts. There are many such examples.

This pattern appears again in democratic politics. Early in American history political parties passed electoral laws virtually ensuring a two-party system against competitors. Their efforts have been so successful that the only time the system broke down was before the Civil War. Americans scarcely know anymore that women and free blacks had the vote in New Jersey until the early 1800s, when they lost the franchise. Variations of this disenfranchisement occurred in other northern states that once allowed at least some women and free Blacks to vote. And as is well known, this problem was vastly larger and much longer lasting in the South. Today one party is seeking to change electoral rules in states where it has the power, again to influence electoral outcomes. Both parties continually gerrymander Congressional districts to preserve their power when unbiased rules might lead to their defeat.

What counts as property rights also reflect historical power inequalities, where the powerful had a disproportionate role in defining those rights. For example, the distribution of political power among those who seized Indian land then influenced how that land was divided into bundles of rights, leading to conflicts today over how much surface rights can be disrupted or destroyed by those owning subsurface rights. Rights reflect relations of power, dispossessing Indians and subordinating ranchers to corporations.

We see an equivalent pattern in democratic politics. Having a well-known family member in elected office usually gives other members an advantage should they choose to enter politics. The names Roosevelt, Taft, Rockefeller, Kennedy, Bush, and Byrd all attest to this fact. The male descendents of our Founders died before becoming adults save one, and John Quincy Adams became a President as had his father. [8] In every case abstract equality among participants is drastically modified by systemically derived inequalities.

These inequalities are strengthened by a quality inherent to human life. Successful parents normally want to use their success to assist their children. The form and extent this assistance takes varies dramatically, of course, but it is a basic human motivation. The ideal of equality under the rules can conflict with love for those closest to us. As Lenore Ealy observed to me, “the challenge is balancing the motivating incentive of giving to our children and grandchildren with the claims of other citizens.”

Finally, as has been the historical case everywhere, the actual terms of exchange in markets reflect formal equality and substantive inequality. For example, in America a job is almost always more important to a worker than most workers are individually to most job providers. This is why both employers and employees see their relationship as hierarchical, involving boss and underling, rather than a partnership.

Resource inequality usually benefits an employer, but when the prospective employee is in very high demand it can be the other way around, as with movie and sports stars (Magruder, 2012). As a general rule public policy is dominated by those whose resources are most able to influence politics. For example, when labor is weak monetary policy ranks unemployment as less undesirable than inflation, when labor is strong, priorities change.

4. Ecology and spontaneous orders

Society exists within the natural world, which is itself characterized by two additional emergent processes: the dynamics of ecosystems and of biological evolution. The first covers emergent networks within a varied natural community of plants, animals, and fungi where species may come and go, but do not themselves fundamentally change. As with spontaneous orders and civil society, the dynamics of ecosystems seem to me to be a variant of Keller's "internal selection." The second, evolutionary system, governs the origin of new species or new variations within a species. It usually covers larger spans of time. It is characterized by natural selection.

Human systems are immersed within and dependent upon natural ones. In *Guns, Germs, and Steel*, Jared Diamond (1999) makes a compelling case that a thorough knowledge of earthly ecosystems and geography before civilization arose would have made it possible to predict where on the planet it would happen. Obviously natural systems can be degraded to the point of collapse, and changes in natural systems have destroyed human ones through their failure to adapt to changes in their environment, as with the Norse in Greenland (Diamond, 2011, 178-276). The people of Easter Island—either foolishly through over-cutting or inadvertently through introduced species—so degraded their ecosystem that it collapsed (ibid, 79-120; for the role of rats, see Marshall, 2012, 30-36). The list is longer but these examples are unchallenged in their clarity.

These examples also illustrate a dilemma.

In the short run human systems adapt more quickly than most natural systems, but they respond chiefly to feedback from the human world. Human technologies can change many times within a generation, because signals circulate rapidly between individuals and systems. The generation born in 1900 lived when horses and carriages were the dominant mode of transportation. Many survived to see the first moon landing in 1969.

Natural systems adapt through generational change, which is the speed of reproduction. It is no accident that natural forms that rapidly reproduce handle humanity's influence more successfully than do more slowly reproducing organisms. Because of this difference in speeds of adaptation, a human system can disrupt a natural one yet at the same time be completely dependent on that system. This tension is intrinsic to interacting systems where one is overwhelmingly cultural and the other overwhelmingly biological.

5. Organizations vs. spontaneous orders

Spontaneous orders make complex organizations possible, and richer orders enable them to be larger and more varied. At the same time spontaneous orders always threaten the continued existence of organizations within them. Research projects can suddenly fail when a theory on which they have based their work is unexpectedly replaced by a new discovery. Political parties can be rejected at the polls. Businesses can disappear because no one buys their products any more. Consequently *there is no lasting harmony of interests between a spontaneous order and the organizations existing within it.* Organizations seek to persist; spontaneous orders threaten that persistence.

There is a close analogy here with the relationship between individual organisms and the ecosystem within which they flourish. Both organisms and organizations can be understood teleologically. They can succeed or fail. For organisms, the same ecosystem that makes them possible can eliminate them, as when a deer is caught by a cougar. If deer could vote, cougars would be imprisoned to the benefit of individual deer but to the long-term detriment of the ecosystem that supports them. Organizations stand in the same relationship with the spontaneous orders within which they exist and flourish.

5: A PARADIGM ARISING

Thomas Kuhn's use of the term "paradigm" was loose, but generally fell into three broad contexts. First it refers to a set of beliefs about the world. Second, paradigm refers to the methods and tools and principal texts that define how a field is practiced. Third, it refers to a scientific achievement serving as an example of how that science is done. Kuhn himself said his major intent was the second (Kuhn, 1970).

Hayek gave us the market order as a paradigm in this sense. Similar insights were developed by Polanyi and, in biology, by Keller and Geller. Their research helped link how egalitarian rules generated organized complexity in biology with how egalitarian rules generated spontaneous orders as another form of organized complexity in the human sphere. Keller also gives us a broader view of our paradigm as a more all-encompassing research project, in Kuhn's first sense. As Keller put it:

> We have learned that a science of self-organized complexity will have to take into account processes of self-assembly and self-organization in multilevel systems, operating on multiple spatial and temporal scales

> through multilevel feedback in which the internal structure and properties of the component elements are themselves responsive to the dynamics of the system. (Keller, 2009a, 30)

This paper has sought to make connections explicit across the board, unifying an approach of enormous potential, thereby expanding it to cover other spontaneous orders such as democracy and the net. It provides a framework for exploring the complex relationships between and within them, and the place organizations play within them.

In the process the emergent paradigm helps clarify a series of confusions that have long plagued clarity of understanding in social science. Failing to distinguish spontaneous orders from organizations has been a source of confusion, because the same word has consistently been used to describe two fundamentally different kinds of order. Hayek emphasized the confusion arising over the term "economy," which refers to both the spontaneous order of a market economy and the economy of a corporation or a household. Science suffers the same ambiguity. Science is a spontaneous order and a scientist "does science" by pursuing a research project. Democracy is a spontaneous order when there is no overarching purpose pursued by the polity, but a democracy in a major war possesses a national unity of priorities and acts like an organization. Significantly, it is when a democracy is most unified under a single hierarchy of goals (most "democratic" from an organizational perspective) that it acts most undemocratically. The significance of this difference is often overlooked. This confusion runs throughout our language.

Social emergence takes three broad forms: spontaneous order, where all share equal status and the system generates a single or very narrow set of signals for systemic coordination; civil society, where status is equal and a great many and sometimes conflicting kinds of feedback provide a rich matrix of information allowing for a wide range of choice and creative response; and other social emergent systems, such as the evolution of customs, in which there need not be equal status among participants, but there is no single goal of the system of relationships thereby established.

This essay has attempted to describe what I think is a promising new paradigm in the social sciences. It is a paradigm that integrates it into the burgeoning study of emergent processes, particularly in biology. It seems to me a rich and exciting framework for research and scholarship.

Notes

1 An insightful philosophical treatment of this perspective, and how it differs from traditional Western philosophical perspectives, is Joanna Macy (1991).

2 "Paradigm" as Kuhn employs it covers several meanings, but these complexities do not matter for the point I am making. See also Masterman (pp.59-90) in Lakatos and Musgrave (1970).

3 "Walking his talk," Benkler made his book available to all as an open-source creative commons document: http://cyber.law.harvard.edu/wealth_of_networks/Main_Page

4 I think Hayek's error arose from his relative lack of knowledge of the American revolutionary tradition of political thinking, particularly that of James Madison. As Madison emphasized, European thought could not comprehend the principles underlying American representative democracy, or any democracy (cf. diZerega, 2011).

5 Personal communication.

6 Robert Putnam (1993) Making democracy Work: Civic Traditions in Modern Italy gives a good account of the history of civil society in Northern Italian city states. (Princeton: Princeton University Press, 1993).

7 As Hayek and Keller both found important foundations in Warren Weaver's work, so much of Habermas' work owes a considerable debt to theorists such as Alfred Schutz (like Hayek, once a student of von Mises) and Thomas Luckmann, who are better known to those conversant with Hayek's work.

8 I am grateful to Prof. Mary Hanna of Whitman College for pointing this important fact out to me.

References

Adelstein, R. (1996). Language orders. *Constitutional Political Economy*, 7: 221-238.

Barabasi, A.-L. (2003). *Linked*. New York: Penguin.

Barabasi, A.-L. (2007). The architecture of complexity. *IEEE Control Systems Magazine*, August: 34.

Benkler, Y. (2006). *The Wealth of Networks; How Social Production Transforms Markets and Freedom.* New Haven: Yale University Press.

Bonner, J.T. (1980). *The Evolution of Culture in Animals.* Princeton: Princeton University Press.

Burczak, T.A. (2006). *Socialism after Hayek*. Ann Arbor: University of Michigan Press.

Caldwell, B. (2004). *Hayek's Challenge: An Intellectual Biography of F. A. Hayek.* Chicago: University of Chicago Press.

Cornuelle, R. (1993). *Rebuilding the American Dream.* New Brunswick: Transaction Publishers.

Crick, B. (1962). *In Defence of Politics*. Harmondsworth: Penguin.

Diamond, J. (1999). *Guns, Germs, and Steel: The Fates of Human Societies.* New York: W.W. Norton.

Diamond, J. (2011). *Collapse: How Societies Choose to Fail or Succeed* (revised ed.). New York: Penguin.

diZerega, G. (2000). *Persuasion, Power and Polity: A Theory of Democratic Self-Organization*. Cresskill: Hampton Press.

diZerega, G. (2004). Toward a Hayekian theory of commodification and systemic contradiction: Citizens, consumers and the media. *The Review of Politics*, 66(3): 445-68.

diZerega, G. (2008). New directions in emergent order research. *Studies in Emergent Order,* 1: 1-23.
diZerega, G. (2010). Conflicts and contradictions in invisible hand phenomena. *Studies in Emergent Order,* 3: 1-27.
diZerega, G. (2011). Spontaneous order and liberalism's complex relation to democracy. *Independent Review,* 16(2): 173-97.
diZerega, G. and Hardwick, D.F. (2011). The emergence of Vancouver as a creative city. In: Andersson, D.E., Mellander, C., Andersson, Å.E. (Eds.) *Handbook of Creative Cities*. Cheltenham and Northampton, MA: Edward Elgar, pp. 365-84.
Habermas, J. (1979). *Communication and the Evolution of Society.* Boston: Beacon Press.
Habermas, J. (1998). *Between Facts and Norms*. Cambridge, MA: MIT Press.
Hayek, F.A. (1960). *The Constitution of Liberty*. Chicago: Regnery.
Hayek, F.A. (1973). *Law, Legislation and Liberty, Part I: Rules and Order.* Chicago: University of Chicago Press.
Hayek, F.A. (1978). Coping with ignorance. *Imprimis*, 7(7): 1-6.
Hayek, F.A. (1979). *Law, Legislation and Liberty, Part III: The Political Order of a Free People.* Chicago: University of Chicago Press.
High, J. (1986). Equilibrium and disequilibrium in the market process. In: Kirzner, I.M. (Ed.) *Subjectivism, Intelligibility and Economic Understanding*. New York: New York University Press, pp. 111-21.
Hyde, L. (1969). *The Gift: Imagination and the Erotic Life of Property.* New York: Vintage.
Jacobs, J. (1961). *The Death and Life of Great American Cities*. New York: Random House.
Jacobs, J. (1984). *Cities and the Wealth of Nations: Principles of Economic Life*. New York: Random House.
Jacobs, J. (1994). *Systems of Survival: A Dialogue on the Moral Foundations of Commerce and Politics.* New York: Vintage.
Jacobs, J. (2004). *Dark Age Ahead.* Toronto: Random House Canada.
Kauffman, S. (2008). *Reinventing the Sacred*. New York: Basic Books
Keller, E.F. (1985). *Reflections on Gender and Science.* New Haven: Yale University Press.
Keller, E.F. (2008). Organisms, machines and thunderstorms: A history of self-organization, Part 1. *Historical Studies in the Natural Sciences* 38(1): 45-75.
Keller, E.F. (2009a). Organisms, machines and thunderstorms: A history of self- organization, Part 2: Complexity, emergence, and stable attractors. *Historical Studies in the Natural Sciences,* 39(1): 1-31.
Keller, E.F. (2009b) *Self-Organization, Self-Assembly, and the Inherent Activity of Matter.* Hans Rausing Lecture, Uppsala University. Stockholm: Swepografiska.
Keller, E.F. and Segel, L.A. (1969). On the aggregation of acrasiales. *Biophysical Society Abstracts of the Annual Meeting,* 13: A69.
Kelly, K. (1994). *Out of Control: The New Biology of Machines, Social Systems, and the Economic World.* Reading, MA: Addison-Wesley.
Kingdon, J. (1995). *Agendas, Alternatives and Public Policies* (2nd Ed.). New York: Longman.
Kuhn, T.S. (1962). *The Structure of Scientific Revolutions.* Chicago: University of Chicago Press.
Kuhn, T.S. (1970). Reflections on my critics. In: Lakatos, I., Musgrave, A. (Eds.) *Criticism and the Growth of Knowledge: Proceedings in the Philosophy of Science*. London: Cambridge University Press, 231-78.
Lachmann, L.M. (1986). *The Market as an Economic Process*. Oxford: Basil Blackwell.
Lakatos, I. and Musgrave, A. (Eds.) (1970). *Criticism and the Growth of Knowledge: Proceedings in the Philosophy of Science*. London: Cambridge University Press.
Lewontin, R. (1997). *Billions and billions of demons.* New York Times Book Review, January 9.
Magruder, J.R. (2012). Can minimum wages cause a big push? Evidence from Indonesia. *Journal of Development Economics,* 100(1): 48-62.
Macy, J. (1991). *Mutual Causality in Buddhism and General Systems Theory.* Albany: State University of New York Press.
Madison, J. (1981). *The Mind of the Founder* (Ed.: Meyers, M.). Hanover: University Press of New England.
Marshall, M. (2012). Ruined. *New Scientist*, August 4-10: 30-36.
Marx, K. (1867/1992). *Capital, Volume I: A Critique of Political Economy.* New York: Penguin.
Pelinka, A. (1999). *Politics of the Lesser Evil: Leadership, Democracy and Jaruzelski's Poland.* New Brunswick: Transaction Publishers.
Plaut, V.C., Markus, H.R., Treadway, J.R., and Fu, A.S. (2012). The cultural construction of self and well-being: A tale of two cities. *Personal and Social Psychology Bulletin,* 38(12): 1644-58.
Polanyi, M. (1969). *Knowing and Being* (Ed.: Grene, M.). Chicago: University of Chicago.
Polanyi, M. (1974). *Personal Knowledge: Towards a Post-Critical Philosophy.* Chicago: University of Chicago Press.
Polanyi, M. (1998). *The Logic of Liberty*. Indianapolis: Liberty Fund.
Prigogine, I. and Stengers, I. (1984). *Order Out of Chaos*. Toronto: Bantam.
Putnam, R. (1993). *Making Democracy Work: Civic Traditions in Modern Italy.* Princeton: Princeton University Press.
Rummel, R.J. (1997). *Power Kills: Democracy as a Method of Nonviolence.* New Brunswick: Transaction Publishers.
Saigusa, T., Tero, A., Nakagaki, T., Kuramoto, Y. (2008). Amoebae anticipate periodic events. *Physical Review Letters,* 100(1): 018101.
Scott, J.C. (1998). *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* New Haven: Yale University Press.
Scott, J.C. (2001). A reply to Hardin, Ostrom, Niskanen, and Eudaily. *The Good Society,* 10(2): 49-51.
Tocqueville, A. de (1835/1961). *Democracy in America,* Vol. I. New York: Schocken.
Toulmin, S. (1992). *Cosmopolis: The Hidden Agenda of Modernity.* Chicago: University of Chicago Press.
Vasconcelos, Vilaca, G. (2010). From Hayek's spontaneous orders to Luhmann's autopoietic systems. *Studies in Emergent Order*, 3: 50-81.
Weaver, W. (1948). Science and complexity. *American Scientist*, 36: 536.
Weaver, W. (1961). A quarter century in the natural sciences. *Public Health Reports*, 76(1): 57.
Weinberger, D. (2012). Shift happens. *The Chronicle of Higher Education*, April 22.
Wilson, E.O. (2012). *The Social Conquest of the Earth*, New York: W. W. Norton.
Wittgenstein, L. (1974). *Philosophical Grammar, Part I: The Proposition and Its Sense.* Berkeley: University of California Press.
Ziman, J. (1978). *Reliable Knowledge: An Exploration of the Grounds for Belief in Science.* Cambridge: Cambridge University Press.

For COSMOS+TAXIS *1(1)*; an invited reply to Gus diZerega's "Outlining a new paradigm."

Spontaneous Orders and the Emergence of Economically Powerful Cities

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Abstract: The importance of cities to economic dynamism and growth cannot be emphasized enough. It is crucial for our understanding of what drives economic growth to understand how cities emerge, develop, and prosper. This paper investigates the emergence of cities from a spontaneous order and urban economics perspective. The analysis focuses on agglomeration effects, externalities and regional clustering as explanations of urban and regional growth. Factors such as local knowledge and dispersion of knowledge are identified as important growth factors. Based on Hayek's famous invocation of the "particular circumstances of time and place," these factors are discussed in a spontaneous-order framework.

Keywords: Cities; dynamic externalities; knowledge flows; spontaneous orders; urban economics.

1 INTRODUCTION

Cities are the engines of economic growth (Jacobs, 1969; Bairoch, 1988). It is in cities that a large share of the innovations and entrepreneurship takes place that fosters economic growth in the long run. Densely populated urban economies in which corporations, occupations, and individuals are close together create an environment in which ideas can flow rapidly from individual to individual. Through their organization cities provides meeting places for face-to-face communication, which further benefits the flows of tacit or local knowledge and thus creates positive agglomeration effects for firms located in an area.

Jacobs (1969) was one of the first scholars to describe the emergence of cities as a spontaneous order rather than from a central planning and organizational perspective.[1] The emergence of cities is spontaneous, as it is "self-ordering, self-sustaining, and self-regulating" (Ikeda, 2004: 253). Jacobs' argument is based on the assumption of ever-increasing social complexity in the formation of multifaceted spontaneous networks that consist of individuals who cover many different fields of knowledge, interests, and activities. The nodes in such networks consist of individuals linked through formal or informal relationships that can be used to transfer knowledge in an effective manner.

