Epistemics, Experts, and Adaptive Systems

WILLIAM N. BUTOS

Email: william.butos@trincoll.edu
Web: http://internet2.trincoll.edu/facprofiles/default.aspx?fid=1000452

1. INTRODUCTION

In *Expert Failure*, Roger Koppl has produced a seminal work that provides a wide-ranging and detailed analysis that identifies and addresses a clear danger to the Liberal Order. The intersection of epistemics, experts, and policy forms a major theme in this work and it sheds new light in connecting the ways experts embedded themselves as the new saviors.

Koppl rightly identifies the contributions to social theory of Mandeville, Smith, Hayek, and others. The "knowledge problem," so famously associated with the work of Hayek and contemporary Austrian economists, as Koppl details in Part II of *Expert Failure*, forms one of the principal analytical entry points for market and social theory. Hayek's argument that theoretical and practical constraints impose limits on what individuals can separately know must be reckoned as one of the important contributions of modern economics. This constraint applies to all market participants, including most decisively to experts who may distort the market process through the administrative and regulatory state, central bankers, Big Players and other non-competitive activities.

The rule of experts represents an unwarranted intrusion into the market process in two ways. First, experts claim to have knowledge that does not comport with Hayek's knowledge constraint which may result in failure. Second, the actual activity of experts' behavior may distort the market process. It is this latter matter that I wish to highlight within the rubric of the generation of knowledge and the market's ability as an adaptive order that reflects and produces knowledge as an emergent characteristic of both individuals and, most importantly, social structures and institutions at the systems level.

2. HAYEK AND THE KNOWLEDGE PROBLEM

A guiding principle in the sequence of overlapping ideas that comprise Hayek's *oeuvre* over a long and varied career was that constraints exist on what individuals can know. This theme and its application to foundational questions in economics are already evident in his early essays during the 1930's, including those specifically penned in the context of the debate on socialist calculation (Hayek 1935). For example, in "The Trend of Economic Thinking" (1933), Hayek holds that economics has shown that the "co-ordination of individual efforts in society is not the product of deliberate planning" but that "an immensely complicated mechanism existed, worked, and solved problems, frequently by means [which] could not possibly be the result of deliberate regulation because nobody understood them." Reminiscent of Carl Menger and presaging his own later work, Hayek observes that the functions of the economic process "are discharged by spontaneous institutions" (p. 129) that form part of a "higher organized system" that is best recognized as an "organism and not an organization" (p. 130).

Hayek's identification in his 1933 paper of the existence of a chasm between the complexity of society and the capacity of a single mind to design (or plan and control) such a system, initiates an important direction in his own thinking and one that provides a linkage to his engagement in the socialist calculation debate. His critique centers on the epistemic requirements a central planning board would have to satisfy to allocate resources efficiently in a dynamic economy. Under such circumstances Hayek argues central planners could never bridge the gap between directing the virtually infinite kinds of adjustments in production and pricing consistent with an efficient use of resources. As Hayek (1935) observes in "The Present State of the Debate," the standard assumption for explaining competitive equilibrium was that a "certain range of technical knowledge is 'given'" in the sense that it was not "concentrated anywhere in a single head but that people with all kinds of knowledge

would be available [and] those that make the most appropriate use of the technical knowledge will succeed." Replicating this competitive result under central planning would require that knowledge about the most appropriate technical methods "will have to be concentrated in the heads of one or at best a very few heads." But such knowledge, Hayek notes, does not exist in a form that would lend itself to such application since "most of it consists in a *technique of thought* which enables the individual engineer to find new solutions rapidly as he is confronted with constellations of circumstances" (Hayek 1997 [1935], p. 5, my italics).

In a similar vein to the statements from the calculation debate paper cited above, Hayek pointedly indicated in "Economics and Knowledge" that the

> really central problem of economics … is how the spontaneous interaction of a number of people, each possessing only bits of knowledge, brings about a state of affairs … which could be brought about by deliberate direction only by somebody who possessed the combined knowledge of all those individuals" (Hayek 1948 [1937], pp. 50-1).