By analyzing cities from a spontaneous order perspective, the current paper relates closely to the arguments offered in Gus diZerega's introductory paper "Outlining a New Paradigm" in this issue. diZerega argues that "[u]nlike spontaneous orders, civil society is not coordinated by any single system of feedback signals, but incorporates many, … [.]" That is, civil societies incorporate many different feedback systems and individuals are essentially free to choose which signals they will adhere to. The manner in which this is organized could likely account for some of the differences between cities and explain how cities evolve over time. The evolution of culture is another spontaneous order that evolves over time; it is like the market in that it helps to shape the characteristics of cities.

The novelty in this paper is the combination of ideas from urban economics with a spontaneous-order perspective on civil society and the emergence of economically powerful cities. The two fields could be linked with respect to at least three points:

1 The Jacobian analytical framework of the emergence of cities
2 The importance of knowledge spillovers and local knowledge
3 The role of individuals in knowledge flows (i.e., methodological individualism[2]).

This paper uses the Jacobian analytical framework of cities as a starting point. Within this framework, the analysis focuses on agglomeration effects, dynamic externalities, regional clustering and local knowledge as explanations for cities and regional growth. The relatively high degree of spatial concentration in cities emphasizes features such as local embeddedness, social and professional networks, and face-to-face communication. Thus, as in Austrian economics, the urban economics framework identifies factors such as local knowledge and the dispersion of knowledge as important growth factors. Despite the inclusion of "place" in the phrase "particular circumstances of time and place" by Hayek (1945), Austrian theory almost entirely lacks a spatial dimension. Recently, however, the situation has started to change (Andersson, 2005; 2012; Desrochers, 1998; 2001; Heijman and Leen, 2004) with the development of a new type of Austrian economics that incorporates a spatial dimension to explain the transmission of knowledge, entrepreneurship, innovations, and markets.

In densely populated cities, both individuals and firms can take advantage of positive agglomeration effects and knowledge spillovers which increase the propensity to innovate and thus increase economic welfare (Audretsch, 1998; Malmberg and Maskell, 2002; Storper and Venables, 2004). In fact, theories of dynamic externalities can be used to explain both how cities form and why they grow (Glaeser *et al.*, 1992). This paper builds on these insights and develops an analytical framework that includes both the emergence and growth of cities using a spontaneous order perspective.

The remainder of the paper is structured as follows. Section 2 provides an overview of the development and importance of cities. The following section discusses the importance of spatial proximity in the emergence and development of urban economies. This section provides a theoretical framework that focuses on dynamic externalities, agglomeration economies and the importance of knowledge flows for knowledge-intensive firms, entrepreneurship, innovations, and city dynamics. Section four discusses the spontaneous order of cities, the Hayekian knowledge problem, and how it can be related to tacit knowledge and face-to-face communication. The final section summarizes and concludes the paper.

2 GLOBAL CITIES AND THEIR ECONOMIC POWER

The importance of cities to economic dynamism and growth cannot be overemphasized. For example, recent data show that nearly 90 percent of total US economic output is produced in cities. American cities also account for approximately 85 percent of all employment (Florida, 2012). This feature is not unique to America; rather urbanization is occurring across the globe. Today, half of the world's population lives in cities, and the United Nations estimates that this will rise to 70 percent in 2050. The economic role of cities seems even greater when the data are disaggregated from the national level. For example, the largest 600 cities, which jointly comprise one-fifth of the world's population, account for 60 percent of the global GDP (McKinsey, 2011).

The group of global cities is not static; rather, the specific cities that constitute the top 600 cities are continually changing. Current economic development in the southern and eastern parts of the world will lead to a shift in economic power. McKinsey (2011) provides a forecast that identifies 136 new cities as new entrants in the top-600 group by 2025. All of them are in the developing world. The economically most important urban development is occurring in China, from which 100 of the new top 600 cities are expected to emerge. Thirteen of the new cities will be in India and another eight cities will be in Latin America. Hence, it is crucial for our understanding of what drives global and regional economic growth to understand how cities emerge, develop, and become economically powerful.

The conventional method of ranking cities involves the use of population size. A common definition of mega-cities includes metropolitan regions with more than 10 million people (Florida *et al.*, 2012). Table 1 presents a ranking of the 10 largest cities in terms of population in 2011 as well as estimates for 2025. The largest urban agglomeration is Tokyo (Japan) with 37 million people, followed by Delhi (India) and Shanghai (China).

Only three of these mega-agglomerations (Tokyo, New York, and Shanghai) qualify for the top-10 ranking lists that measure the economic power of global cities (see Table 2). That is, many of the largest cities in terms of population appear to be located in the developing world, with a rapid rate of urbanization. Many of these urban agglomerations suffer from the same socio-economic problems that were present in the developing world during the industrial revolution in the nineteenth century (Dahiya, 2012; Retsinas, 2007). Thus, if we are interested in the most economically powerful cities, we must employ other metrics.

Economic strength is not only a function of population; one must also include factors such as productivity, technological change, human capital (skills), financial development, the rule of law, and other institutions. Until recently, it has been difficult to compare and rank cities according to their economic power. The main problem has been the lack of high-quality systematic data (Florida, 2012). A number of research institutes and think tanks throughout the world have exerted a significant amount of effort into finding this type of data, and there are now relatively reliable (and comparable) metrics at hand. Table 2 presents five of these measures; the sixth metric is a weighted average of the first five measures as computed by Florida (2012).

Table 1: The 10 largest urban agglomerations in terms of population, 2011 and 2025

	2011			2025		
Rank	City	Country	Population	City	Country	Population
1	**Tokyo**	Japan	37,200,000	**Tokyo**	Japan	38,600,000
2	Delhi	India	22,650,000	Delhi	India	32,940,000
3	Mexico City	Mexico	20,450,000	**Shanghai**	China	28,400,000
4	**New York**	United States	20,350,000	Mumbai (Bombay)	India	26,560,000
5	**Shanghai**	China	20,210,000	Mexico City	Mexico	24,580,000
6	Sao Paulo	Brazil	19,920,000	**New York**	United States	23,570,000
7	Mumbai (Bombay)	India	19,740,000	Sao Paulo	Brazil	23,170,000
8	Beijing	China	15,590,000	Dhaka	Bangladesh	22,910,000
9	Dhaka	Bangladesh	15,390,000	**Beijing**	China	22,630,000
10	Kolkata (Calcutta)	India	14,400,000	Karachi	Pakistan	20,190,000

Source: United Nations, Department of Economic and Social Affairs, Population Division (2012).
Note: Bold indicates that the city is also present in one of the rankings of the economically most powerful cities in the world (Table 2).

Table 2: The world's most powerful cities

Rank	**GEPI**[a]	**GCCI**[b]	**GCI**[c]	**GFCI**[d]	**GCGDP 2025**[e]	**Overall ranking**[f]	**Overall score**[f]
1	Tokyo	New York	New York	London	New York	New York	48(5)
2	New York	London	London	New York	Tokyo	London	43(5)
3	London	Singapore	Paris	Hong Kong	Shanghai	Tokyo	37(5)
4	Chicago	Hong Kong; Paris	Tokyo	Singapore	London	Hong Kong; Paris	25(4) 25(4)
5	Paris		Hong Kong	Tokyo	Beijing		
6	Boston	Tokyo	Los Angeles	Zurich	Los Angeles	Chicago	20(5)
7	Hong Kong	Zurich	Chicago	Chicago	Paris	Singapore	15(2)
8	Osaka	Washington	Seoul	Shanghai	Chicago	Shanghai	11(2)
9	Seoul; Washington	Chicago	Brussels	Seoul	Rhein-Ruhr	Los Angeles	10(2)
10		Boston	Washington	Toronto	Shenzhen	Zurich	9(2)

Sources: [a] Martin Prosperity Institute (GEPI=Global Economic Power Index); [b] The Economist (GCCI=Global Cities Competitiveness Index); [c] AT Kearney (GCI=Global Cities Index); [d] Z/Yen (GFCI=Global Financial Centers Index); [e] McKinsey Global Institute (GCGDP=Global Cities Gross Domestic Product)
***Note*:** [f] The last two columns are based on weighted averages of the five other global city rankings. The score shows the total score from the five lists (i.e. 10 points for first place, 9 points for second place etc.). The number in brackets shows the number of rankings in which a city is among the top ten.

The foci of these indices differ, but together they provide a good indication of which cities are the most economically and financially influential.[3] New York ranks in first or second place in each of the five metrics and thus receives the highest overall score. London is the second most powerful city, ahead of Tokyo.

Table 2 shows that although the economic power in the world is shifting towards Asia and especially China, it is likely that it will take a long time before any of the Asian cities (except for Tokyo) rises to the top of any of these measures. Which factors or processes then make these top-ranked cities so economically and financially influential and powerful? A related question is this: why is there such as low correlation between the economically most important cities and the largest cities in terms of population?

3 THEORIES OF KNOWLEDGE FLOWS, DYNAMIC EXTERNALITIES AND CITIES

Theories of city growth are based on the assumption that progress is generated by spatially co-located firms in which the knowledge flows between individuals working in such firms are significant. In this context, cities grow because individuals interact with one another while freely absorbing knowledge. In more rural areas, the interactions and, hence, the knowledge spillovers between individuals are less intense, which is one explanation of why cities generally grow more rapidly than rural areas. The focus on knowledge flows between individuals who work in a locality is evidence that urban economics tend to adopt an individualist methodology.

If we view cities as the engines of economic growth and development and believe that spatial proximity facilitates the transmission of ideas, we should then expect knowledge flows to be especially important in cities. Marshall (1890) defines several factors that generate local advantages such as specialized labor, specialized suppliers, and local knowledge. Local knowledge is disseminated through local networks and other information-based channels.

3.1 Dynamic externalities

Theories of dynamic externalities may be used to explain both how cities form and why they grow (Glaeser *et al.*, 1992). The key determinants of the relevant models are spatial co-location and knowledge spillovers, which improve the growth rate for regional specialized firms relative to regionally isolated firms. The dynamic externality approach consists of three different theories of externalities and knowledge spillovers that differ on several important issues (*ibid.*):

- Marshall-Arrow-Romer (MAR) theory
- Michael Porter's theory
- Jane Jacobs' theory

The MAR approach applies to intra-industry knowledge spillovers, that is, those that occur between firms within *a single* industry. The theory originates from Marshall (1890), who applied it to city formation and industrial districts. It was subsequently formalized by Arrow (1962) and then refined and extended by Romer (1986). In essence, MAR theory argues that industry specialization leads to increasing knowledge spillovers among firms, which facilitates long-term growth for both the specialized industry and the city in general. However, because of incomplete property rights, knowledge of new innovations will spread to neighboring firms without compensation. Because the outflow of knowledge is not fully compensated, the returns on investments are reduced and, hence, incentives to innovate are also smaller. Thus the rates of innovation and growth benefit from reduced competition between firms that immediately copy new products (Romer, 1990). Based on this, MAR theorists argue that local concentration is beneficial for the rate of innovation and growth, because it enables cooperating firms to internalize their innovations.

In contrast, Porter (1990) disagrees with MAR and argues that local competition is more beneficial for co-located firms because innovations are easier to adapt in a competitive environment; therefore "externalities are maximized in cities with geographically specialized, competitive industries" (Glaeser *et al.*, 1992: 1128). In competitive environments, innovations are more rapidly adopted, and innovations improve more rapidly. In Porter's theory, firms that do not develop technologically will not keep up with their competitors, even though such firms cannot internalize all the returns from their innovation.

Jacobs (1969) disagrees with both MAR and Porter. She argues that industrial diversity (compared with industrial specialization) generates more beneficial conditions for entrepreneurship and innovations, because the most important knowledge flows are obtained from outside a city's core industry. However, Jacobs agrees with Porter (1990) that local competition generates a better climate for the adaptation of innovations than local monopolies (as MAR theorists contend). The empirical literature on dynamic externalities is inconclusive on the issue.

3.2 Internal and external knowledge capacity

A consensus in the literature on agglomeration economies is that firms benefit from internal learning, but that external knowledge in urban regions is also of great importance. Empirical research indicates that regional external knowledge flows generate benefits that nearly equal intra-firm investments (Keller, 2010; Lööf and Nabavi, 2012). Consistent with the arguments proposed by Jacobs (1961), urban economists demonstrate that geography is relevant. Although the largest multinationals and the most innovative firms are closely linked to the "global stock of knowledge," it is still the case that these firms predominately conduct their innovation processes in a few key regions (Rugmann, 2000).

Empirical innovation research shows that both innovation and knowledge spillovers are spatially localized and concentrated (Feldman and Kogler, 2010; Johansson *et al.*, 2012). For example, large metropolitan areas produce disproportionally more patents than do smaller regions. The results suggest that spatial co-location in large entrepreneurial cities generates increasing returns on innovations, unlike in smaller cities. However, co-located firms with higher levels of internal knowledge capacity are likely to reap more benefits from positive externalities than others (Johansson *et al.*, 2012). That is, a firm must have relatively high levels of internal knowledge capacity in order to absorb the external knowledge flows in a region. Using Swedish register-based data, Johansson *et al.* (2012) argue that there are significant differences between innovative and non-innovative firms in their ability to absorb and assimilate external knowledge. Being located in a region with high levels of external knowledge increases the productivity and long-term growth of innovative firms, whereas there is no corresponding effect for non-innovative firms. That is, to take advantage of external knowledge flows, a firm must possess a large internal knowledge base.

How (or why) does spatial proximity affect innovations and firm productivity? Firms benefit from being located close to a dense market that provides a variety of knowledge resources and a labor force consisting of a wide spectrum of qualifications and competences. Diversity in the supply of knowledge and human capital provides the foundation for knowledge exchange and creative interaction between firms and individuals in a region. Thus, agglomeration effects increase the rates of return on human capital and innovation (Gleaser and Ponzetto, 2010), which then raise the overall urban economic growth rate. In densely populated areas knowledge spillovers make it profitable for firms to be located near one another because they can benefit from the knowledge and innovation activities of other firms (Fujita and Thisse, 2002). In such settings, a firm can also take advantage of knowledge spillovers from specialized business services and other sources of external knowledge.

4 THE SPONTANEOUS ORDER OF CITIES

The economic importance of cities to global economic development implies that national level data can be quite misleading. One important effect of globalization is that national political borders become less relevant in economic terms; in this economic climate, firms choose locations based on expected profitability and individuals choose to live in places in which they have access to opportunities. Thus, both capital and labor choose the locations with the highest returns, opportunities, and productivity. Empirical research shows that regional economic growth is highly persistent (Fritsch and Wyrwich, 2012; Decressin and Fatás, 1995). Cities or regions that have a high level of economic growth generally have a long history of entrepreneurship and innovation.

Jacobs (1961; 1969) argues that diversified cities/urban economies are optimal environments for innovation and entrepreneurship. Through innovations, job and wealth creation, entrepreneurship generates long-term increases in living standards (Acs and Audretsch, 1988; Cagetti and de Nardi, 2006). Empirical research also shows that both innovation and entrepreneurship benefit immensely from face-to-face communication and spatial proximity.

Jacobs initially studied cities with a focus on the internal structure of neighborhoods and how such structures support meetings between individuals. She applied an ecological analytical framework that has subsequently been drawn upon to support a more explicit spontaneous-order argument (diZerega, this issue). In Jacobs' original framework, a city is defined as "a settlement that consistently generates economic growth from its own local economy" (Jacobs, 1969: 262).

4.1 Spontaneous orders, knowledge and cities

Spontaneous order is the idea that when individuals strive "to achieve their own purposes and plans [this] can through the guiding signals and incentives of the price system result in a socially desirable allocation and distribution of resources" (Boettke, 2013: 2). The concept corresponds to terms such as emergent order, self-organizing systems and mutual causality (diZerega, 2004: 446). Economic theory includes all purposive human action, and hence it is not possible to isolate or dispatch the economic realm of human action. Spontaneous orders are coordinated by "order-specific feedback," which together with agglomeration effects and location-specific attributes act as constraints. The modern understanding of spontaneous orders stems from Polanyi (1961) and Hayek (1970); it refers to the way independent individuals pursue plans in order to accumulate order-specific assets. In the market economy, actors aim to maximize their economic wealth while in a democracy they maximize votes according to election rules (Andersson, 2013). Other spontaneous orders have yet other order-specific rules which constrain actors when they attempt to maximize order-specific assets. In civil society, actors need to take into account the constraints of different co-existing orders while maximizing utility or different order-specific resources.

Hayek uses spontaneous order theory to explain and praise the market and to argue that moral traditions are generated by evolution. A spontaneous order is created by the decisions of individual actors and is thus a by-product with no specific aim or goal. Individuals can use the abstract signals, such as prices or evolved rules, generated by an order to pursue their own goals. For example, prices in a market system give rise to rational expectations and enable individuals to act on information that they do not explicitly possess. Because no single individual or group is in control of all of the information that is needed to determine prices or the evolution of culture, no individual in society is capable of planning all economic activities or determining how the culture will evolve. In a market economy, "planning" is instead conducted by all the firms and individuals that operate in the market. For cities, the relevant prices include land rents, wages and other input prices. The decision to locate in a specific region can be seen as an investment decision where the net present value should be positive, thus implying a net contribution to firm value.

Hayek (1937; 1945; 1948) argues that the market economy is the system that best allocates dispersed knowledge and hence generates the highest level of wealth. Market prices are "a mechanism for communicating information" (Hayek, 1945: 526) and can be viewed as a coordinating mechanism that transfers knowledge across all members of society. Market prices transmit only relevant information to market participants. In this sense the price system facilitates the "division of labor but also a coordinated utilization of resources based on equally divided knowledge" (Hayek, 1945: 528).

Economic problems in society stem from change where the entrepreneur is the driving force of the market process. In her incessant quest for profit, the entrepreneur acts on changing market conditions and pushes the market system towards equilibrium. According to Israel Kirzner (1997: 62), the Austrian approach "sees equilibrium as a systematic process in which market participants acquire more and more accurate *mutual knowledge* of potential demand and supply attitudes, and ii) sees the driving force behind this systematic process … as *entrepreneurial discovery*." Unlike mainstream neoclassical economics, it sees the competitive process of entrepreneurial discovery as a systematic process that pushes the system towards equilibrium. Here, the entrepreneurial process is a way to gradually discover new knowledge and push back the boundaries of sheer ignorance (Kirzner, 1997). The competitive process engenders mutual awareness of prices as well as output and input qualities and quantities, pushing them towards equilibrium.

Therefore, economically successful societies have a superior ability to adapt to and take advantage of economic changes. Such societies consist of individuals who are alert to entrepreneurial opportunities (Kirzner, 1997) and earn profits from trade and innovation. These are societies with effective knowledge dispersion in which individuals have "the knowledge of the particular circumstances of time and place" (Hayek, 1945: 521). Knowledge spillovers make up one of the building blocks of urban economies that can be used to explain both the emergence and growth of cities. For firms to take part in localized knowledge flows and "changing conditions" based on tacit or specialized knowledge they have to be spatially co-located with other firms. Interesting to note is that it is only firms with relatively high levels of human capital that benefit economically from such external knowledge flows (Lööf and Nabavis, 2013).

Both spontaneous-order theory and urban economic theory show how the dispersion of knowledge affects economic development and growth. In urban economics, one speaks of dynamic externalities, which refer to knowledge spillovers among workers in co-located firms. In the spontaneous order framework there is a greater focus on the market process, where the entrepreneur acts on changing conditions and drives the economy forward. The similarities consist of arguments that invoke individual knowledge or knowledge flows as well as entrepreneurship or innovation. The spread of tacit or specialized knowledge among the members of a society is not costless. To access or take part in the knowledge flows individuals have to meet face-to-face, which is a costly process. Andersson (2005) introduces another implication of a spatial perspective on the entrepreneurial process, namely that the choice of location is an entrepreneurial act which reflects profit opportunities. By being alert to new locations or benefits of co-location, firms that locate in a specific city or region can make entrepreneurial profits in the same way that an entrepreneur discovers a new innovation or profits from differences in relative prices. Hence, the inclusion of space in the theory of entrepreneurship makes it more complete (Andersson, 2005).

Kirzner argues that spontaneous orders (as discussed by Boettke, 2013) should be analyzed by assuming a fixed and given framework. For example, given pre-defined moral codes, ethical rules, and legal institutions that define factors such as property rights and the freedom of contract the analysis occurs within a pre-specified institutional framework. According to Kirzner, analysis of the emergence of institutional frameworks is much more difficult, and he is therefore skeptical whether the "existing economic tools" are sufficient for this task.

4.2 Cities consists of more orders than the market

A market economy is the most conventional example of a spontaneous order. But civil society consists of more than just the market. Cities thus also include spontaneous orders such as languages, networks, and cultures. They help people access these orders through face-to-face communication.

The role of culture is briefly touched upon in the discussion of tacit knowledge. Many agglomerations develop special cultures which increase both benefits and costs for participants. The culture of an agglomeration increases the costs of entry. Kiriakos (2011) offers an interesting study of "the cost of not being there." In her analysis she focuses on the cost of not being located in Silicon Valley for Finnish professionals. Interviews with Finnish information technology workers reveal disadvantages of being in Finland instead of in Silicon Valley. Examples that are brought up in the interviews are indirect costs such as not being invited to network meetings or seminars and missing out on business opportunities for the only reason that one has a Finnish address and phone number. The discussion relates to the characteristics of face-to-face communication that are highlighted by Storper and Venables (2004).

The culture of an agglomeration also includes the spontaneous order of language. To take part in and be able to access the tacit knowledge in an industry one has to be able to communicate with the other participants. How this communication develops over time is a spontaneous-order process. The channels for communication may be considered as order-specific links. Within densely populated areas there are many examples of clubs, networks and associations that facilitate the communication of tacit or specialized knowledge. Such entities enable their members to get superior knowledge of new ideas and innovations that are important for technological change and entrepreneurship. They are also important conduits of new business and employment opportunities. Within these networks specialized cultures and ways of communication evolve over time. Firms invest in these economic networks in order to get superior information about relevant ideas, inventions, and innovations. The links accumulate economic value over time. One can apply the same type of analysis to these networks as to the market. They are enabled by human action but the order is a by-product; there is no unified goal or aim of the networks and their associated cultures or specific languages.

4.3 Dissemination of knowledge

Depending on its characteristics, knowledge can be divided into two main categories: specialized/private knowledge versus ubiquitous/transparent knowledge. For the emergence of cities, the first category is relevant to the discussion of the spontaneous order of cities. In addition, there are two types of specialized knowledge: tacit versus codified (Storper and Venables, 2004). In the context of entrepreneurship and innovation, it is knowledge that is both specialized (private) and tacit that is of primary importance.

The main difference between codified and tacit knowledge is how it is communicated. Codified knowledge can be communicated through symbols such as written texts, whereas tacit knowledge requires direct experience within a given context. Tacit knowledge is a kind of personal knowledge that can only be transferred through social interaction such as face-to-face communication, conversations, debates, imitation and observation. In addition, spatial agglomerations often exhibit a contextual homogeneity or culture which engenders steep geographical distance gradients and increases the benefits from spatial proximity. The consequence is that face-to-face interaction has four major benefits: efficient communication; enhanced trust and incentives in relationships; improved screening and socialization; and extra effort and innovation (Storper and Venables, 2004).

5 CONCLUDING REMARKS

This paper shows that spillovers of tacit knowledge still depend on spatial proximity, despite the global reach of information and communication technology (ICT). Dynamic externalities generate city growth and emergence. Both spontaneous order theories and urban economics focus on the effects of dispersed knowledge and knowledge flows. Both also highlight the importance of entrepreneurship for economic development. The current paper focuses on these aspects, with the aim of showing how the two fields can gain from each other.

Since the late 1990s, an increasing number of papers aim at bringing the two frameworks together. These papers have enriched the analytical framework and led to a deeper appreciation of the effects of spatial co-location. Another important development is the increasing availability of data that enable urban economic researchers to apply an individualist methodology when analyzing knowledge flows among individuals. These parallel developments have supported an understanding of spatially situated human action that is compatible with Austrian methodology.

Notes

1 Note, however, that Jacobs was not a "theorist of spontaneous orders" although her analytical framework could be understood in terms of spontaneous orders.

2 Desrochers (2001, 26) argues that the "traditional geographical perspectives" do not contain an individualist approach but rather applies a "regional innovation system" approach. Because of the access to detailed register-based data on both the individual and firm levels, empirical research on cities and externalities has become increasingly individualist in its methodology.

3 Another dimension is given in Acs, Bosma, and Sternberg (2008). They use Global Entrepreneurship Monitor (GEM) data to rank world cities according to i) early stage entrepreneurial activity, ii) entrepreneurial perceptions and, iii) the characteristics of early-stage entrepreneurial activity.

References

Acs, Z., Audretsch, D. (1988). Innovation in large and small firms: An empirical analysis. *American Economic Review*, 78: 678-90.

Acs, Z., Bosma, N., Sternberg, R. (2008). The entrepreneurial advantage of world cities: Evidence from global entrepreneurship monitor data. *Working paper H200810* (Scientific Analysis of Entrepreneurship and SMEs).

Audretsch, D. (1998). Agglomeration and the location of innovative activities. *Oxford Review of Economic Policy*, 14: 18-29.

Andersson, D.E. (2005). The spatial nature of entrepreneurship. *Quarterly Journal of Austrian Economics*, 8: 18-29.

Andersson, D.E. (2012). The spatial market process. In: Andersson, D.E. (Ed.) *The Spatial Market Process*. Bingley, UK: Emerald, ix-xvi.

Andersson, D.E. (forthcoming). Cities and Planning: The Role of System Constraints. In: Andersson, D.E., Moroni, S. (Eds.) *Private Urban Planning: Opportunities and Limits*. Cheltenham, UK: Edward Elgar.

Arrow, K.J. (1962). The economic implications of learning by doing. *Review of Economic Studies*, 29: 155-73.

Bairoch, P. (1988). *Cities and Economic Development: From the Dawn of History to the Present*. Chicago, IL: University of Chicago Press.

Boettke, P.J. (2013). Entrepreneurship and the entrepreneurial process: Israel M. Kirzner and the two levels of analysis in spontaneous order studies. SSRN: http://ssrn.com/abstract=2213004 or http://dx.doi.org/10.2139/ssrn.2213004

Cagetti, M., De Nardi, M. (2006). Entrepreneurship, frictions, and wealth. *Journal of Political Economy*, 114: 835-70.

Dahiya, B. (2012). Cities in Asia, 2012: Demographics, economics, poverty, environment and governance. *Cities*, 29: S44–S61.

Desrochers, P. (1998). A geographical perspective on Austrian economics. *Quarterly Journal of Austrian Economics*, 2: 63-83.

Desrochers, P. (2001). Geographical proximity and the transmission of tacit knowledge. *Review of Austrian Economics*, 14(1): 25-46.

diZerega, G. (2004). Toward a Hayekian theory of commodification and systematic contradiction. *The Review of Politics*, 66: 445-68.

diZerega, G. (2013). Outlining a new paradigm, *Cosmos and Taxis*, 1(1).

diZerega, G., Hardwick, D.F. (2011). The emergence of Vancouver as a creative city. In: Andersson, D.E., Andersson, Å.E., Mellander, C. (Eds.) *Handbook Of Creative Cities*, Cheltenham, UK: Edward Elgar, 365-84.

Decressin, J., Fatás, A. (1995). Regional labor market dynamics in Europe. *European Economic Review*, 39: 1627-55.

Feldman, M.P., Kogler, D.F. (2010). Stylized facts in the geography of innovation. In: Hall, B.H., Rosenberg, N. (Eds.) *Handbook of the Economics of Innovation* (Volume 1). Amsterdam, NL: Elsevier, 381-410.

Florida, R. (2012). http://www.theatlantic.com/business/print/2012/05/what-is-the-worlds-most economically-powerful-city/256841/. (Retrieved January 31, 2013).

Florida, R., Gulden, T., Mellander, C. (2008). The rise of the mega-region. *Cambridge Journal of Regions, Economy and Society*, 1: 459–76.

Florida, R., Mellander, C., Gulden, T. (2012). Global metropolis: Assessing economic activity in urban centers based on nighttime satellite images. *The Professional Geographer*, 64: 1–10.

Fritsch, M., Wyrwich, M. (2012). The long persistence of regional entrepreneurship culture: Germany 1925-2005. DIW Berlin Discussion Paper No. 1224.

Fujita, M., Thisse, J.F. (2002). The formation of economic agglomerations. In: Huriot, J., Thisse, J.F. (Eds.) *Economics of Cities*. Cambridge, UK: Cambridge University Press.

Glaeser, E., Kallal, E., Scheinkman, J., Shleifer, A. (1992). Growth in cities. *Journal of Political Economy*, 100: 1126-52.

Heijman, W., Leen, A.R. (2004). On Austrian regional economics. *Papers in Regional Science*, 83: 487-93.

Hayek, F.A. (1937). Economics and knowledge. *Economica*, 4: 33-54.

Hayek, F.A. (1945). The use of knowledge in society. *American Economic Review*, 35: 519-30.

Hayek, F.A. (1948). *Individualism and Economic Order*. Chicago, IL: Chicago University Press.

Ikeda, S. (2004). Urban interventionism and local knowledge. *Review of Austrian Economics*, 17: 247-60.

Jacobs, J. (1961). *The Death and Life of Great American Cities*. New York, NY: Random House.

Jacobs, J. (1969). *The Economy of Cities*. New York, NY: Random House.

Johansson, B., Lööf, H., Nabavi, P. (2012). How can firm benefit from access to knowledge-intensive producer services? CESIS Working Paper No. 283, The Royal Institute of Technology, Stockholm.

Keller, W. (2010). International trade, foreign direct investment, and technology spillovers. In: Hall, B., Rosenberg, N. (Eds.) *Handbook of the Economics of Innovation*, Amsterdam, NL: Elsevier.
Kirzner, I.M. (1997). Entrepreneurial discovery and the competitive market process: An Austrian approach. *Journal of Economic Literature*, 35: 60-85.
Kiriakos, C.M. (2011). Why being there matters: Finnish professionals in Silicon Valley. In: Andersson, D.E., Andersson, Å.E., Mellander, C. (Eds.) *Handbook of Creative Cities*. Cheltenham, UK: Edward Elgar, 307-24.
Lööf, H., Nabavi, P. (2013). Learning and productivity of Swedish exporting firms: The importance of innovation efforts and the geography of innovation. CESIS working-paper No. 296, Royal Institute of Technology, Stockholm.
Marshall, A. (1890). *Principles of Economics*. London, UK: Macmillan.
McKinsey & Company (2011). *Urban World: Mapping the economic differences*. McKinsey Global Institute.
Malmberg, A., Maskell, P. (2002). The elusive concept of localization economies: Towards a knowledge-based theory of spatial clustering. *Environment and Planning A*, 34: 429-49.
Porter, M.E. (1990). *The Competitive Advantage of Nations*. New York, NY: Free Press.
Retsinas, N.P. (2007). Mega-cities, mega-problems. *Los Angeles Times*, February 28.
Romer, P.M. (1990). Increasing returns and long-run growth. *Journal of Political Economy*, 94: 1002-37.
Rugman, A.M. (2000). *The End of Globalization*. London, UK: Random House.
Storper, M., Venables, A.J. (2004). Buzz: Face-to-face contact and the urban economy. *Journal of Economic Geography*, 4: 351-70.

For COSMOS+TAXIS *1(1)*; an invited reply to Gus diZerega's "Outlining a new paradigm."

Rules of Spontaneous Order

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Abstract: This paper is a reply to Gus diZerega's essay on the nature, scope and ambition of spontaneous order studies. I am in broad agreement with diZerega's claims and so I will seek neither rebuttal, nor restatement. Instead, I want to argue some different points of emphasis in the spontaneous order research program. Specifically, I argue that emergent social order should be studied as an application and indeed exemplar of the evolutionary theory of rule-based co-operation.

Keywords: Spontaneous order; complexity; economic evolution; Hayek; rules

1 INTRODUCTION

This essay is a response to Gus diZerega's engaging, thoughtful and wide-ranging survey of the subject domain of spontaneous order studies and of the various analytic and methodological approaches within its ambit. The launch of a new scholarly outlet for the study of emergent social phenomena is an ideal opportunity to engage in such purpose and reflections. I want to pick up some themes and challenges that diZerega has posed, and push them along a little further. This essay will develop the analytic framework that diZerega has proposed, but I will seek to steer these arguments in a particular direction, namely toward a study of evolving rule-systems for distributed co-operation. Specifically, I argue that the most overarching source of spontaneous order in any social system is imitation, or the copying of rules. This produces co-operation and evolution, which in the social sciences are the proper focal points for the study of spontaneous order.

Like any relatively new science[1] spontaneous order studies is still very much in the 'collecting' phase of gathering together instances of spontaneous orders, and of gathering and auditioning methods and tools for their study. Its research program is still advancing through the following templates —'X is (also) a spontaneous-order domain'; and 'Y is (also) a spontaneous-order theorist'. My purpose in this essay is not to add another X or Y—for I do that elsewhere, with X = Innovation and Y = Elinor Ostrom and Deirdre McCloskey (Potts, 2012). Instead, I seek here to build on diZerega's survey with some particular refinements and points of emphasis.

Many sciences develop by the differential contributions of 'lumpers and splitters'.[2] Lumpers see in advance the bringing of things together that may appear different, so that overarching patterns and similarities may be revealed. Spontaneous-order theory, it would seem, is dominated by lumpers. Splitters seek to make sub-classifications to highlight different mechanisms and to make sense of new data. Mature sciences tend to be dominated by splitters. I want to do both some lumping and some splitting.

The lumping is in respect of the theory of *co-operation*: I want to lump spontaneous order studies—and the study of emergent social phenomena generally—with the study of co-operation. This often sits below the surface. Yet the study of spontaneous orders can benefit from having this in plain view. It also helps reveal intriguing questions that are otherwise ill-framed: such as why spontaneous orders are often so hard to see, or why we so readily attribute design or intention to the complex order they produce when there is none. This also helps frame the classical 'Scottish Enlightenment' sense of spontaneous orders as a species of what we might think of as unintended co-operation.

The splitting is in respect of the mechanisms of spontaneous orders. I want to make the case that there are two broad and distinct mechanisms at work in a spontaneous order—complex networks (adaptation) and evolution (copying)—and while they are often seen together, they are in fact different mechanisms and processes. The research program of spontaneous order studies benefits from splitting them. On the one hand there are spontaneous orders made of complex information networks that facilitate the use of distributed information and knowledge through signals and adaptation. A classic example is F.A. Hayek's (1945) essay on the price mechanism 'The use of knowledge in society'. On the other hand, there are spontaneous orders that emerge though differential rule copying, as through an evolutionary process that results in the change of population structures. A classic example is F.A. Hayek's (1973) theory of cultural evolution, which might well have been called 'the use of society in knowledge'. There are several reasons to emphasize this split. One is that they draw on different theoretical and analytic foundations (*viz*. complexity and network theory versus evolutionary theory). Another is that while networks are essentially about information dynamics, evolution is about rule dynamics.

This lumping and splitting helps us to see the relation between spontaneous orders and civil societies, which is the theme of Part III of diZerega's essay, where he argues that Jane Jacobs' work is more in the manner of civil society rather than of spontaneous order, and that civil societies are analogous to social ecosystems. I want to step back from the social ecosystem metaphor and argue that civil society is what happens when we have both sorts of dynamics: namely, information networks and the emergence and evolution of rules.[3] But these differences in emphasis should not detract from the overarching agreement.

Gus diZerega has proposed a broad map of the elements of the study of spontaneous order and the range of its applications (see also diZerega, 2008). Studies of spontaneous order have a wide compass. There are multiple definitions and meanings, many accepted methods, and an inclusive attitude to membership. But to progress much beyond a broad-church concept it will need to refine its definitions and sharpen its focus. This new journal is an instrument in the effort to do that. Toward that end, I want to make the case that spontaneous-order studies can be usefully framed as the study of the rules by which co-operation evolves.

2 INVISIBLE HANDS & EVOLVED MINDS

But before we get to that, consider a basic reason why the study of spontaneous orders is hard, namely that we seem instinctively predisposed not to see emergent unintentional order. We tend to overwrite it with intention and design.

The concept of an emergent or spontaneous order has been a part of inquiries into the human, natural and social sciences at least since the writings of the Scottish moral philosophers (Barry 1982). In 1714 we find in Bernard Mandeville's *Fable of the Bees* a story of 'private vices and public virtues'. The concept of 'the invisible hand' is in Adam Smith's *History of Astronomy* (1749), in his *Theory of Moral Sentiments* (1756) and in the *Wealth of Nations* (1776). In 1782, Adam Ferguson wrote in *History of Civil Society* of social order as 'the result of human action, but not the execution of any human design'. The abstract idea of a spontaneous order has long been recognized as central to the study of human society, the growth of knowledge, and the economy.

These deep eighteenth-century insights catalysed further recognition of the domain of spontaneous orders as alternative explanations of the appearance of design. Perhaps most famously this occurred in Charles Darwin's theory of evolution by natural selection—still a classic argument against design—but eventually leading to the modern science of complex adaptive systems and of emergent order. Nevertheless, the core of the analytic idea of a spontaneous order that developed through the nineteenth and twentieth centuries can be claimed to have centred on the concept of a market or institutional price mechanism (as in the work of Carl Menger, for example) as an information-processing system that co-ordinates the distributed actions of individuals, and which results in an overall pattern of order or *cosmos*, a term that Hayek (1979) highlighted in Chapter 2 of *Law, Legislation and Liberty*. This spontaneous order emerged from a parallel process of mutual feedback and local adaptation, co-ordinated through price signals.

The study of the spontaneous order of culture, economy and society has developed across a number of domains: specifically, through what Ludwig von Mises called a *catallaxy* in relation to the economic order; what Hayek called 'the Great Society' and 'the extended order';[4] what Karl Popper called 'the Open Society' in relation to the classical liberal polity; what Michael Polanyi called the spontaneous order of the enterprise of science; and in the study of the equilibrating tendencies of the price system (e.g. in the work of Leonid Hurwicz, although not in that of Kenneth Arrow). These advances have helped us to see the range of where spontaneous orders exist and provide insight into the mechanisms and processes by which they work. Gus diZerega, in his opening essay, proposes several other key contributors and domains, including Jane Jacobs on cities, Thomas Kuhn on scientific revolutions and Evelyn Fox Keller on slime moulds. A register of additional domains of spontaneous-order studies extends well beyond market economies and reaches into the study of, for example: law (Hayek, 1967); language (Pinker, 1995; Habermas, 1998); democracy (Scott, 1998; diZerega, 1989); religion (Andersson, 2010); the family (Horwitz, 2005); and arts and literary production (Camplin, 2010; Cantor and Cox, 2010).