The economic problem facing any society, as Hayek would put it later (1948 [1945]), is thus "a problem of the *utilization* of knowledge which is not given to anyone in its totality" and whose success mainly depends on making "fuller use … of the existing knowledge" by "conveying to the individuals such additional knowledge as they need in order to enable them to dovetail their plans with those of others" (pp. 78-79, emphasis added).

At the same time, however, Hayek provides suggestive hints about the *generation* of knowledge. For example, we find in "Economics and Knowledge" (and somewhat ironically not in the 1945 paper) that "we are still pretty much in the dark about . . . the nature of the process by which individual knowledge is changed" and that hypotheses about knowledge "must necessarily run in terms of assertions about causal connections, about how experience *creates knowledge*" (pp. 45, 47, emphasis added). And in "The Meaning of Competition" (1948 [1946]) he notes that when dealing with the plans of several persons "the problem becomes one of how the 'data' of the different individuals … are adjusted to the objective facts of their environment." (p. 93), hinting at the creative and adaptive actions of individuals. These are interesting and potentially seminal insights; all the same, questions regarding the generation of knowledge are left in the shadows. Instead, Hayek's central focus in his catallactic theory refers to the market's capacity to communicate dispersed and tacit individual knowledge, not to the circumstances by which completely new knowledge. Thus, in "The Use of Knowledge in Society" (1948 [1945]) when he speaks of the function of the function of the market system as enabling "the utilization of knowledge not given to anyone in its totality" (p. 78), he exposes himself of the notion that there actually is such a thing as that totality independent of the circumstances of its generation, and that the problem is how best to accumulate and use it. In short, Hayek's emphasis is on the market as a discovery process, not as a emergent knowledge-generating process at the system level.

3. KNOWLEDGE AS ADAPTIVE AND CREATIVE CLASSIFICATION

My interest centers on some generalizable notion of knowledge as an emergent characteristic of individuals and the social structures that arise in which some kind of *classification* is generated. The classification is adaptive and capable of novel (creative) responses involving a highly complex nexus of interactions between the individual and its environment and may take various forms such as market prices and other market phenomena.

When we try to apply this conception to increasingly complex biological and social systems, a variety of complications very naturally arise. We not only encounter organisms that use highly complex classificatory structures capable of producing novel outcomes of their environments, but also various hierarchies of communities having their own distinct structural and functional attributes. Once we enter the world of humans, we must not only take account of single components but also of social structures and systems created by their interactions. Thus, while a useful starting point or initial unit of analysis for social theory is the individual, the analysis cannot either stop there or presume that social systems have no relevant implications for individuals. Indeed, an important claim in the present context is that those broader social structures are decidedly not aggregations of individuals but distinct structures having their own emergent characteristics. In particular, whether our focal point is the family, the community, or the market economy, my claim is that the interactions that take place in these social structures generate their own particular kinds of classifications. This leads to three relevant points:

1. These structures and systems are analyzable as distinct entities, having particular capacities for producing classifications as conditioned (obviously in highly complex ways) by both their functional and structural characteristics and those of their components.
2. The properties of such structures and systems, whether they are designed or undesigned (such as, respectively, a taxis or cosmos) will produce emergent outcomes in the form of the generation of knowledge; however, their respective feedback and stability properties are different.
3. The feedback properties of a cosmos, such as a free market system, incorporate the inputs of all who participate while a taxis, such as a centrally planned economy, is limited to a far smaller set of knowledge inputs; these differences, respectively, are ordinarily revealed in a cosmos as participatory dynamism and in a taxis as turgidity by insufficient feedback constrained by the imposition of predetermined goals by planners.

The knowledge-generating properties of a cosmos (or "spontaneous order") are not simply a summing-up of the inputs but constitute a transformation of those inputs into something different, something that no single individual could have generated. This applies to a system of free markets in generating the constellation of ever-changing market prices. The prices produced at the system level constitutes an adaptive adjustment driven by the knowledge ongoing interactions of individuals who themselves implement their own creative dispositions. These feedback loops are compromised in a taxis because central economic planning precludes access to relevant knowledge beyond the planners' own purview; the absence of a market process under central planning means the range and quality of useful knowledge is constrained by "a single mind," in "Economics and Knowledge" (Hayek, 1948 [1937]) and the ability for the system to adapt is compromised. This is the case even with an "expert" planner—as Hayek (1960, p. 292) put it: "To make the best available knowledge at any given moment the compulsory standard for all future endeavor may well be the most certain way to prevent new knowledge from emerging."