It is noteworthy that spontaneous orders are both very common[5]—they are in an important sense all about us, as the above list illustrates—and yet are nevertheless very difficult to see, in the sense that we must overcome a 'nativist' perception that these are the result of a designed order. Specifically, it is difficult to see complex structures and systems—such as families, cities, science, economies and so on—as not being designed or planned, both because of their apparent complexity and because they are seemingly co-operative systems or outcomes. It is hard to see them as spontaneous orders.

Consider why this is. First, you can't see them directly. They have to be statistically constructed so that the ordered patterns become apparent. But there is a further difficulty that acts against the grain of any analytic exploration. The problem is that our brains seem wired as if to actively filter out or misconstrue spontaneous orders. This is not simply a problem of rational ignorance about how economic systems work (Caplan, 2006). Instead, it would seem to be the case that the human perceptual and classificatory apparatus has evolved in such a way as to instinctively misconstrue spontaneous orders as either purely *natural*—as exogenous or unintended—or as entirely *artificial*—as endogenous and intentional. Under this hypothesis, we have a cognitive blind spot in respect of order that is both endogenous (caused by human action) and unintentional (not by human design).

The human brain (and probably other organisms too) has trouble with endogenous forces and processes in the social realm that are unintentional. Endogenous-Intentional covers the range of artificial or rational operations (see Figure 1 below). Exogenous-Unintentional is the realm of the natural. Exogenous-Intentional is the mystical. But Endogenous-Unintentional is problematic: we more or less filter it out. But that invisible world is the realm of spontaneous orders.

Figure 1: System-agency in attribution of order

	Intentional	*Unintentional*
Exogenous	Mystical	Natural
Endogenous	Artificial/Rational	Spontaneous Order

The invisibility of spontaneous order has the perverse effect of generating demand for hierarchically imposed forces to defeat the latent anarchy of the Hobbesian social 'state of nature' with the artificial creation of centralized governance. The tendency to see a mystical basis of society is perhaps deep in the human psyche and instinct, and the modern mind has developed to replace this with an attribution that oscillates instead between natural and artificial. But it would appear that there is a similar tendency to neglect the possibility of spontaneous order. They may simply not see it, or they may see it but find in it quasi-mystical properties that may appear dogmatic or ideological. Hayek observes that

> [m]any of the greatest things man has achieved are not the result of consciously directed thought, and still less the product of deliberately coordinated effort of many individuals, but of a process in which the individual plays a part which he can never fully understand. They are greater than any individual precisely because they result from the combination of knowledge more extensive than any single mind can master (Hayek, 1952, 149-50).

That millions of people pursuing their own purposes and plans without central direction could result in anything other than utter chaos seems implausible: no design without a designer; large-scale order must thus be the result of large-scale planning. That chaos does not generally result, and that societies and market economies not only function without detailed centralized direction, but for the most part function best without it, is testament to the supreme importance of this idea as a foundational insight into the nature of modern society and economic systems.

The human mind seems to have evolved to attribute any perceived order to the guiding intention of an ordering hand or mind, and thus to seek causal explanations or stories (Boyd, 2009). So there may be opportunity to develop a minor research program at the intersection of evolutionary psychology and behavioural economics to explore this systematic 'anomaly' (*à la* Kahneman, 2011). Call this 'behavioural microeconomics of spontaneous orders'; it may then underpin various attribution biases, systematic overconfidence in entrepreneurial judgments, expectation formation, and many other choice anomalies.

3 CO-OPERATION

The reason we care about spontaneous orders at all—which is to say the reason why we seek to better understand how they work and their range of application—is because of what they are not: namely, a spontaneous order is not the consequence of coercive force. It is not an expression of individual power over others. A spontaneous order is a state of co-ordination that is achieved through mechanisms that are, in law, nature and game theory, co-operative. A spontaneous order is the outcome of a mutual co-operative strategy, that is, as diZerega notes, 'based on certain broadly shared values that are simpler than the values actually motivating many people'.

A spontaneous order is an unintentional co-operative solution that arises from agreement about rules, not outcomes. It is a solution to a co-ordination problem that arises without recourse to force of command or acts of coercion. The price mechanism is both an efficient and a peaceful mechanism. There are also other efficient and peaceful ways to achieve order. Co-ordinated outcomes can also be realized through rule-governed voluntary collectives, such as when clubs or civil societies create public goods. Or it can occur when many people adopt the same behaviour, technology, institution or idea. In these instances, the order essentially exists in the correlated population of rules that agents carry. It exists dynamically in the institutional space of order provided by those rules.[6]

The concept of a spontaneous order has long been associated with the order of the market, in which price signals co-ordinate economic activity without the need for central planning. It has also been noted that this spontaneous order seemingly relies on institutional arrangements such as property rights that are provided by government, and therefore rely on its coercive powers. But as Ostrom (1990), Greif (1993), Anderson and Hill (2004), and Leeson (2008; 2010) among others show, there is considerable scope for the development and enforcement of rules to govern co-operative behaviour without recourse to the state. This connection between the mechanisms of co-operation and spontaneous orders is at the forefront of modern science and is having a particularly strong impact in the reframing of the social sciences (Nowak, 2010; Wilson, 2012).

Theoretical, experimental and empirical findings are converging on a set of conditions that appear to be necessary for the emergence of co-operation in 'collective-action' or 'social-dilemma' situations. These are: (1) low discount rates, patience, or long time horizons; (2) low information-sharing or communication costs; (3) equally strong agents; and (4) shared ideas about defection and how it should be punished (Leeson, 2008: 70). In the absence of these conditions, mutual co-operation is not expected to emerge spontaneously. diZerega makes a similar observation, noting that 'all spontaneous orders possess certain abstract features in common' —'all participants have equal status. All are equally subject to whatever rules must be followed. All are free to apply those rules to any project of their choosing'. He also recognizes that 'these rules facilitate co-operation among strangers'. There is obvious overlap between these approaches as well as room for cross-fertilization: for example, in the understanding of decentralized enforcement (or what is called 'altruistic punishment' in the evolutionary-games literature).

There are two main concepts of *orders* in the literature: first, that based on command incentive (for example, power or coercion); and second, that based on non-command incentive (for example, markets or other spontaneous orders). And there are two main concepts of *spontaneous* orders in the literature: that which is based on information (or complexity); and that which is based on rules (or evolution). Spontaneous orders are co-operative orders. These are valuable in themselves because they are not coercive orders. Spontaneous orders are in several ways voluntary and non-coercive. But they are also invariably rule-governed, rather than command-governed. They are better understood as rule systems than as communication systems; but in both cases they are co-operative systems.

4. INFORMATION & RULES

Hayek's most well-known paper, and by several accounts one of the most important papers in economics (Arrow *et al.*, 2011), is his 1945 essay—'The use of knowledge in society'. It explains how the information contained in price signals enables vast numbers of economic agents to continuously adapt not only to changes in the relative scarcity of different commodities, both locally and globally, but also to changes in the preferences and plans of others, all through mutual adaptation and without central direction. The result is the coordination of millions of individuals' plans without anyone doing the planning, a result also known as the spontaneous order of the market through the mechanism of the price system. Hayek (1945: 527) notes in passing that '[i]f it were the result of deliberate human design … this mechanism would have been acclaimed as one of the greatest triumphs of the human mind'. His point is that we don't tend to value things, such as spontaneous orders, that can't be traced to rational planning or individual construction.

Hayek unpacks the spontaneous orders in the market-price system by focusing on distributed information or knowledge. The centrepiece of Hayek's (1945: 520) argument lies in recognizing that the economic problem is ultimately 'the utilization of knowledge not given to anyone in its totality' and, crucially, that there are 'different kinds of knowledge'. There is scientific or technological knowledge – 'which occupies now so prominent a place in public imagination that we tend to forget that it is not the only kind that is relevant' – and there is local distributed 'knowledge of particular circumstances of time and place'. For Hayek this second type of 'very important but unorganized knowledge' about local conditions and opportunities is key to understanding why the decentralized price system is superior to central planning. Following von Mises' information-and-calculation-based critique of socialism (1922/1951), Hayek argues that the price system enables a society to make effective use of distributed knowledge of the particular circumstances of time and place, something that is not just difficult but impossible in a centrally organized system.

Hayek and the Austrian school of economics (along with certain strands of post-Keynesian macroeconomics[7]) have emphasized that the fundamental economic problem is not so much an *allocation problem* (the textbook shibboleth 'the allocation of scarce resources') but is properly understood as a *co-ordination problem* as regards the co-ordination of distributed knowledge and individual plans. Prices carry information that embodies widely distributed knowledge as information that enables agents to adapt their own actions in response. A system of markets with variable prices is thus a kind of many-to-many communication network or system:

> The most significant fact about this system is the economy of knowledge with which it operates, or how little the individual participants need to know in order to be able to take the right action. … It is more than a metaphor to describe the price system as a kind of machinery for registering change, or *a system of telecommunications* which enables individual producers to watch merely the movement of a few pointers in order to adjust their activities to changes of which they never know more than is reflected in the price movement (Hayek, 1945: 527; italics added).

The allocation-coordination distinction is important because if the economic problem is defined as an allocation problem *and* if the role of prices is to define the general equilibrium solution to this problem—as in textbook neoclassical economics—then the socialists would have a point. Specifically, what economists such as Oskar Lange (1936; 1937), Henry Dickenson (1933) and Abba Lerner (1937; 1938) noted in the 1930s was that if we can compute those prices by some other means, then we don't actually need the market-generated *process*; we can just go straight to the optimal allocation using 'shadow prices' and the implementation of an optimal central plan. Hayek's 'The use of knowledge in society' was a rebuttal to this claim by reasoning that there is no way the planners can get that information to compute those prices in the first place because most of it – 'the particular circumstances of time and place' – is distributed and subjective and cannot be centralized. This is why a market society co-ordinated by the price mechanism will work, and why any large complex society based on central planning will eventually fail (Boettke, 2000).

The price mechanism is a massively parallel communication system that produces (or computes) the spontaneous order of the market. As Steve Horwitz explains:

> Because so much of our knowledge is tentative, fragmented and tacit, we require the use of spontaneously evolved social institutions to generate social order. Spontaneous ordering processes are *communication procedures* that enable us to overcome our very narrow and partial views of the world and to make use of the differently partial and narrow knowledge that others possess (Horwitz, 2001: 91, italics added).

It enables the efficient and effective utilization of distributed knowledge through its embodiment in prices and the adaptive behaviour that price changes induce. This account that focuses on distributed and partially tacit knowledge, on prices as information signals, and on the communications system metaphor has become the dominant theoretical account of the efficacy of the price mechanism and the market system. Peter Boettke (1990, italics added) explains that 'early Hayek, as well as later Hayek, is concerned with *the communicative function* of social institutions in general, whether they are money prices within the economic system or the rules of behavior within social interaction. Exploring this communicative function is what motivates his research'.

This is not only in the development of work on mechanism design (see for example Hurwicz, 1969; Myerson, 2009) but also as evidenced by the research program on information asymmetries and bounded rationality, all of which proceeds from a computational and information-centred view of markets.

Most definitions of spontaneous order are in the Smith-von Mises-Hayek tradition of decentralized information communication networks without a central co-ordinator. The price-mechanism model of co-ordination via information feedback is almost canonical in the study of spontaneous orders. A related model emphasizes a different aspect of the process of spontaneous order emergence: the role of rule use, rule creation and rule copying (Dopfer, 2004; Dopfer and Potts 2008; 2013). Rule-use and rule-copying also produce a spontaneous order. This is 'the use of society in knowledge'.

This approach is more explicitly evolutionary in the Darwinian sense of centring on the differential replication (variation and selection) of units of knowledge such as genes, technologies or rules (Nelson and Winter, 1982; Aldrich *et al.*, 2008; Hodgson and Knudsen, 2011). It is also more explicitly modelled on theories of cultural and technological evolution (Hayek, 1973; Boyd and Richerson, 1985; Rogers, 1995; Ziman, 2001; Mesoudi, 2011).

We may understand rules as the units of knowledge that compose a cultural, technological or economic order, in the sense of rules as the ordering instructions that govern individual choice, action and behaviour (rules of choice, behavioural heuristics), as well as rules that govern how people interact in organizations or shared or common rules that define institutions. We may also think of technology as rules for ordering matter-energy into particular forms to generate particular capabilities (Arthur, 2009). By rules, then, we refer to the knowledge that composes an economic, social, technological or cultural order and specifically to the idea that these rules have an origin, a point at which they are developed, and a trajectory by which they are adopted into a relevant *carrier population* that may potentially stabilize at some level to form an institution. In the language of Dopfer *et al.* (2004) and Dopfer and Potts (2008), this 'generic rule and its carrier population' forms a 'meso unit': a macro-economy is an order of meso-units (Wagner, 2012). The order of a macro-economy is an order of rules fitting together, both in the connectionist or complex-systems sense of the rules fitting with other rules (Potts, 2000) and also in the Darwinian-population sense of a population of rules coming into order. Rules are what evolve in the process of economic evolution and the order of the 'market ecology' is an order of rules.

From this perspective, then, the spontaneous order of the market can be viewed from an evolutionary perspective that is centred on not only a given population and structure of rules. It is also centred on the process by which new rules originate and enter into the economic order, and on the evolutionary trajectory through which they are adopted by a carrier population, as well as on the effect of that process on existing rules, a process that Joseph Schumpeter (1945) famously characterized as 'creative destruction'. The point of this emphasis on rules and the evolutionary process is to make clear the difference between a process of adaptation within a given set of rules or knowledge and a process of the adoption of new rules. In the first case, exemplified by Hayek's 'use of knowledge in society', we are dealing with the outcome of a many-to-many communication network operating through price signals that are processing distributed knowledge. In the second case, exemplified by Schumpeter's creative destruction model of economic evolution, we are dealing with a process in which new ideas, rules or knowledge enters into and transforms a system as the rule is originated, adopted and retained by a carrier population. It will often be the case that these two co-ordination processes occur simultaneously, but they are nevertheless different types of spontaneous order. Any endeavour to develop the theory of spontaneous order needs to make this distinction clear.

Yet these ideas are often run together in the spontaneous-order tradition, where there is a tendency to think of distributed knowledge and changes as being caused by exogenous shocks, as well as to think of the re-coordination that the price mechanism provides as carrying over to the 'exogenous shocks' of new technology or new ideas.[8] There is a tendency to think of these things (new information, new knowledge and new ideas) as more or less the same concept at the limit, but there is a crucial difference. In short, the first requires *adaptation* (doing something different, requiring reaction); the second requires *adoption* (doing something new, requiring learning). With novelty, the problem is not with whether something has changed and what to do about it; the problem is about how to act in a situation never before encountered, a situation in which learning is required about how to act at all.

There are broadly two solutions to the challenge of learning how to act in a new situation: (1) develop a new strategy; or (2) copy someone else. As if to parallel Hayek's argument regarding knowledge as technical knowledge and knowledge of time and place (where the common premise was that all knowledge was technical knowledge), the basic problem with modern economics is that it assumes that any situation involving novelty necessarily involves developing a new strategy, and moreover that this is a costless process. That is, it presumes that the challenge of learning is met by the agent acting rationally, and without reference to the actions or the examples of others. But while economists tend to model rational behaviour this way, it is actually far from obvious that this is itself a model of rational behaviour. Specifically, once we account for the opportunity costs involved, the frequency with which novel situations or commodities are met, and the common situation that some other agents have already invested time and resources in figuring out what to do, imitation or copying can be, in the language of Vernon Smith, an ecologically rational strategy (see also Banerjee, 1992; Bikhchandani *et al.*, 1992; Potts *et al.*, 2008; Ormerod, 2012). This is the use of society in knowledge, which is an idea that Hayek himself wrote about in terms of cultural group selection in which 'successful practices get passed on through tradition, learning and imitation' (Caldwell, 2000: 6).

Under certain conditions copying is an effective strategy, both individually and globally, and results in a grown order that through differential adoption effectively co-ordinates new rules into the economic order. This is of course not a novel argument; copying mechanisms underpins most theories of cultural evolution. However, the concept has not yet been properly integrated into studies of spontaneous order, and nor has the full implications of this generalization from information to knowledge been fully elaborated in terms of subject matter, empiricism, theory, and analysis. There are many definitions of spontaneous order but these are largely in terms of information and systems co-ordination. I argue that a more general approach should be based on rules and on a comprehensive rule classification. It should also be centred on rule-copying. This explains how spontaneous orders are grown, and accounts for this in the presence of novelty. A special case is then when there is no rule-copying or rule dynamics, and just decentralized co-ordination through positive and negative feedback, such as through the price mechanism.

5. TWO DEFINITIONS OF SPONTANEOUS ORDER

From Adam Smith to Vernon Smith the standard account of a spontaneous order is of a process of mutual adaptation that is facilitated by the information economy of the price mechanism. The price mechanism is herein understood as a communication system that can efficiently process widely distributed knowledge and information (Hayek, 1945). Agents can co-ordinate their individual plans by paying attention to price movements alone, and without the requirement of any central controlling agency. In this account, spontaneous order means 'order without design', but specifically refers to an outcome produced by the price system. The price system is said to be a complex evolutionary mechanism that co-ordinates the production of the economic order.

Several partially overlapping yet analytically distinct approaches to the study of spontaneous orders are embedded in this definition. There is a communication-network definition that emphasizes the solution to the distributed-knowledge problem and the role of price signals as a co-ordination mechanism. This emphasizes information feedback processes among individual agents and the limited knowledge of each agent. A different emphasis is in complexity-based approaches to the study of spontaneous orders, which tend to focus on the systems properties of the connections and interactions between the agents, and on the emergent properties of the system because of these structures of interactions. This also includes agent-based computational approaches, using rule-based agents interacting on complex networks. Further along this path is the evolutionary and institutional approach that pushes the agents and information further into the background and brings the population dynamics of rules or knowledge into the foreground.

As such there are two standard approaches to spontaneous order, broadly in terms of whether the focus is on the outcomes (i.e. the order *per se*, or the state of co-ordination or equilibrium), or on the processes, mechanisms and institutions that generate or constitute those outcomes. This difference is in practice hard to separate, and indeed James Buchanan[9] has explained that it doesn't even make sense to speak of an order separated from the process by which it is arrived at or discovered. In a brilliant short note entitled 'Order defined in the process of its emergence' he explains:

> I want to argue that the "order" of the market emerges only from the *process* of voluntary exchange among

the participating individuals. The "order" is, itself, defined as the outcome of the *process* that generates it. The "it," the allocation-distribution result, does not, and cannot, exist independently of the trading process. Absent this process, there is and can be no "order" (Buchanan, 1986b: 73-4; italics in original).

That the outcome and the process are in a sense the same phenomenon has meant that definitions of spontaneous orders can shift back and forth between the mechanism or process and the outcome. A line of thinking from Adam Smith through John Stuart Mill, Carl Menger, Frank Knight and F.A. Hayek centres on the price mechanism—and the study of markets and market-like situations that compute and communicate price or price-like information—as the core of the study of spontaneous order. In the modern form, this is then associated with the workings of a complex system (Wagner, 2008). Vriend (2002), Lavoie (1989) and Potts (2000) associate Hayek's view with complexity, and Barkley Rosser (2012: 125) explains that '[i]n Hayek's view, emergence and complexity are essentially the same thing, given his linking of the concept of complexity to the emergentist tradition of Mill, Lewes and Morgan'.

But a wider definition views the spontaneous order of the market economy as the product of an *evolutionary process* operating broadly over organizations, institutions and technologies (Schumpeter, 1942; Nelson and Winter, 1982; Dopfer and Potts, 2008; Hodgson and Knudsen, 2010). Here the price mechanism is just one of several mechanisms involved in this evolutionary rule-based process. Steven Horwitz explains that spontaneous orders

comprise practices, rules, institutions, and so forth that have developed not because human actors rationally foresaw their likely benefits and deliberately, consciously constructed them, but rather because they are unintended consequences of various human actors' pursuit of their own purposes and plans (Horwitz, 2001: 82).

Despite this, the concept of a spontaneous order has come to be synonymous with that of a co-ordinating rule or convention that has emerged through use, salience and selection, rather than being deliberately designed. A spontaneous order is associated with the *co-ordinating rule* that generates the spontaneous order. This is the meaning of spontaneous order in evolutionary game theory, such as Thomas Schelling's focal points (Schelling 1960), or the notion of *conventions* or *institutions* as equilibrium solution concepts in a game, such as an evolutionary stable strategy (Maynard Smith and Price, 1973; Sugden, 1989; Young, 1993; Aoki, 2007).

A related meaning of spontaneous order is as an evolutionary process, and specifically a variation-and-selection mechanism, that blindly produces an ordered outcome though the twin mechanisms of variety generation and selection against variants that do not meet some minimum fitness criterion. The order here is attributed not to the individual elements and their interactions, but to the population as a whole and its associations with other populations. This 'ecological' or 'macro' ordering represents a state of order and co-ordination that is not attributable to design or intention but comes about through distributed interactions. Schumpeterian creative destruction is an example, as is the Austrian (liquidationist) theory of the business cycle.

A spontaneous order in the more classical sense refers to a broad phenomenal outcome of a state of co-ordination between many independent agents or parts such that they fit together. The order of the market, in the sense of Adam Smith's invisible-hand metaphor, fits this meaning, and more generally this refers to Hayek's notion of the 'Great Society', or the 'extended order', or of Popper's (1945) 'Open Society'. This includes not only a co-ordination of actions but also of plans and therefore of expectations:[10]

Living as members of society and dependent for the satisfaction of most of our needs on various forms of cooperation with others, we depend for the effective pursuit of our aims clearly on the correspondence of the expectations concerning the actions of others on which our plans are based with what they really do (Hayek, 1973: 36).

Hayek (1978) updated Smith's invisible hand with the concept of a spontaneous order. In the past few decades Hayek has himself been updated with the concepts of self-organization or the theory of *complex adaptive systems* (CAS). While the CAS framework has developed from a number of lines including non-linear dynamics, agent-based modelling, computational simulation, network theory, and other analytic domains, there is an acknowledged debt to the work of Hayek and others in introducing the idea of emergent order as a unifying concept. This is evident in neuroscience (Hayek, 1952), markets (Hayek, 1945) and the extended order of society (Hayek, 1973; see also Andersson, 2008).

Complex systems theory offers a sharper conception of analytic concepts, including agent, rule, interactions payoff and networks (or spaces of interactions, see Potts, 2000), and also descriptors such as the notion of self-organized criticality (Bak, 1999), emergence and the ubiquity of *power laws* as a signature of self-organization. Complex systems theory has also furnished a suite of off-the-shelf models for the study of CAS, such as cellular automata, Boolean networks, random graphs, and, more recently, increasingly sophisticated and easy-to-use simulation platforms and analysis packages. These factors have sharpened up the analytic conception, modelling approaches and empirical research into the study of spontaneous orders understood as belonging to the class of CAS.

A central insight, which also can be traced to Hayek, concerns what it means to describe a spontaneous order as complex. For Hayek and others, the main distinction was between a complex and a simple system, whereupon a hierarchical order (such as an organization) was actually a simple system because it could be described and understood. As Steve Horwitz explains, referencing Hayek's (1973) discussion of made versus spontaneous orders:

> Organisations are fairly simple structures, with a degree of complexity that the maker of the order can survey. In addition, organisations are usually directly perceivable by inspection and serve the specific purpose(s) of those who constructed them. Spontaneous orders, such as the market, are, by contrast, capable of any degree of complexity, they are rule based and their structures may not be obvious, plus they serve no particular purpose; rather, they serve the multitudinous purposes of those who participate in them (Horwitz, 2005: 671).

CAS theory has provided a deeper understanding of what it actually means to describe a spontaneous order as complex. In particular, complex systems theories distinguish complex not from simple but from complicated. A complicated system will have many parts or elements composing it. It is informationally complicated because there is a lot to know. However, a system with only a few parts could be a complex system. The crucial factor determining complexity concerns the interactions (not the number of parts). A complex system is complex because of feedback, and that feedback is a property or structure of the rules that govern the system. Complex systems are complex because they set up rule systems that drive information feedback between the elements (and whether there are a few or millions doesn't really matter).

It should also be clear that the study of spontaneous orders, and equally that of complex adaptive systems, is ultimately a study of rules and rule systems, and it is this ontology and method that distinguishes the spontaneous order approach from that of constructivist rationalism. An 'extended order' is a rule system. All spontaneous orders are rule systems because their governance structure is a process of rules rather than of hierarchic organization. For Hayek:

> it is only as a result of individuals observing certain common rules that a group of men can live together in those orderly relations which we call society (1973: 95).

Boettke elaborates:

> all we need are rules or social institutions (conventions, symbols) that produce mutually reinforcing sets of expectations to maintain a degree of social order, and these rules or institutions must serve as guides to individuals so they may orient their actions (Boettke, 1990: 76).

The spontaneous-order literature (for example the journal *Studies in Emergent Order*) does two things that differ from the above. First, it draws a somewhat different emphasis on the properties of a spontaneous order that focus on the properties of the elements as human agents with moral dimensions (a focus that Adam Smith also made). Specifically, it emphasizes the properties of the agents as independent, in the sense of pursuing their own plans without regard to those of others (and vice versa), except to the extent that other people's plans will impact on their own (and vice versa), thus recognizing that there is a co-ordination problem that needs to be solved. It has to be solved in such a way that it minimizes the extent to which each individual needs to concern themselves with the plans of others. Institutional solutions that maximize individual autonomy and minimize public sharing of information and coercion are to be preferred.

6. PRIVATE CHOICE AND PUBLIC INFORMATION

The genius of Hayek's (1937; 1945) contribution to the theory of the market order was to see clearly how it worked with *distributed private information*:

> The peculiar character of the problem of a rational economic order is determined precisely by the fact that the knowledge of the circumstances of which we must make use never exists in concentrated or integrated form, but solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess (Hayek, 1945: 519).

This became a critique of central planning when it was shown that planning required all information to be known in its entirety to one central mind. Hayek's point was that information does not need to be *centralized*, but rather that market mechanisms work to co-ordinate *decentralized* information and knowledge into a single variable of price. Market prices aggregate distributed information and knowledge and reflect the relative scarcity and value of a good. Based on this market information (either its level or its changes), the distributed actions of agents throughout the system can be continuously re-coordinated without central planning:

> It is the source of the superiority of the market order, and the reason why it regularly displaces other types of order, that in the resulting allocation of resources more of the knowledge of particular facts will be utilized which exists only dispersed among uncounted persons, than any one person can possess (Hayek 1989: 4).

The decentralized model triggered a second observation – closely bound up with the 'Austrian' subjectivism of human action – that knowledge could remain entirely *private*, with the only public information being the emergent market price. Again, this was a powerful insight because it showed that the minimal information conditions (private subjective knowledge, public price) were also sufficient conditions: nothing else was required for the market mechanism to coordinate the efficient allocation of resources. In the Hayekian framework, private (or local) choice and action explains emergent market order by its effect on 'public' (or global) price (Hirshleifer, 1971).

The key point is that no agent need observe other agents' actual choices and actions – that is, they attain no benefit from doing so – as it is sufficient to observe only the price, which, as an aggregator of distributed knowledge and information, enables an agent to observe in a single piece of information the choices and actions of a great number of other agents (Angeletos and Pavanm, 2007). The economics of market co-ordination are thus, as a principle of sufficiency, wholly separate from the public or social context of choice and action: that other agents' choices can or might be observed is immaterial to the mechanics of the emergent market order.

In turn, the economics of 'observing other peoples' choices' has gone in a different set of directions. The seminal theory on choice observation concerned the economics and sociology of consumption and the use of observed (public) choice in *competitive social signalling* (Veblen, 1899; Leibenstein, 1950; 1976). Here, the information was carried directly in publicly revealed or displayed choice (via public consumption); price information was thereby inverted. The concern here is *social competition*.

A second game-theoretic line concerned observation of others' choices in order to extract private information about their *strategic intentions*: in its simplest form, about the strategic 'type' of the observed agent (for example co-operator or defector). This does not concern the effects of distributed choice, but specific observation of other agents or agent populations and it is thus concerned with information-signalling. Prices enter parametrically via the pay-off matrix rather than being key information. The concern is *social co-operation*.

A third line of choice observation concerned *social learning* in which direct observation of others' choices revealed information about the costs and benefits of adoption of new ideas and technologies. This is neither essentially competitive nor co-operative but evolutionary in that it relates to the public externalities associated with the benefits of learning by observation and imitation (Dosi *et al.*, 2005; Apesteguia *et al.*, 2007; Rendell, 2010). This concerns *social evolution*.

These three lines of economic analysis of observed choice have all been extensively developed. They have contributed much to our understanding of economic co-ordination and dynamics. However, none of these lines explicitly seeks to generalize to Hayek's seminal formulation of private choice over a distributed space beyond its minimal sufficiency conditions; that is, to examine the implications of observation of other peoples' choices *and* prices working in parallel. I want to argue that this is the logical direction for spontaneous-order studies to go because this enables us to develop a unified approach to the study of spontaneous orders that integrates both the distributed knowledge problem (and the role of the price mechanism in solving the coordination problem) and also the new knowledge problem (and the role of the copying mechanism in solving *that* coordination problem).

The reason that the copying mechanism is a logical extension of the price mechanism is simply because there is information in other people's choices, and when copying the rules used by other people to make choices over novel circumstances, the copier gets access to that information without even necessarily knowing what it is. That information can remain private, while only the choice rule is publically copied.

Notes

1 Although, as we will see below, the origins of this idea date back to the early 18th century (Barry, 1982).

2 A phrase first used by Charles Darwin.

3 This is the reason that I do not follow so readily in the direction of Habermas, or in the accommodation of Hayek and Marx. Rather I see this going in a different direction that is more toward Michael Oakeshott, John Rawls and James Buchanan; for example, in respect of emergent constitutional orders.

4 Peter Boettke (1990: 61) suggests the overarching theme of Hayek's research program is: 'how do social institutions work, through the filter of the human mind, to co-ordinate human affairs'?

5 Although Buchanan (1986) argues for the restriction of the concept of spontaneous orders to price systems.

6 Arthur (2009) makes a similar claim about technology.

7 In particular, see the work of Bob Clower, Axel Leijonhufvud, George Shackle, Brian Loasby and Peter Earl (Lachmann, 1976).

8 This is most clearly apparent in, for example, so-called 'endogenous growth theory' (Romer 1990).

9 Buchanan also usefully explained why we should prefer the term emergent order to spontaneous order, but we will not take that up here.

10 See the work of Austrian/Post-Keynesians such as G.L.S. Shackle, Robert Clower, Axel Leijonhufvud and Brian Loasby on macro co-ordination, epistemics and complex systems (see Potts, 2000).

References

Aldrich, H., Hodgson G., Hull D., Knudsen T., Mokyr, J. and Vanberg, V. (2008). In defence of generalized Darwinism. *Journal of Evolutionary Economics*, 18(5): 577–96.

Anderson, T. and Hill, P. (2004). *The Not So Wild Wild West: Property Rights on the Frontier*. Stanford, CA: Stanford University Press.

Andersson, D.E. (2008). The double-edged nature of the Hayekian knowledge problem: systemic tendencies in markets and science. *Studies in Emergent Order*, 1: 51-72.

Andersson, D.E. (2010). Cosmos and taxis in religious life: Pattern regularities and new challenges. *Studies in Spontaneous Orders*, 3: 172-94.

Aoki, M. (2007). Endogenising institutions and institutional change. *Journal of Institutional Economics,* 3(1): 1-31.

Apesteguia, J., Huck, S. and Oechssler, J. (2007). Imitation: Theory and experimental evidence. *Journal of Economic Theory*, 136: 217-35.

Arrow, K., *et al.* (2011). 100 years of the *American Economic Review*: The top 20 articles. *American Economic Review*, 101(1): 1-8.

Bak, P. (1996). *How Nature Works: The Science of Self-Organized Criticality*. New York: Copernicus Press.

Banerjee, A. (1992). A simple model of herd behaviour. *Quarterly Journal of Economics*, 107(3): 7997-817.

Barry, N. (1982). The tradition of spontaneous order. *Literature of Liberty*, 5(2): 7-58. available at: www.econlib.org/library/Essays/LtrLbrty/bryTSO.html (Accessed October 18, 2013).

Bikhchandani, S.,Hirshleifer, D. and Welch, I. (1992). A theory of fads, fashion, custom and cultural change as information cascades. *Journal of Political Economy*, 100(5): 992-1026.

Boettke, P.J. (1990). The theory of spontaneous order and cultural evolution in the social theory of FA Hayek. *Cultural Dynamics*, 3(1): 61-83.

Boettke, P.J. (ed.) (2000). *Socialism and the Market: The Socialist Calculation Debate Revisited*, 9 volumes. New York: Routledge.

Boyd, B. (2009). *The Origin of Stories*. Cambridge: Harvard University Press.

Boyd, R. and Richerson, P. (1985). *Culture and the Evolutionary Process*. Chicago: University of Chicago Press.

Buchanan, J.M. (1986a). Cultural evolution and institutional reform. In: Buchanan, J.M. *Liberty, Market and State*. New York: New York University Press, pp. 75-85.

Buchanan, J.M. (1986b). Order defined in the process of its emergence. In: Buchanan, J.M. *Liberty, Market and State*. New York: New York University Press, pp. 73-74.

Camplin, T. (2010). The spontaneous orders of the arts. *Studies in Emergent Order*, 3: 195-211.

Caldwell, B. (2000). The emergence of Hayek's ideas about cultural evolution. *Review of Austrian Economics*, 13: 5-22.

Cantor, P. and Cox, S. (2010). *Literature and the Economics of Liberty: Spontaneous Order in Culture*. Auburn: Ludwig von Mises Institute.

Caplan, B. (2006). *The Myth of the Rational Voter.* Princeton: Princeton University Press.

Dickenson, H. (1933). Price formation in a socialist community. *Economic Journal*, 43: 237-50.

diZerega, G. (1989). Democracy as a spontaneous order. *Critical Review*, 3(2): 206-40.

diZerega, G. (2008). New directions in emergent order research. *Studies in Emergent Order*, 1: 1-23.

Dopfer, K. (2004). The economic agent as a rule maker and rule user: Homo Sapiens Oeconomicus. *Journal of Evolutionary Economics*, 14: 177-95.

Dopfer, K. (2012). The origins of meso economics. *Journal of Evolutionary Economics*, 22(1): 133-60.

Dopfer, K. and Potts, J. (2008). *The General Theory of Economic Evolution*. London: Routledge.

Dopfer, K. and Potts, J. (2013). Rules and economic evolution. Paper presented at Brisbane Club meeting, Vienna, April 20, 2013.

Dosi, G., Marengo, L., Fagiolo, G. (2005). Learning in evolutionary environments. In: Dopfer, K. (Ed.) *Evolutionary Foundations of Economics.* Cambridge: Cambridge University Press.

Foster, J., Metcalfe, J.S. (2012). Economic emergence: An evolutionary economic perspective. *Journal of Economic Behavior and Organization*, 82: 420-32.

Greif, A. (1993). Contract enforceability and economic institutions in early trade: The Maghribi trader's coalition. *American Economic Review*, 83: 525-48.

Habermas, J. (1998). *Between Facts and Norms*. Cambridge: MIT Press.

Hayek, F.A. (1937). Economics and knowledge. *Economica*, 4: 33-54.

Hayek, F.A. (1945). The use of knowledge in society. *American Economic Review*, 35(4): 519-30.

Hayek, F.A. (1952). *The Sensory Order: An Inquiry into the Foundations of Theoretical Psychology.* Chicago, IL: University of Chicago Press.

Hayek, F.A. (1967). *Studies in Philosophy, Politics and Economics.* Chicago: The University of Chicago Press.

Hayek, F.A. (1973). *Law, Legislation and Liberty, Vol. 1: Rules & Order.* Chicago: University of Chicago Press.

Hayek, F.A. (1978). The results of human action but not of human design. In: Hayek, F.A. *New Studies in Philosophy, Politics, Economics*. Chicago, IL: University of Chicago Press, 96–105.

Hayek, F.A. (1989). *The Fatal Conceit*. Chicago: University of Chicago Press.

Hirschliefer, J. (1971). The private and social value of information and the reward to inventive activity. *American Economic Review*, 61: 561-74.

Hodgson, G.M. and Knudsen, T. (2011). *Darwin's Conjecture*. Cambridge: Cambridge University Press.

Horwitz, S. (2001. From Smith to Menger to Hayek. *The Independent Review*, 6(1): 81-97.

Horwitz, S. (2005). The functions of the family in the great society. *Cambridge Journal of Economics*, 29(5): 669-85.

Hurwicz, L. (1969). On the concept and possibility of information decentralization. *American Economic Review*, 59(2): 513-24.

Kahneman, D. (2011). *Thinking, Fast and Slow.* New York: Farrar, Straus and Giroux.

Lachmann, L.M. (1976). From Mises to Shackle: an essay on Austrian economics and the kaleidic society. *Journal of Economic Literature,* 14: 54-62.

Lange, O. (1936, 1937). Economic theory of socialism I & II. *Review of Economic Studies*, 4 & 5: 53-71 & 123-42.

Lavoie, D. (1989). Economic chaos or spontaneous order? Implications for political economy of the new view of science. *Cato Journal*, 8: 613-35.

Leeson, P.T. (2008). Coordination without command: Stretching the scope of spontaneous order. *Public Choice*, 135: 67-78.

Leeson P.T. (2009). *The Invisible Hook.* Princeton, NJ: Princeton University Press.

Leibenstein, H. (1950). Bandwagon, snob and Veblen effects. *Journal of Political Economy*, 64(2): 183-207.

Leibenstein, H. (1976). *Beyond Economic Man*. Cambridge: Harvard University Press.

Lerner, A. (1937). Statics and dynamics in socialist economics. *Economic Journal*, 47: 251-70.

Lerner, A. (1938). Theory and practice in socialist economics. *Review of Economic Studies*, 6: 71-5.

Marmefelt, T. (2009). Human knowledge, rules, and the spontaneous evolution of society in the social thought of Darwin, Hayek, and Boulding. *Journal of Economic Behavior and Organization*, 71: 62-74.

Maynard Smith, J. and Price, G. (1973). The logic of animal conflict. *Nature*, 246: 15-18.

Mesoudi, A. (2011). Culture and the Darwinian Renaissance in the social sciences and humanities. *Journal of Evolutionary Psychology*, 9(2): 109-124.

Myerson, R. (2009). Fundamental theory of institutions: a lecture in honor of Leo Hurwicz. *Review of Economic Design*, 13: 59-75.

Nelson, R.R. and Winter, S.G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge: Harvard University Press.

Nowak, M. (with R. Highfield) (2011). *Supercooperators*. New York: Simon & Schuster.

Ormerod, P. (2012). *Positive Linking.* London: Faber.

Ostrom, E. (1990). *Governing the Commons.* New York: Cambridge University Press.

Pinker, S. (1994). *The Language Instinct.* New York: William Morrow.