In terms of the questions considered in this paper, the argument that the market generates a unique classification as a consequence of the interactions of market participants is not meant to invest in the market any cognitive capability whatsoever. What matters, rather, is that markets (and other social structures) exhibit capacities for feedback of varying proficiency and agility for generating classifications. The process by which emergent characteristics appear, sustain themselves over some finite period of time, and change or get replaced in the context of transactions and scarcity is the subject matter of the theory of the market process. Such explanations necessarily involve an account of the economics of the interactions of individuals and the feedback mechanisms in order to arrive at the system-level outcome.

4. HAYEK'S EXTENSION OF KNOWLEDGE

The Sensory Order (1952) offers Hayek's clearest statement of an order that generates knowledge. The implicit story contained in *The Sensory Order* is that individuals are not mere processors of information, passively responding to stimuli. Instead, Hayek argues that cognitive activity, despite being constrained by abstract rules, both learnt and inherited, and its own physiology, should be understood as an active, input-transforming, knowledge-generating adaptive system. The cognitive problem Hayek deals with is not about how knowledge is harvested or discovered by an individual, but with the process of a single brain generating knowledge. The intriguing question that *The Sensory Order* raises is whether its insights can be applied to the social domain.

The question arises as to how we should take account of the fact that when individuals interact in various social contexts, those interactions have the capacity to generate certain kinds of social outcomes that reflect a system-level classification over sets of inputs. Hayek seems to have been aware of this when he says:

> The growth of knowledge and the growth of civilization are the same only if we interpret knowledge to include all the human adaptations to environment in which past experience has been incorporated. Not all knowledge in this sense is part of our intellect, nor is our intellect the whole of our knowledge. Our habits and skills, our emotional attitudes, our tools, and our institutions—all are in this sense adaptations to past experience which have grown up by selective elimination of less suitable conduct (1960, p. 26).

And this kind of knowledge, which Hayek then refers to as "tools," is crucial for the process of civilization because its embodiment in traditions and institutions means that it can be transmitted and communicated through time as "tested and generally adopted ways of doing things" (p. 27).

As part of this more extensive application of what constitutes knowledge, Hayek also includes (as we might expect) "abstract (or general) rules" and their manifestation as law:

> If the law thus serves to enable the individual to act effectively on his knowledge and for this purpose adds to his knowledge, it also embodies knowledge, or the results of past experience, that are utilized so long as men act under these rules (p. 157).

We therefore have before us a somewhat finer taxonomy of what constitutes Hayekian knowledge. While I think there is no question that Hayek's conception of knowledge fundamentally sees it as originating as an individual characteristic, he also identifies a kind of system-level knowledge that emerges experientially from social processes. Also significant is the idea expressed by Hayek in *The Constitution of Liberty* (1960) that the law "adds to knowledge," suggesting that by stabilizing rules of property, transference, and enforcement of contracts (Hayek 1960, p. 158), the law actually produces a kind of knowledge essential for social intercourse. At the same time, Hayek is quite clear in seeing such outcomes as adaptations and thus as inherently mutable, with the flip side being that any evolved rule or tool cannot be assumed to be either optimal according to some externally imposed welfare criterion or suitable for all circumstances and times.

The upshot here is that Hayek's general approach is at least suggestive of social structures as adaptive classifying structures. Given this we should first take note that specific capacities for classification and the possibility for higher cognitive functions obviously differ across different kinds of biological organisms and social structures and, thus, for different kinds of adaptive-classifier systems. Once we broaden our conception of "knowledge" to include the generation of classifications at the systems level opens up the scientific process of examining exactly how the market produces certain classifications, what feedback loops exist between the individual components of the system and the system-level outputs (including its own "rules"), what factors determine the classification-generating capacities of systems whose structures differ, and how the system adapts in terms of producing new structures or rules and modifying or retaining others. Whereas the social structures we observe vary in terms of the extent to which they may be placed along a spectrum of undesigned or designed orders, their classification-generating capabilities and characteristics would also figure prominently in their analysis and assessment.