Popper, K. (1945). *The Open Society & Its Enemies.* London: Routledge.

Potts, J. (2000). *The New Evolutionary Microeconomics.* Cheltenham: Edward Elgar.

Potts, J. (2012). Innovation commons. Paper presented at Schumpeter Society conference, Brisbane, July.

Potts, J., Hartley, J., Cunningham, S. and Ormerod, P. (2008). Social network markets, *Journal of Cultural Economics*, 32(3): 166-85.

Rendell, L. *et al.* (2010). Why copy others. *Science*, 238(5975): 208-13.

Rogers, E. (1995). *Diffusion of Innovation*. New York: Free Press.

Romer, P. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5): 71-92.

Rosser, J.B. (2012). Emergence and complexity in Austrian economics. *Journal of Economic Behavior and Organization*, 81: 122-28.

Schelling, T.C. (1960). *The Strategy of Conflict*. Cambridge: Harvard University Press.

Schumpeter, J.A. (1942). *Capitalism, Socialism and Democracy.* London: George Allen & Unwin.

Scott, J. (1998). *Seeing Like a State.* New Haven: Yale University Press.

Smith, V.L. (2003). Constructivist and ecological rationality in economics. *American Economic Review*, 93(3): 465-508.

Sudgen, R. (1989). Spontaneous order. *Journal of Economic Perspectives*, 3: 85-97.

Vanberg, V. (1986) 'Spontaneous Market Order and Social Rules', *Economics and Philosophy* 2: 75–100

Veblen, T.B. (1899). *The Theory of the Leisure Class.* Chicago, IL: Aakar Books.

Vriend, N. (2002). Was Hayek an ACE? *Southern Economic Journal*, 68: 811-40.

Wagner, R.E. (2008). Finding social dilemma: West of Babel, not East of Eden. *Public Choice*, 135: 55-66.

Wagner, R.E. (2012). A macro economy as an ecology of plans. *Journal of Economic Behavior & Organization*, 82: 433-44.

Wilson, E.O. (2012). *The Social Conquest of Earth.* New York: Liveright.

Young, H.P. (1993). The evolution of conventions. *Econometrica*, 61: 57–84.

Ziman, J.M. (Ed.) (2000). *Technological Innovation as an Evolutionary Process*. Cambridge: Cambridge University Press.

Computable Cosmos

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Abstract: This essay contrasts the Hayekian notion of spontaneous order with mathematically deducible and computationally attainable equilibria within economic systems, which are often the focus of general equilibrium analysis. My analysis focuses on the perspectives these two approaches to social systems take on the evolution of system configurations, which can be interpreted as equilibria, limiting ergodic distributions, attracting states, homeostatic orders, or simply states of the system. While Hayek's notion of a spontaneous order is very broad, suggesting the impossibility of precise systematization of causal forces, equilibria are typically determinate as a result of a narrowly defined Walrasian definition. Combining elements of Hayekian spontaneous order with recent insights from computer science, I introduce the concept of a real-time concurrent computable equilibrium system, or computable cosmos. In contrast to agent-based computational models, computational cosmoi are endowed with the property of fundamental system indeterminacy, which originates from the concurrency of agent behaviour.[1]

Keywords: Agent cloud; computational economics; general equilibrium; stability analysis; statistical physics.

INTRODUCTION

A casual study of some of Hayek's works, such as *Law, Legislation and Liberty* (Hayek, 1979/2012), or his article on the role of knowledge in economic systems (Hayek, 1945), makes clear the breadth and scope of his analysis, with the notion of spontaneous order or 'cosmos' at its core. Yet Hayek's treatment of the subject also betrays its complexity and intractability, notwithstanding his own assertion that although 'we cannot see, or otherwise perceive the order of meaningful actions, […] we are [...] able mentally to reconstruct it by tracing the relations that exist between the elements'. In yet another passage he remarks that although such emergent orders lack a man-made purpose, 'our awareness of its existence may be extremely important for our successful pursuit of a great variety of different purposes'.

While Hayek's notion of social order may seem to resemble the ubiquitous concept of equilibrium, the two are clearly of a different nature, both in the way they are defined as well as treated theoretically. In contrast to Hayek's definition of spontaneous order, which is associated with the question of how aggregate order can arise out of any apparent chaotic or random behaviour exhibited by its constituent elements, the notion of equilibrium is connected to Leon Walras' (1874/1954) mathematical treatment. Walrasian economics is based on a general equilibrium treatment of supply and demand, as they are thought to interact in interconnected markets.

Each perspective involves conceptual trade-offs. While Hayek analyses the interconnected roles played by individuals, formal and informal institutions, and markets, he also recognizes the complexity and frequent intractability of emergent orders, and therefore proceeds by systematically ring-fencing and tightening his own theoretical structure. He does this by means of an intricate web, consisting of a comparative dialectic chronicled in much of his work on the subject[2].

Contemporary economists' view of markets, by contrast, is mathematical and thus exudes the definitiveness one associates with a series of interlocking mathematical proofs and lemma. What is however sacrificed is the multifaceted nature of a more complex market co-ordination process, a loss which results from the abstraction and simplification implicit in only considering a highly stylized perspective of markets.

This essay compares Hayek's notion of a spontaneous or homeostatic order, in a computable sense, and modern economists' take on this issue. While some may be sceptical towards the juxtaposition of these two theories, due to their different theoretical conceptions, the question of *system stability* is shared by both approaches and can be explored from various angles. Once I have made clear how much narrower and more deterministically treated system equilibria really are as compared with their Hayekian counterpart, I will deepen my analysis by introducing recent advances in computer hardware and software. I then define a real-time concurrent computable equilibrium system, or *computable cosmos*, and compare this with agent-based computational models. Both approaches make use of modern multi-core digital processors.

HAYEKIAN AND PURELY ECONOMIC SELF-ORGANIZING SYSTEMS

A large number of labels describe the configurations toward which systems—if and whenever they do so—self-organize *endogenously* over time. Qualifiers such as 'resting points', 'fixed points', 'equilibria', 'equilibrium growth paths', 'spontaneous orders', 'homeostatic orders', 'limiting ergodic distributions', and very likely a few others come to mind, all beset with their own idiosyncrasies. Within the specific context of the Hayekian notion of an emergent order, the social order or equilibrium he has in mind manifests itself as an abstract regularity or pattern. This regularity is detectable at a regional or global level in a topological sense, with individual actors' precise adaptive actions exhibiting a comparatively low degree of predictability in any given instance. At the same time, however, a certain degree of constancy in conduct and reaction to stimuli is expected to occur at the individual micro level, so as to make it possible for an abstract macro order to emerge.

A notion of equilibrium from the mathematical-statistical domain which closely mirrors the Hayekian definition is that of a *limiting ergodic distribution*, in which large numbers of observations occurring (or drawn) over time eventually settle down to a stable *distributional pattern* with ascertainable statistical properties, in spite of the fact that each new observation that is added to the existing pool is again random or stochastic. Hayek himself almost certainly contemplated a system which transcended primitive notions of statistical stability or stationarity, such as a system endowed with seemingly complex or even chaotic behaviour.[3] Such a system would however only appear to be random or chaotic because of people's inability to grasp the complex forces of cause and effect. In Hayek's view, however, an abstractly defined order is still in existence, and its properties are at least partially traceable, if only in some probabilistic sense.

The perspective of mainstream economic theory on self-organizing order or stability within mathematical and applied general equilibrium analysis is more tractable than Hayek's notion of a spontaneous order, at least in terms of the degree of complexity involved in mathematical modelling. Yet any rigorous analysis of such systems, which seeks precise answers to the questions of existence, uniqueness, and stability of equilibria, can be mathematically demanding, involving fixed-point theorems and investigations of dynamic stability using Lyapunov functions, to give but two examples. Still, tractable solutions and theorems are obtained in most cases, notwithstanding the mathematical sophistication required.

At the same time much of this tractability is only attained by abstracting from a more general problem. The aim is to achieve a dimensionality which makes possible the application of analytical methods and the derivation of so-called 'closed-form' solutions. One example of such a simplification involves reducing the real-world problem of analysing numerous interconnected markets to a model with only three such markets (Anderson *et al*., 2004; Hirota, 1981; 1985; Scarf, 1959). This three-market case invites speculation over the extent to which general results derived from such a simplified model carry over to a 'massively scaled' version of the same model. The only way to deal with this question is by employing (computer) simulations. Such simulations are particularly important to my discussion and I will discuss them in later sections.

So far I have argued that Hayek's notion of a self-organizing system is broad, complex and largely mathematically intractable. This is certainly true if we understand tractable as good at replicating most of the elementary factors in an emergent order. Examples of sources of intractability in emergent orders include agents' locally bounded and idiosyncratic information sets, their boundedly rational processing of such information, and the imperfect functioning of 'global co-ordination devices'.

Like the laws of motion of gas nebulae or the mutual attraction or repulsion of atoms making up larger compounds, social actors perceive, adapt, and act *concurrently* in *real time*. By contrast, the iterative approach in traditional Walrasian general equilibrium systems is strictly *sequential* and *deterministic*, and so does not take into account any real-time concurrency or fundamental indeterminacy. Before contrasting this with the novel concept of a *computable cosmos*, I will first attempt to explain why the mathematically modelled Walrasian *tâtonnement* mechanism constitutes a rigidly sequential and thus not a real-time concurrent mechanism. I will then explain the implications of this such as how each particular solution reflects considerations of mathematical tractability at the aggregate level.

SIMPLE ITERATED WALRASIAN *TÂTONNEMENT* DYNAMICS

Walras' (1874/1954) dynamic market equilibrium mechanism is his *tâtonnement* process. Walras limited his theory to a verbal-intuitive statement that explained the underlying logic of this process. It is however now more commonly formalized as a mathematical system of equations, which consists of *aggregate excess demand functions* for all interdependent markets (e.g. Arrow, 1952; Debreu, 1954; Hildenbrand, 1994; Mantel, 1974; Radner, 1968; Smale, 1976; Sonnenschein, 1973). An excess demand function for a given market sums all consumers' individual demands net of all their individual incomes (or supplies) of the particular good traded in that market. As is well known, the attainment of equilibrium in any one market requires that its excess demand function is identically equal to zero for some vector of prices. This vector determines consumers' demands and incomes.

By analogy, a specific equilibrium vector of prices that results in a zero-valued vector of excess demand in *all markets simultaneously* constitutes a general equilibrium solution to the entire mathematically modelled market system. Economists working with such systems of excess demand functions can approach their analysis by employing two different but interrelated approaches to the problem. The first one involves solving the system of (often non-linear) equations simultaneously in a static sense. The second concerns itself with the question of whether and how a dynamic updating scheme may be capable of transitioning the system towards a general equilibrium price vector, when it starts from a given initial *disequilibrium* price vector and a predetermined distribution of endowments. The question of *existence* addresses the conditions under which at least one equilibrium price vector is guaranteed to exist, while that of *uniqueness* deals with conditions with only one such general equilibrium 'resting point'.

In this essay I prefer to focus my attention on the *stability* criterion, which implies a solution to the first two problems, and which asks whether and in which way unique or multiple 'resting points' can be attained dynamically along a transition path from an initial disequilibrium price vector. A somewhat less demanding but equally important criterion concerns under what conditions the system remains *non-explosive* or *controllable*, interpreted in a strictly dynamic sense[4]. This requires a more detailed description of the traditional Walrasian *tâtonnement* price-adjustment mechanism, which is a somewhat artificial sequential dynamic process, reflecting the assumed behaviour of a Walrasian auctioneer.

The Walrasian dynamic *tâtonnement* process starts with an assumed disequilibrium vector of market prices[5] as well as an assumed initial distribution of consumer endowments of all traded goods. In this simple description of an economy, the only activity is exchange, and any notions of production, investment or general economic growth are entirely absent. In addition, many early models restrict the analysis to three goods and three consumers, so as to ensure analytical tractability.

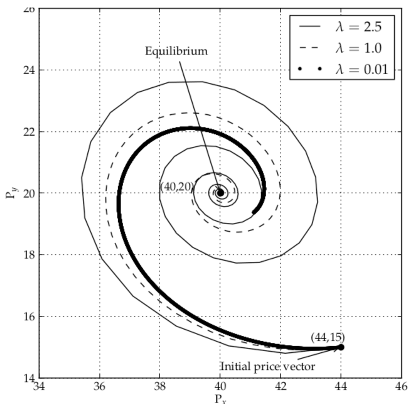

Figure 1: Simulated trajectories of a Scarf-type economy; three dynamic simulations with different linear speed-of-adjustment coefficients, all asymptotically approaching the equilibrium price vector

With given prices and endowments, the second step assumes that each consumer computes the value of her endowments (i.e. her income) and the quantity and value of her demands. These endowments and demands are conditional on a pre-specified stable individual demand function. Each consumer reports her computed supply and demand for goods to a global authority in the guise of the *Walrasian auctioneer,* who can then centrally process all individual consumers' supplies and demands in order to compute the value of the excess demand in each market. If this turns out to be different from zero for any, some, or all markets, a third step is needed.

The third step is key.[6] So long as the prevailing vector of market prices causes excess demands to be different from zero everywhere and all markets are therefore simultaneously in *dis*equilibrium, the auctioneer has to decide how to *update* the current vector of prices. Preferably, the updating should result in a new system of excess demands that is closer to the zero-valued vector. There is a good reason for why this step has become such a closely scrutinized one in the literature. It is because the manner in which the prevailing price vector is updated is the single most important factor in determining the *stability* of the modelled market, aside from the initial conditions and the distribution of consumers' endowments.

In the fourth and final step, the updated price vector is passed back (or publicly "cried out" as in a realistic auction environment) to all the consumers, enabling them to update the value of their incomes and demands for all goods in the economy. This information will then in turn pass back to the Walrasian auctioneer for the next round of re-computing excess demands, in which all steps are repeated in a looping iteration. The iterative process stops when the most recently updated price vector is sufficiently close to the static equilibrium. It is however important to note—within the specific context of this iterative process—that the actual exchange of goods is at all times assumed to be *completely suspended* until the general equilibrium price vector is found. It is only after this discovery that trade among agents will occur. Figure 1 illustrates three simulated relative price trajectories obtained from a typical Scarf-type general equilibrium model. Each simulation uses a different linear speed-of-adjustment coefficient. In this case, one common element shared by all three simulations is dynamic stability, since all of them approach the system's static 'resting point' asymptotically.

This completes the description of the iterated Walrasian *tâtonnement* dynamics and also serves as an example that illustrates typical dynamic economic modelling. At the same time it also demonstrates the somewhat artificial set-up of the model, as well as the sequential way it treats the question of the dynamic attainability of a general equilibrium. It accomplishes this through a system of (non-linear) differential equations.

A critical stance is particularly valid if one thinks in terms of the multifaceted, complex and seemingly chaotic character of a Hayekian cosmos. Which features of the sequential dynamic equilibrium process should be viewed with more scepticism from the vantage point of an endogenously emerging spontaneous order or cosmos?

The first and perhaps most serious problem is the assumption of the existence of a Walrasian auctioneer. This assumption has been criticized by the so-called 'Post-Walrasian' school of economics (Colander, 1996, 2006; Holt *et al.*, 2011; Kirman, 2010a, 2010b). The most critical Hayekian insight is the recognition of the central role played by decentralized and locally perceived knowledge, which continuously percolates through the aggregate system. Such a system thus comprises cognitively constrained actors, which however still gives rise to an order with a surprising degree of regularity, vitality, and robustness (Hayek, 1945).

The second problem, which is indirectly related to the first, is the assumption that an orderly and exhaustive collection of *all* relevant market information is conceivable between the various steps in the sequential process. This assumption enables consumers to report their incomes and demands to the auctioneer, who is able to compute excess demands once *all* information from *all* consumers has arrived.[7] It also enables the auctioneer to 'cry out' the updated and *uniformly and uniquely perceived* price quotations to the consumers, all of whom are assumed to perceive and employ this vector of prices symmetrically.

In fact, besides the assumed exhaustiveness of information, the whole structure of information exchange is highly artificial in the way the perfectly and globally knowable price vector is assumed to be publicly ascertainable between updating steps. Moreover, individuals supposedly transmit their information through impenetrable paths or silos to the global auctioneer, so that each agent is ignorant of his neighbour's consumption choices.[8] The implication is that these models disregard temporary misperceptions and bandwagon effects; any notions of localized group-level information pooling, pre-processing or inter-agent knowledge exchange are entirely beyond the reach of this type of model.

One final weakness is the assumed lack of diversity of the information criteria circulating in the economy. All that appears relevant can thus be reduced to the set of prices and endowments.[9] An example of how additional information criteria can matter in the determination of equilibria is the relative wealth endowments of individuals. This may affect the quantity, quality, and speed of dissemination of information, which in turn can lead to non-negligible consequences for the aggregate system as a whole and in particular for its overall stability, a result which Andersson (2008) explains in conceptual terms.

But does a research programme that focuses on simulating artificial economies with the help of digital processors constitute a more viable option for theorizing about market co-ordination problems? And what are the general implications, if any, which follow from allowing actors to behave and co-ordinate *concurrently* and in *real time*, instead of imposing the methodological straitjacket of iterative processing?

COMPUTABLE *COSMOI* AND THE SOCIAL-TO-DIGITAL MAP

The application of digital processors as part of the scientific method has been on the rise within many disciplines. In conjunction with this general development, increasing attention is being paid to *algorithms* or *numerical methods*, which are suitable for analysing a broad class of problems. This trend has also affected the social sciences, including economics (Judd, 1998). Another and perhaps even more influential use of the computer-assisted approach has been seen in mathematics, where the new field of 'experimental mathematics' has eschewed the traditional route of explicit derivation in favour of alternative 'brute-force' methods using digital processors (Bailey *et al.*, 1997).

To this day modern computer hardware tends to be introduced to computer science students through the abstractly defined concept of a Turing machine (Turing, 1936). Turing machines form the theoretical precursors of contemporary computer hardware. Sometimes, digital processors executing algorithms are interpreted as *discrete state automata* (DSA)[10], a conceptual sub-class of the more general Turing machine that is more suitable for understanding the operation of real-world computers, because of the theoretical capacity of Turing machines to store infinite numbers of states (and thus to possess *infinite memory*), and the self-evident limitation of DSA in this regard. For the purposes of our discussion, we may define computer programs or algorithms as software-encoded sequences of declarations, expressions, control statements and functions, all of which serve to manipulate information states or data (otherwise defined in the relevant literature as the generation of *side effects*). These are stored in alterable form in the computer's memory over the lifetime of a running program[11].

One theory espouses the somewhat more radical view that the *entire universe* may be one grand computation carried out using a discrete state automaton (Zuse, 1970). This conjecture gave birth to the sub-discipline of digital physics, which remains unrefuted (although some would say that it cannot be refuted). The universe-as-computation conjecture, with all its vexing implications for the philosophical determinism-versus-free-will debate, poses a hypothesis that many may find difficult to digest. The less ambitious undertaking of modelling the market co-ordination process using discrete state machines (i.e. algorithms executed on digital processors) should thus be relatively uncontroversial.[12]

I will now outline such an attempt of formulating a computer-simulated economy or *computable cosmos.* I will be mindful of clearly signposting the differences that exist between my conjectured approach, on the one hand, and that embodied by the application of so-called agent-based computational models (ABMs), on the other. The use of ABMs in any field related to economics is still relatively scant, although it has become more popular recently (Ashraf *et al.*, 2012; Colander *et al.*, 2008). In my proposed implementation of such a computable cosmos, I hope that its constituent characteristics will make self-evident how it is still remotely based on the traditional Walrasian *tâtonnement* mechanism, especially when viewed in its *algorithmic* form. At the same time, the approach is more ambitious in its ultimate goal of approximating, at least in principle, the more broadly defined concept of a Hayekian emergent-order system. It should be able to achieve this by allowing for rich and varied knowledge exchanges at the micro level. The most distinguishing features of a computable cosmos—which demarcates it from the ABM literature—are agents' action *concurrency* and *real-time* computation, as well as the fundamental notion of systemic *indeterminacy*. The software paradigm I will be employing throughout to illustrate the design of such a system is that of the actor model (Hewitt *et al.*, 1973)[13], which I will argue lends itself ideally to the software-encoded implementation of a computable cosmos.