5. ECONOMIC ORDERS, THE GENERATION OF KNOWLEDGE, AND EXPERTS

The market economy is an abstract Hayekian order constituted by: (1) individuals pursuing their own ends under resource constraints and (2) their exchange and production activities involving agreements specifying the voluntary transfer of claims to property. The order that results from these conditions is typically referred to as the *catallaxy*, and it is this order that provides the essential starting point for the theory of market processes. We can invoke a distinctly Hayekian perspective here by noting that individual knowledge is agent-specific and that it is this knowledge that guides each individual's market activities and the particular interactions he undertakes, whether such interactions refer to the execution of a (pre-specified) plan or become modified as a consequence of the process itself as the individual learns more about the environment and himself. Although each individual is necessarily and constitutionally ignorant of many of the details of the actual market transactions that are occurring beyond the immediate confines of his own interactions, market prices emerge from the totality of those ongoing interactions.

Agents learn by participating in the market process—that is, if the market process is a discovery process having the capacity to actually convey useful information to agents (as Hayek and Kirzner would hold), then the path of the process cannot be in any relevant sense preordained. Thus, the constellation of prices that emerge as a result of the interactive processes that constitute the market process cannot be inferred from initial conditions, including quite obviously the particular knowledge of the agents themselves. While clearly any individual may have been able to conceive of a range of possible market prices, it is only through the actual process of market interaction that such a classification can be generated. And in the absence of that market process, those market prices could not have emerged. This point is reflected in Stephan Boehm's insight that "knowledge yielded by market processes is knowledge generated through the operation of the market order—that is, it cannot be generated in any other way" (Boehm 1994, p. 169).

The personal knowledge of many interacting individuals produces a transformation in the constellation of market prices that cannot be explained by any aggregation procedure from those individuals. Market prices are not para-

metric but are an emergent property of the market process itself and cannot be generated by any other process other than the one that gave rise to their emergence. When we look to the market economy, we see a system that appears to perform adaptive and anticipatory functions quite well (McQuade 2018). Paris not only gets fed, but it gets fed differently each day and in a way its unforgiving gourmands desire.

The catallaxy serves as a useful analytical platform for examining the economics of an exchange and production order founded on property rights. Yet, actual market economies rarely present themselves in this pure form; instead, we ordinarily encounter systems where government intervention is often substantial. Such intervention runs the gambit from isolated and limited incursions into specific markets to widespread interventions across markets to the abolition of the price system under socialism. A major component of such interventions can be attributed to Koppl's analysis of "experts."

The point I wish to suggest here is that these systems can be subjected to a comparative institutional analysis in terms of their classification-generating capability. If so, then it is possible to categorize economic systems or orders according to structural characteristics that derive from the framework—the rules, routines, conventions, and institutional arrangements—within which they function. The adaptive qualities of these systems and the outcomes they produce are not only closely tied to their capacities to use dispersed knowledge but also to their capacities to generate classifications. This perspective allows us to expand our understanding of the epistemic implications of different kinds of economic systems by bringing together previously noted insights and perhaps new ones under the broader theme of "adaptive classifying systems" (McQuade 2007).

This perspective directs attention to how the market adapts in terms of the classificatory flows particular kinds of interventions are likely to engender in the context of Koppl's identification of experts, Big Players, and the Administrative State. For example, when we consider the self-proclaimed experts and Big Player effects of discretionary monetary policy, the market's classificatory outputs of interest rates and credit flows will be displaced and superseded by the classifications of the Big Player. Experts fail because their conceit violates Hayekian constraints on knowledge; but their hubris also produces policies and regulations that displace the market process and its knowledge generation. These distortions are often severe and unseen, possibly fomenting serious resource misallocations and system-wide disruptions in productive activities, the redistribution of wealth and income, and wide-spread involuntary unemployment. The causes of such effects are all too often misidentified, resulting in the call for soliciting "experts" to remediate a situation for which they are largely responsible.