The Walrasian *tâtonnement* process is a sequentially unfolding one, in which exhaustive information collection was always shown to precede the functional evaluation of the system of excess demands and the vector of spot market prices. To make the conventional mathematical treatment of the market co-ordination problem feasible, this assumption of exhaustive information aggregation turned out to be a necessary one, since both the updating of the price and the consumers' demand functions depended on the supply of a complete, well-defined and knowable argument. This was then communicated to them for computation purposes.

It is therefore clear that the method's insistence on employing a system of dynamic differential equations, governing the aggregate behaviour of the entire system, necessarily implies information processing of the Walrasian type. By contrast, Hayek's work shows that the circulation, mutation, as well as perception of information or knowledge in society should not only be viewed as more complex, but also as richer regarding the amount and type of content which is transmitted between emitting and receiving actors.

Even more important, individuals all act *concurrently*, or at least possess the capacity of doing so in principle, while it is typically only because of institutional or innate factors that some individuals are capable of acting with lower latency, higher frequency, and more impact in practice. At the same time this particular diversity in behavioural properties never implies sequentially executed actions, and *intended* or *planned* actions are certainly always conceived of concurrently, actor-specific frictions in execution notwithstanding. So in contrast to the conventional Walrasian general equilibrium model, in which all agents are effectively homogenous in behaviour if not in endowments, a more realistic modelling approach should account for agent-specific differences. This should be apparent in the manner they process and perceive knowledge, thus introducing heterogeneity in that dimension.

Any attempt at generating a conceptual (and eventually computable) mapping that mimics a capitalist market system, which is translated into a finite state automaton, constitutes a fruitful and feasible exercise. This is so because many of the important features that constitute a snapshot of a capitalist society can be encoded using a finite set of digital information states[14], as long as the scale and complexity of the system is kept to a manageable dimensionality[15]. Indeed, a simple mapping of this type applies to the simulation of a Scarf-type economy with three goods and three consumers (see Figure 1). This is in spite of differences between the two approaches regarding information-processing properties, basic iterated structure, and the extent of simplification.

But what is then the nature of the new actor model of computation, and how would it allow researchers to seek answers to questions associated with a market co-ordination problem that is considerably more complex than the Walrasian one? And how does it differ from agent-based computational models so that it is more deserving of the 'computable cosmos' description?

Herbert Gintis (2007) offers an instructive and recent example of an agent-based computational model, which is remotely based on the Walrasian price-adjustment system, but otherwise possesses more detail and complexity. Gintis' model transforms the Walrasian model into a system that includes analytically intractable non-linearities, such as agent-specific private reservation prices and replicator dynamics (Taylor and Jonker, 1978). Agents may thus copy or imitate more successful agents in a trial-and-error fashion. Moreover, because prices in the economy are modelled as *private reservation prices*, which apply to small-group trade and bargaining, the traditional Walrasian auctioneer is no longer present. The information content that is relevant to the market exchange process is thus local in nature.

Although the computation of the dynamically evolving price and exchange processes possesses certain random elements, such as probabilistic matching of agents in trade and replication (or imitation), the model is still a sequential one; the simulation steps follow the logic of a circuit flow possessing few if any logical branches. And in spite of the fact that the random matching of agents does introduce an element of indeterminacy into repeated simulations, this observed randomness is more closely related to simple 'sampling indeterminacy'. It is not related to the more fundamental and systemic type of indeterminacy one associates with spontaneously evolving orders. The salient regularities that emerge in repeated simulations are essentially constant in a convergent sense. They only differ from one another (in repeated simulations) through minor variations in the 'sampling noise' that random matching generates.

Earlier in our discussion we noted that computers are machines that allow programmed logic to mutate states (or generate side effects). These states, in turn, are accessible in the form of data. The data is stored in the hardware's random access memory during the lifetime of a running program, which in the shape of a compiled source code encapsulates and executes that logic either on the central processing unit (CPU) or on other special-purpose dedicated processing components (e.g., graphics processing units (GPU)).

The logic of the program as source code may define, inter alia, the behaviour and more static properties of agents, institutions, intermediaries and other system-relevant actors. Many of these will generate side effects and thus mutate states. Conversely, the stored information may encompass continuously updated variables such as private and public price signals, the evolving distribution of wealth, technology shock processes, agents' changing perceptions of market conditions, monetary factors, and other agent-specific or public-domain variables. What is important is whether they are deemed relevant for a realistic simulation of a market co-ordination process.

A genuinely real-time *concurrent* variant of this modelling problem would allow agents to act *in parallel* during the lifetime of the program, instead of computing their behaviours and attendant side effects in *sequential* fashion. Not only would this imply a computational modelling paradigm that exhibits much more realism in agent interaction, but it would also introduce more fundamental indeterminacy than is possible through simple sampling variability. The concurrent-actor approach may thus generate aggregate pattern regularities that one would associate with a Hayekian spontaneous order.

The actor model was originally designed as a framework for concurrent software logic, and is currently implemented as part of the *Erlang* programming language (Armstrong, 2007). It constitutes an almost perfect tool for the implementation of a real-time concurrent computable equilibrium system, or *computable cosmos,* as described above. The model was developed in the mid-1980s at the Ericsson Computer Sciences Laboratory. The goal was to create a programming language for telephony network switches. Such programs have to be highly fault-tolerant and concurrent in operations, using a large number of extremely lightweight threads[16]. The design of the language was therefore highly *domain-specific* and moulded to the specific characteristics, needs, and objectives of the particular hardware platform on which developed and compiled source code was to be executed.

In *Erlang* and the actor model it encompasses, a very large pool of actors—each endowed with some software-encoded behavioural logic—can be launched concurrently and in massive numbers. This trait allows actors to communicate with each other via the sending and receiving of messages, to which they then can be programmed to react by means of content processing and response formulation. It would not take too great a leap of imagination to recognize the intimate connection between the specific features of this domain-specific programming paradigm and a relevant computable-cosmos model. But what would be the benefits and costs of doing so, especially when compared with the orthodox mathematical approach embodied in Walrasian *tâtonnement* models?

One benefit from employing a real-time concurrent modelling would be an almost exact mapping of the simulation of a system that is governed by random or chaotic knowledge cascades. Such cascades would percolate through a cloud of knowledge-exchanging agents of the type that is so characteristic of Hayekian emergent orders. Furthermore, it is a well-known property of concurrent programming systems that they introduce fundamental indeterminacy, given that the concurrent dissemination of messages among agents is handled through software-controlled arbiters. Such arbiters ensure that the exact order in which messages are received and processed by actor addressees is unknowable *a priori*. The order is in one sense *chaotic* in practice (Hewitt, 2010).

It is chiefly this fundamental indeterminacy, which is also associated with a market economy, which explains why I chose to call the approach a computable cosmos. The randomness and potential richness in information or knowledge transfer facilitated by such a system intimately mirrors the Hayekian ideal of a spontaneous or homeostatic order. Moreover, all side effects and thus state mutations of the system have to be implemented by adhering to the practice of 'message passing', a design-specific straitjacket imposed by *Erlang* itself. This constraint forces programmers to use a set of laws or heuristics, which mirrors a market co-ordination system. It is thus natural to approach it as an emergent-order problem.

A fitting analogy to the workings of a simulated concurrent actor market model would literally be that of an autonomously functioning brain composed of a large number of synapses. Each synapse emits, accepts, processes and again re-emits electrical impulses in rapid succession in a seemingly disorganized fashion at the aggregate level.

Well-defined software-encoded logical rules or heuristics may be incorporated into the source code, describing actor-specific and possibly also *satisficing* behaviour (Simon, 1947). It bears repeating that *Erlang* and its implementation of the actor model were developed specifically for the purpose of developing software systems that could control telephony communication systems or switches. Such systems have the attributes of complexity, fault-tolerance, concurrent operation, and a high throughput of message exchanges. These are all ideal prerequisites for the implementation of a computer-simulated market exchange model exhibiting rich and complex information transfer.

By contrast, one immediate drawback confronting any model builder, at least as compared with the treatment of conventional systems of differential equations, is the handling of time itself. Within the context of Walrasian *tâtonnement*, we discovered that each new time period was clearly demarcated. It was thus implicitly defined by the specific step in which a new market price vector was computed and 'cried out', based on the system's prevailing excess demands. The iterative treatment of the market co-ordination process led to the natural identification of adjacent time periods, and time-series simulations of the model were obtained by iterating forward a first-order non-linear differential equation.

In real-time concurrent simulations of a market economy, no such easily defined demarcations of adjacent time periods obtain. This particular problem—associated with the collation, handling, and feeding back into the system of time-denoted state information—is a well-known one in digital processor-based simulations of market economies, and also tends to crop up with frequent regularity within agent-based computational models (LeBaron, 2001).

Within the specific context of an *Erlang*-programmed computable cosmos, one possible way of obtaining chronologically ordered values of current system states would be via the inclusion of a logically programmed 'statistical authority agent'. Such an agent could at regular intervals be instructed to survey a random sample of evolving households and firms (within the simulation) exactly in the same way real-world statistical authorities would be instructed by governments. In principle, this would even allow the model builder to introduce some of the vexing real-world complications with which statistical authorities routinely grapple, such as time lags in collection and eventual publication, the introduction of potential biases, and revisions as part of the data collection process.

The theoretical possibilities of computable *cosmoi* do not end there. As a result of each and every actor's capacity to have her own digital 'vessel' with information on both her own characteristics as well as her *individually perceived* public-domain information states, an extremely rich and varied information landscape is conceivable at the model design stage. This would make it possible to explore numerous ways in which the system endogenously self-organizes over the lifetime of the simulation, including in-depth investigations into the dynamic stability property of the system.

One final but important remark is that one particular mode of inquiry, which necessarily undergoes a significant transformation in the role it plays in any such analysis, is that embodied in the *mathematical* characterization of the properties of any such modelled system of the market co-ordination process. We have seen that in traditional mathematical and applied analyses of general equilibrium systems, mathematical perspectives and tools which originate from the study of dynamic systems, functional analysis and topology have a critical bearing on the entire body of knowledge associated with the relevant subject matter. By contrast, within the context of computable cosmoi, but also discrete state automata more generally, the role of mathematics remains indispensable in many ways, yet digital processor-driven applications tend to migrate away from seeking answers to the properties of the system in its entirety, toward the characterization and specification of the behaviour and evolving information states encapsulated by individual, concurrently acting agents.

CONCLUSION

The use of computers within economics is an attempt to introduce a greater degree of both realism and complexity into what would otherwise end up as a whole class of mathematically intractable models. In this essay I have sought to compare and contrast conventional applied general equilibrium models with the novel concept of a *computable cosmos,* showing one feasible way forward for designing a computer-simulated *catallaxy*. The proposed approach would display richer and more varied knowledge exchange processes than those found in a Walrasian world.

I have alluded to the possibility of employing a mature programming language, *Erlang*, and its own built-in implementation of the concurrently capable actor model, in an effort to design a simulated complex market economy. The proposed model's simulated evolution would not only unfold in real time, but with a fundamental, systemic degree of indeterminacy, thus eliminating the precise and iterated structure of conventional applied general equilibrium models. I have chosen to call this proposed software-encoded implementation a *computable cosmos*, both because of to the fundamental indeterminacy that real-time concurrent computer programs exhibit and because the possible mutation of a very large number of digitally stored information states mirrors an information-rich exchange environment.

The biggest challenge faced by adopters of computable *cosmoi* is that of software-encoding behavioural rules and heuristics that govern the conduct of such concurrently acting actors. The biggest question remains why and how spontaneous orders emerge.

Notes

1 I would like to thank David Emanuel Andersson, Nicolai Petrovsky and an anonymous referee for useful comments. All remaining errors are my own.

2 One part of Hayek's work where this approach is revealed is in the second chapter (Cosmos & Taxis) of *Law, Legislation and Liberty* (Hayek, 1 79/2012).

3 The comparison with chaos is suitable in this context. Chaotic and unpredictable dynamic behaviour arises out of the solution to mathematical equations that are nevertheless determinate and functionally specifiable. A good introductory reference is Hirsch *et al.*, 2012.

4 For example, dynamic systems can remain away from equilibrium indefinitely, yet at the same time be non-explosive. This can be achieved by exhibiting stable orbital solution paths which keep oscillating around the equilibrium point (Scarf, 1959).

5 Strictly speaking, the process really employs a system of relative prices as one of the goods in the economy is commonly defined as the *numéraire* good which measures prices. In the popular DSGE macroeconomic modelling paradigm, the *numéraire* good is the consumption good.

6 In a seminal paper, Stephen Smale (1976) shows that global stability is only guaranteed if the Walrasian auctioneer has recourse to the derivatives (otherwise known as the Jacobian) pertaining to all excess demand functions. Given that real-world economies consist of essentially infinitely many such inter-related markets, the upshot of the result is that a stable updating scheme employs implausibly large amounts of information. This point is particularly relevant when viewing it from a perspective which recognizes Hayek's views on the informationally efficient mechanisms underpinning capitalist systems.

7 This is a well-known limitation applied researchers and policy-makers in macroeconomics have to grapple with: crucial economic indicators always arrive with a substantial time lag and are typically liable to be revised at an even later date.

8 This assumption is particularly problematic in view of 'keeping-up-with-the-Joneses' effects, conspicuous consumption, and the habit-persistence literature in general (Constantinides, 1990; Duesenberry, 1949; Veblen, 1899/2007).

9 One counter-example is provided by a model which dispenses with the Walrasian auctioneer and also allows for the exchange of quantity-information, leading to states of rationing. This model is described in Benassy, 1990 and, more accessibly, in Bridel, 2011.

10 Many economists, especially macroeconomists but also algorithmically-inclined game theorists, are likely to have employed a mathematical construct that can be represented in terms of a more general discrete state automaton, which is given by a Markov chain process.

11 Genuine data or state persistence in the form of physically recorded states that persist outside the scope of any running program is typically rendered operational through the use of physical hard drives or solid-state discs, or previously through the use of magnetic tapes.

12 Figure 1 already provides the visual output from a computer simulation (and is thus an implementation of a DSA approach) for a fairly standard Walrasian general equilibrium exchange economy, obtained by iterating forward through time the non-linear difference equation in the vector of market spot prices.

13 All computer programs are alike in their purpose of facilitating state or data changes, or mutations, prescribed by some overarching logic that is encapsulated in the source code of the program. How that logic is ultimately presented, arranged and structured, and thus engineered, can be fundamentally different across programs. It largely depends on the programming paradigm employed by the architect, of which the *functional* and the *object-oriented* are the two most prevalent in use. The former paradigm has dominated the industry for the last 30 years or so, while the latter one has experienced a renaissance of sorts in more recent times, due to the specific needs imposed by parallel computing.

14 We may consider a necessarily non-exhaustive set of factors such as wealth and other resources, socio-demographics, stable preference attributes, technology, and to some extent even less tangible characteristics such as cultural and psychological biases as being of relevance in this context.

15 The so-called *curse of multi-dimensionality* represents a well-known problem in both the economic and the physical sciences. It is particularly relevant for finite-state or discrete problems that are amenable to computer simulation and analysis. The problem manifests itself specifically in the explosion of the state space with the addition of each additional dimension to any problem under scrutiny.

16 Threads in computer hardware design are lightweight processes which can run in parallel. They typically also share some minimum amount of memory through which they can communicate most efficiently. This particular feature is however not supported in *Erlang* and the actor model's implementation of concurrent agent behaviour; agents can only share information states by sending and receiving messages which are copied. They are *not* provided as memory pointers.

References

Anderson, C.M., Plott, C.R., Shimomura, K.-I., Granat, S. (2004). Global instability in experimental general equilibrium: the Scarf example. *Journal of Economic Theory*, 115: 209-49.

Andersson, D.E. (2008). The double-edged nature of the Hayekian knowledge problem: systemic tendencies in markets and science. *Studies in Emergent Order,* 1: 51-72.

Armstrong, J. (2007). A history of Erlang. In: Proceedings of the Third ACM SIGPLAN Conference on History of Programming Languages, New York, NY, USA, 616-26.

Arrow, K.J. (1952). An extension of the basic theorems of classical welfare economics. Cowles Commission for Research in Economics, The University of Chicago, Chicago, IL, USA.

Ashraf, Q., Gershman, B., Howitt, P. (2012). How inflation affects macroeconomic performance: an agent-based computational investigation. National Bureau of Economic Research, Inc.

Bailey, D.H., Borwein, P.B., Plouffe, S. (1997). On the rapid computation of various polylogarithmic constants. *Mathematics of Computation*, 218: 903-13.

Benassy, J.-P. (1990). *Non-Walrasian Equilibria, Money, and Macroeconomics*. Amsterdam, NL: Elsevier.

Bridel, P. (2011). *General Equilibrium Analysis: A Century after Walras*. London, UK: Routledge.

Colander, D. (1996). *Beyond Microfoundations: Post Walrasian Economics.* Cambridge, UK: Cambridge University Press.

Colander, D. (2006). *Post Walrasian Macroeconomics*. Cambridge, UK: Cambridge University Press.

Colander, D., Howitt, P., Kirman, A., Leijonhufvud, A., Mehrling, P. (2008). Beyond DSGE models: Toward an empirically based macroeconomics. *American Economic Review*, 98: 236-40.

Constantinides, G.M. (1990). Habit formation: a resolution of the equity premium puzzle. *Journal of Political Economy*, 98(3): 519-43.

Debreu, G. (1954). Existence of an equilibrium for a competitive economy. *Econometrica*, 22: 265-90.

Duesenberry, J.S. (1949). *Income: Saving, and the Theory of Consumer Behavior.* Cambridge, MA: Harvard University Press.

Gintis, H. (2007). The dynamics of general equilibrium. *Economic Journal,* 117: 1280-1309.

Hayek, F.A. (1945). The use of knowledge in society. *American Economic Review*, 35: 519-30.

Hayek, F.A. (1979/2012). *Law, Legislation and Liberty: A New Statement of the Liberal Principles of Justice and Political Economy.* London, UK: Routledge.

Hewitt, C. (2010). Actor model of computation: Scalable robust information systems. *arXiv*,1008:1459.

Hewitt, C., Bishop, P., Steiger, R. (1973). A universal modular ACTOR formalism for artificial intelligence. In: *Proceedings of the 3rd International Joint Conference on Artificial Intelligence*. San Francisco, CA: Morgan Kaufmann Publishers Inc., 235-45.

Hildenbrand, W. (1994). *Market Demand: Theory and Empirical Evidence.* Princeton, NJ: Princeton University Press.

Hirota, M. (1981). On the stability of competitive equilibrium and the patterns of initial holdings: an example. *International Economic Review*, 22: 461-67.

Hirota, M. (1985). Global stability in a class of markets with three commodities and three consumers. *Journal of Economic Theory,* 36: 186-92.