We can extend these points to a single Big Player for all markets operating in a regime of central planning. A long and deep literature has decisively demonstrated that central planning suffers from fatal deficiencies in terms of meeting the needs of consumers. Central planning runs afoul of the knowledge problem, as Hayek and Mises argued, because central planners are unable to marshal dispersed individual knowledge and because the absence of a price system prevents rational economic calculation. From the perspective of my comments here, a complementary approach presents itself in that the classification-generating capacities of a central planned economy reflect the limited potential of a "single mind" as opposed to that of the many interacting minds of the catallaxy. Economics provides ample insight that the adaptive and anticipatory properties of the centrally planned system will reflect this difference in crucial and, indeed, alarming ways. As Koppl points out, over-reaching experts, across the scope and scale of policies, may succeed in co-opting and inhibiting the benefits of the market process.

NOTES

1. See Weimer 1982; Gray 1984. Kirzner emphasizes the "continuity of overlapping ideas" of Hayek as opposed to a putative "unity" in his work in "Hedgehog or Fox: Hayek and the Idea of Plan Co-Ordination" (2000, pp. 180-202).
2. Hayek (1933, n. 4) attributes the distinction between organism and organization to Mises, citing his Gemeinwirthschaft (2nd ed.) of 1932, although the distinction was also raised by Menger (1892).
3. See Butos and McQuade (2002), p. 124. In *The Constitution of Liberty* (1960, pp. 24-25), Hayek as much as denies the systemic knowledge-generating effect, asserting that "Knowledge exists only as the knowledge of individuals. It is not much better than a metaphor to speak of the knowledge of society as a whole. The sum of the knowledge of all the individuals exists nowhere as an integrated whole. The great problem is how we can all profit from this knowledge, which exists only dispersed as the separate, partial, and sometimes conflicting beliefs of all men."
4. In *The Sensory Order* (1952) Hayek develops the notion of a cognitive "classification" by the brain. His insight can be generalized to other adaptive-feedback systems, such as the market process. Such systems are generative and capable of emergent outcomes. Much like a finite number of inputs, such as the alphabet and the rules of syntax, such systems can support an infinite number of creative outputs. Also, see Koppl, et al. (2015).
5. To forestall any misunderstandings about the concept of knowledge that might arise in connection with the ontology of these social structures and systems, there is no implied suggestion of anthropomorphism or "collective consciousness," or "group mind. The kind of knowledge possessed and generated by the human brain is reflexive, self-organizing, and purposeful. A spontaneous order, such as the market, is populated by social structures and systems that are non-reflexive, unconscious, and non-teleological. The differences of these orders—the brain and market- however are fully capable of generating emergent characteristics but the kinds of knowledge generated are contingent on the orders in which they operate. See Hayek (1952, p. 4; 1978, pp. 40-41) and Butos & McQuade (2001, pp. 123-125). The suggestion advanced here, then, is really two-fold: first, it recognizes that the capacity to produce a classification is not a uniquely human characteristic, and second, that we should expect classificatory capacities to differ across entities dependent on their structure, complexity, and other characteristics associated with their adaptive capabilities (see Kaufmann 2000, especially pp.114-116).
6. See Butos and McQuade (2017), McQuade (2007, 2018).
7. *The Sensory Order* (1952) offers Hayek's clearest statement of an order that generates knowledge. A major theme is that individuals are not mere processors of information, passively responding to stimuli. Instead, Hayek argues that cognitive activity, despite being constrained by abstract rules, both learnt and inherited, and its own physiology, should be understood as an active, input-transforming, knowledge-generating, creative, adaptive system. Addressing this question has become something of a flashpoint for Hayekian scholars. The current majority stance holds that the relevance of Hayek's cognitive theory is essentially captured by its contributions to subjectivism and to methodological issues, as principally contained in the final chapters of *The Sensory Order* (for example, see Caldwell 2003) and has little direct relevance to economic theory. However, others have uncovered more far-reaching sources of inspiration and applications to economics and social theory of Hayek's work, including the theory of entrepreneurial learning (Butos and Koppl 1999; Butos 2003), economic expectations (Butos & Koppl 1993,1997; Koppl 2002), the economics of science (McQuade and Butos 2003, McQuade 2007), and the theory of adaptive social systems (McQuade 2004, McQuade and Butos 2005, Harper 2014, Lewis 2016). Also, see Vanberg's magisterial Introduction to Hayek's writings on theoretical psychology (2017), and the volumes on *The Sensory Order* edited by Butos 2010 and Marsh 2011.
8. See Butos And McQuade (2017).
9. In *The Tyranny of Experts,* Easterly (2013) criticizes the authoritarian top-down approach retarding economic development. Also see Hamburger (2014) on the administrative (or "deep") state.
10. I thank Scott Scheall, Leslie Marsh for helpful comments and especially those of Thomas McQuade whose imprint permeates this paper. The usual caveat applies.