Hirsch, M.W., Smale, S., Devaney, R.L. (2012). *Differential Equations, Dynamical Systems, and an Introduction to Chaos* (3rd Edition). Waltham, MA: Academic Press.

Holt, R., Rosser, J.B., and Colander, D. (2011). The complexity era in economics. *Review of Political Economy,* 23: 357-69.

Judd, K.L. (1998). *Numerical Methods in Economics*. Cambridge, MA: MIT Press.

Kirman, A. (2010a). *Complex Economics: Individual and Collective Rationality*. London, UK: Taylor & Francis.

Kirman, A.P. (2010b). *Walras' Unfortunate Legacy*. Shanghai, CN: HAL.

LeBaron, B. (2001). A builder's guide to agent-based financial markets. *Quantitative Finance*, 1: 254-61.

Mantel, R.R. (1974). On the characterization of aggregate excess demand. *Journal of Economic Theory,* 7: 348-53.

Radner, R. (1968). Competitive equilibrium under uncertainty. *Econometrica*, 36(1): 31-58.

Scarf, H.E. (1959). Some examples of global instability of the competitive equilibrium. Cowles Foundation for Research in Economics, Yale University, New Haven, CT.

Simon, H.A. (1947). *Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization (*1st ed.). New York, NY: Macmillan.

Smale, S. (1976). Dynamics in general equilibrium theory. *American Economic Review*, 66: 288-94.

Sonnenschein, H. (1973). Do Walras' identity and continuity characterize the class of community excess demand functions? *Journal of Economic Theory,* 6: 345-54.

Taylor, P., Jonker, L. (1978). Evolutionarily stable strategies and game dynamics. *Mathematical Biosciences*, 40: 145-56.

Turing, A. (1936). On computable numbers with an application to the 'Entscheidungsproblem'. Proceedings of the London Mathematical Society, London, UK.

Veblen, T. (1899/2007). *The Theory of the Leisure Class*. Fairford, UK: Echo Library.

Walras, L. (1874/1954). *Elements of Pure Economics: Or the Theory of Social Wealth.* London: Taylor & Francis Group.

Zuse, K. (1970). Calculating space. Project MAC, Massachusetts Institute of Technology, Cambridge, MA.

Comments on Palmberg, Potts, and Scheffel

GUS DIZEREGA

We are exploring theoretical territory opened up by the contrast between what F. A. Hayek termed cosmos and taxis. Each of us brings to this project the conceptual tools we learned within our respective disciplines, tools specialized for the services they supply to economics, political science, sociology, or other disciplines. This complex discussion comes with two costs and one opportunity that outweighs the costs. Disciplinary tools were often developed in ignorance of the distinctions captured in the terms cosmos and taxis. Certainly that is the case in my own field of political science. In addition, often there is no simple translation of terms from one discipline to another. This journal can play an important role in clarifying the relationships between disciplines and integrating their insights into the kinds of analysis we are pursuing in this forum.

The benefit is that as we approach these issues from different perspectives we will be sensitive to different dimensions of their operation. The result will be a richer appreciation of emergence than would be possible from development within a single discipline.

The following remarks will be mostly critical, but if considered by themselves these criticisms will leave the wrong impression. I found both Johanna Palmberg's and Jason Potts' papers of considerable value, enriching my own thinking. Eric Scheffel's paper seems of interest to economists mostly, and so I am unable to comment on it beyond the methodological issues I raise. But given the space allotted me and the time available, focusing on more critical issues seems most productive for encouraging future discussions.

Hopefully my remarks will set the stage for what I believe to be two important initial discussions. First, can economics, and particularly Austrian economics guide our understanding of social cosmos? Or is Austrian theory as an application of Hayekian insights appropriate for economics, but inadequate for guiding insights essential to understanding cosmos in other fields? Put differently, does the spontaneous-order model create a framework more abstract than the most abstract account of Austrian theory, and include phenomena unable to be assimilated by Austrian economics? I argue yes. Second, what is the relationship between emergent social phenomena, emergent biological phenomena, and spontaneous social phenomena? Exploring the finer points of what constitutes emergence or spontaneous order is central to resolving these questions, and this is a discussion well worth having.

JOHANNA PALMBERG

Johanna Palmberg's discussion of how understanding spontaneous orders contributes to our understanding of vital cities testifies to the richness of insights our project can open up. At the same time I believe a more self-consciously careful use of this term would deepen her analysis, for I believe "spontaneous order" is not equivalent to "emergence" but rather an important subset of emergence, one requiring standardized feedback and formally equal status among participants. Neither of these is necessary for emergent social phenomena to manifest.

If my distinction is valid, culture does not evolve "just like the market," because while price signals are central to the market process, they comprise only one of many signals that collectively weave together the broad cultural patterns within which we live and to which we contribute. Moral traditions and culture evolve, but they have no single signal for success or failure equivalent to prices on the market, votes in democracies, or agreement among specialists in science. They are central to civil society, but they respond to no single set kind of feedback.

Palmberg's economic approach to our topic is also evident in her endorsement of methodological individualism. Methodological individualism is only one of three dimensions an adequate analysis of complex social processes needs to incorporate, as Paul Lewis (2010) demonstrates. Peter Berger and Thomas Luckmann (1996) capture this point in their distillation of the argument to three statements: society is a human creation (methodological individualism), humans are social creations, and society is an objective reality. Analyzing emergent orders clearly goes far beyond a traditional Austrian approach, for we can grasp how they both reflect and shape the desires and actions of individuals.

Hayek (1973; 1988) was already exploring this insight, as with his argument that reason itself was a emergent result of people whose thinking and behavior were initially shaped by customs that had arisen due to other causes. Once reason emerged that to some degree enabled us to separate ourselves from society and think critically about it.

Coming from an economic perspective, Palmberg argues that "market prices transfer only relevant information to market participants," and credits Hayek with this view as well. I disagree and think Hayek would as well, for he recommended measures such as guaranteed income floors to replace the community-based mutual assistance networks that large-scale markets weaken. More fundamentally, much information participants might regard as vitally relevant need not be reflected in prices because prices are shaped by how specific property rights are defined. For example, if genetically modified food were required to be labeled as such, many consumers would not buy it, which is why food corporations refuse to label it and oppose being required to do so.

I also suggest thinking about market entrepreneurship as systemically akin to Thomas Kuhn's ordinary and revolutionary science would help her analysis. Entrepreneurship can be both equilibrating and disequilibrating, depending on the context of analysis and the specific entrepreneurial act involved. We are dealing with patterns of adaptation that are never at equilibrium.

But I do not want to sound only critical. Palmberg's analysis in my view is a step forward, enabling us better to appreciate dimensions of place in the real world of human life. I agree with her analysis of externalities and knowledge spillovers, and that Jane Jacobs' analysis is superior to that of the other approaches she considers. My point is that treating economic theory as a subset of a larger paradigm will deepen her analysis, not rebut it. I believe her doing so would sensitize her to insights from other areas of research on emergence.

For example, I think Steven Kauffman's analysis of adaptation in emergent systems adds weight to her critique of both the Marshall-Arrow-Romer and Porter models. Too many links, as in explicit responsibility for all negative externalities and internalization of all positive externalities, slows down systemic adaptation (Johnson, 2001: 78). The takeaway is that while the worst negative externalities should be internalized because adaptation in human societies should be for the benefit of humans, internalizing most positive externalities is less important and might be counterproductive.

JASON POTTS

I like Potts' description of emergent social orders as examples of seeing rule-based cooperation as evolution and his argument that imitation is the primary path by which rules capable of generating complex social orders arise. Imitation leads to cooperation, and evolution is the result. Much competition from this perspective seems to be an emergent quality. This emphasis is an important corrective from what I regard as too much emphasis on competition and the almost complete neglect of cooperation in many kinds of evolutionary studies. And not just in the social sciences. So I am happy we both admire E. O. Wilson's *The Social Conquest of the Earth.*

Potts approaches these issues from a different perspective than I do and illuminates different aspects of the phenomena. Whereas my own approach emphasizes, as Hayek put it, the use of knowledge in society, Potts suggests we can learn much from approaching the subject as the use of society in knowledge, as described in Hayek's theory of cultural evolution.

I agree. Potts' point is very important.

But at the same time I am concerned that in pursuing his project a crucial distinction between social emergence and spontaneous order has been obscured. Potts uses spontaneous order and emergent social processes interchangeably. I do not, and think it is important that we be more "splitters" to use Potts' delightful term, than even he is.

I argue we gain considerably by confining spontaneous orders to the kinds of phenomena to which Hayek and Polanyi first applied the term: science and the market. They are sufficiently distinct from other emergent processes, like common law or custom, so as to deserve being distinguished. Centrally, science and the market are rooted in equality of formal status among participants and simplified feedback signals reflecting the values implicit in their generative rules, values which are very simplified compared to the values motivating human beings to act within them. In addition, they are creatures of the modern world, which I hold to be significant.

Spontaneous orders grow out of the institutionalization of liberal values of equality of legal status and protection of spheres of voluntary private action. Thus, to the market and science I add liberal democracy and the worldwide web. Of course markets preceded modernity, as curious investigators like Aristotle preceded modern science, but nothing like a worldwide integrated network of impersonal exchanges did.

It is this impersonality that can remove markets from immersion in civil society.

Consequently, unlike Potts, I argue it is important to distinguish families, law, religion, and the arts from spontaneous orders. They are also emergent phenomena but lack impersonal feedback systems and often equality of status as well as often operating within contexts of far "thicker" values than spontaneous orders.

So from my perspective what Potts has done is very valuable but a bit different from what he describes. He has helped provide a deeper framework for understanding social emergence and integrated it more clearly into evolutionary processes that are distinct from simply coordinating information. Spontaneous orders are a subset of emergent social orders.

What follows are a few more focused discussions of the issues that he raises where my view is different, but are tangential to his project.

1. Potts argues that spontaneous orders are not expressions of individual power over others. Here my more focused approach comes to his aid, for all families are characterized by inequalities of power, minimally between parents and children. Law is scarcely equalitarian. Even within spontaneous orders like the market, while in a formal sense power is never exercised "over" others, the concrete reality is often quite different. Once rules become explicit, apply to all equally, and are subject to modification, those with more resources are able to influence decision-making and will have more power to shape the rules in their favor. The rules may still apply to everyone equally, but they lock in or even exacerbate power inequalities. Consider changes in bankruptcy law, tort reform, modifications of copyright law, and specific definitions of what constitute property rights as examples.

2. I also take issue with Potts' argument that spontaneous orders are "better understood as rule systems than as communication systems." I think they are importantly both. As spontaneous orders, the market, science, democracy, and the web attain enormous size and impersonality, because the rules generating them manifest in people's plans equally as simplified communicative feedback signals. Perhaps there is no disagreement among us here, but I have become very averse to presenting systems of social analysis in terms of dichotomies. Perhaps this is why I emphasize Habermas more than does Potts whereas, with his emphasis on evolution, he leans towards Oakeshott (whom I also admire).

3. If my distinction between the class of social emergence and spontaneous orders as a part of that class is taken seriously I think it allows us to identify another kind of emergence that Potts seems to either deny or ignore. He writes of organizations that they "serve the purposes of those who constructed them." At the moment of their creation this is true, but upon their creation they often take on a life of their own and begin redefining themselves and their hierarchy of goals, often in ways their initial creators would have opposed. Organizations also have emergent properties.

To sum up, Potts has done a service in emphasizing the evolutionary dimensions of social emergence and as such contributes another dimension to an approach focusing on information coordination. He has encouraged me to better appreciate the distinction, and the importance of exploring the distinction, between these two approaches to studying emergent social phenomena. For example, in writing this response I came to a more explicit awareness of how spontaneous orders, by virtue of their equality of status and more focused feedback, are genuinely modern phenomena with only hints from earlier times, whereas emergence has been a continual factor in human life.

ERIC SCHEFFEL

I think I have more basic disagreements with Eric Scheffel's paper, but due to our being in different disciplines with different technical vocabularies, I may be wrong.

Scheffel suggests that a spontaneous order is a homeostatic system. I disagree. A living organism, particularly an adult, is a homeostatic system. It exists far from equilibrium, but with a stable set of properties that define a boundary. Interestingly, a homeostatic system can be described teleologically. An organism has a goal or end of health and survival, and it can either succeed or fail.

It is difficult to use this terminology for a market, which is more like an ecosystem that does maintain a kind of pattern if we consider it abstractly enough, but in which every component is changing not just in the sense of an organism's metabolism, but more dramatically and fundamentally. Ecosystems do not have boundaries analogous to that of an organism, unless perhaps it is that of the earth considered as

Gaia. By contrast, an organization, a taxis, could perhaps be treated as a homeostatic system.

This disagreement in our approaches points to a deeper difference in studying emergent phenomena. In my opening paper I contrasted two contrasting approaches, one rooted in the physical sciences and epitomized by the work of Albert-Laszlo Barabasi and Steven Kauffman, the other in biology and epitomized by Evelyn Fox Keller's approach. I sided with Keller. The first approach, insightful and valuable as it can be, is inadequate for understanding emergent living systems. Scheffel seems to side with Kauffman's and Barabasi's approach. I wish he had explored his reasons for doing so and contrasted them with my counter-argument. Had he done so I would be more confident that I understand him and that my criticisms are valid, or I would have a different understanding and perhaps far less disagreement, if any.

As it is, Scheffel compares the laws of motion of gas nebulae in physics with "social actors [who] perceive, adapt, and act concurrently in real-time." But unlike gas nebulae, social actors also interpret what they perceive and those interpretations then influence the adaptive strategies they pursue. Consequently, because interpretation emerges out of the context of a mind encountering a situation, a situation which often involves continuous contact with other minds themselves similarly situated, actors can surprise us in ways purely physical systems cannot.

An emergent social order involves more than "rich and varied knowledge exchanges," even though he is correct that these exchanges are important and the models he criticizes do not give them the attention they deserve. To refer to my opening paper, Scheffel is describing a world from within "normal science" and what I call Kirznerian rather than Schumpeterian entrepreneurship.

Emergent social orders also exhibit frequent but unpredictable interpretations and reinterpretations of knowledge, and even entirely unforeseen discoveries, such that new knowledge emerges, knowledge that is context-specific in its origins, unpredictable in its content or impact, and not reducible to what was previously known. It is creative. As Keller observed, sometimes it is the statistically least anticipated outcomes that are most adaptive. We cannot program for new discoveries, but new discoveries are a central dimension of spontaneous orders. They exist within a very abstract pattern to be sure, but this pattern gives us no secure guidance as to which prospective discoveries will be made, let alone which will work out better than others.

More generally, I am unconvinced that any theory which gives equilibrium preferential status is very useful for shedding light on the operation of spontaneous orders. Consequently I am unconvinced that the attention paid to Walrasian analyses is particularly useful for shedding light on spontaneous orders of any sort.

I think these criticisms are on the mark, but Scheffel writes as an economist to economists, employing a technical vocabulary not often encountered in other fields. I would have greatly appreciated more attention by him to definitional issues such as what he means by spontaneous order, and also to making his more specialized terminology more accessible to non-specialists.

References

Berger, P., and Luckmann, T. (1966). *The Social Construction of Reality: A Treatise in the Sociology of Knowledge.* London: Penguin Books.

Hayek, F.A. (1973). *Law, Legislation and Liberty, Vol. 1: Rules and Order.* Chicago: University of Chicago Press.

Hayek, F.A. (1988). *The Fatal Conceit* (Ed. W. W. Bartley). Chicago: University of Chicago Press.

Johnson, S. (2001). *Emergence: The Connected Lives of Ants, Brains, Cities, and Software*. New York: Scribner.

Lewis, P. (2010). Peter Berger and his critics: The significance of emergence. *Society*, 47(3): 207-13.

Wilson, E.O. (2012). *The Social Conquest of the Earth.* New York: W. W. Norton.

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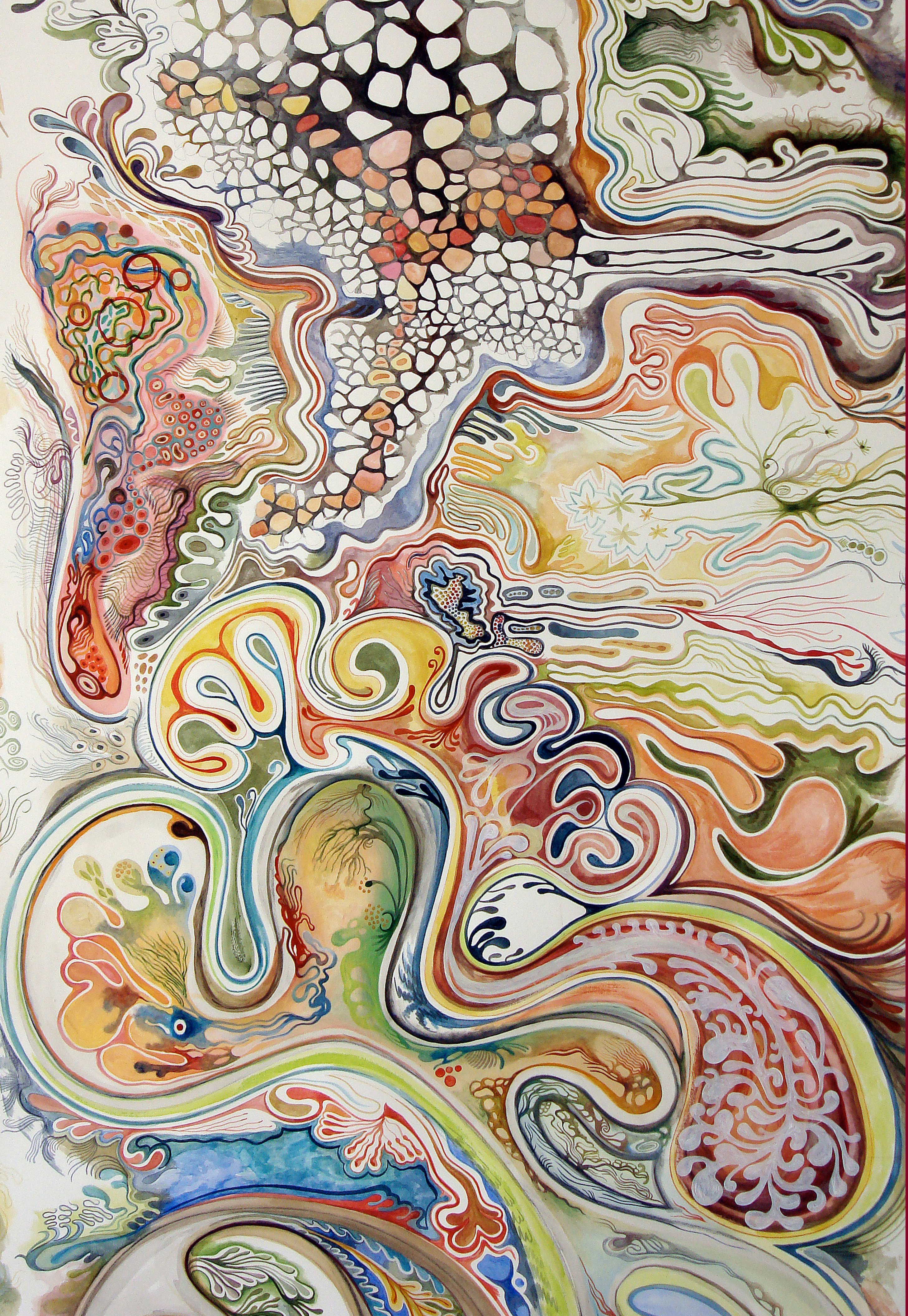

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