REFERENCES

Boehm, Stephan. 1994. Hayek and Knowledge: Some Question Marks. In: M. Colonna, H. Hagemann, and O. F. Hamouda (eds.), *Capitalism, Socialism and Knowledge: The Economics of F.A. Hayek,* v. 2, pp. 160-177.

Butos, William N. 2003. Entrepreneurship and the Generation of Knowledge. In: Roger Koppl (ed.), *Advances in Austrian Economics*, v 6. (*Austrian Economics and Entrepreneurial Studies*), pp. 97-112.

__. 2010. *The Social Science of Hayek's The Sensory Order*. William N. Butos (ed.). *Advances in Austrian Economics* 13.

Butos, William N. and Koppl, Roger. 1993. Hayekian Expectations: Theory and Empirical Applications, *Constitutional Political Economy*, 4 (3), 303-29.

__. 1997. The Varieties of Subjectivism: Keynes and Hayek on Expectations. *History of Political Economy*, 29 (2), 329-359.

__. 1999. Hayek and Kirzner at the Keynesian Beauty Contest. *Journal des Economistes et des Etudes Humaines*, 9 #2/3, 257-75.

Butos, William N. and McQuade, Thomas J. 2002. Mind, Market, and Institutions: The Knowledge Problem in Hayek's Thought. In: Jack Birner, Pierre Garrouste and Thierry Aimar (eds.), *F.A. Hayek as a Political Economist*, 113-133.

__. 2017. Polanyi, Hayek and Adaptive Systems Theory. *Cosmos + Taxis* 4:1, 1-22.

Caldwell, Bruce. 2004.. *Hayek's Challenge*. University of Chicago Press.

Easterly, William. 2013. *The Tyranny of Experts*. Basic Books.

Gray, John 1984. *Hayek on Liberty*. Blackwell.

Hamburger, Philip. 2014. *Is Administrative Law Unlawful?* Chicago: University of Chicago Press.

Harper, David. 2014. Property Rights as a Complex Adaptive System: How Entrepreneurship Transforms Intellectual Property Structures. *Journal of Evolutionary Economics* 24 #2, 335-355.

Hayek, F. A. 1933. The Trend of Economic Thinking, *Economica*, 40 (May), 121-37.

__. 1935 (ed.). *Collectivist Economic Planning.* Chicago: University of Chicago Press.

__. 1948. *Individualism and Economic Order*. Chicago: University of Chicago Press.

__. 1952. *The Sensory Order*. Chicago: University of Chicago Press.

__. 1960. *The Constitution of Liberty*. Chicago: University of Chicago Press.

__. 1973. *Law, Legislation and Liberty. Volume I: Rules and Order.* University of Chicago Press.

__. 1978. *New Studies in Philosophy. Politics and the History of Ideas*. Chicago: University of Chicago Press.

__. 1997. *The Collected Works of F.A. Hayek. Volume 10: Socialism and War,*
Bruce Caldwell (ed.). Chicago: University of Chicago Press.

Kaufmann, S. A. 1993. *The Origins of Order: Self-Organization and Selection in Evolution*. Oxford University Press.

Kirzner, Israel M. 1992 [1988]. The Economic Calculation Debate: Lessons for Austrians. In: *The Meaning of Market Process,* Routledge, 100-18. [*Review of Austrian Economics*, 2 (1), 1-18].

__. 1997. Entrepreneurial Discovery and the Competitive Market Process. *Journal of Economic Literature*, 35 (2), 60-85.

Koppl, Roger 2002. *Big Players and the Theory of Economic Expectations*. Palgrave Macmillan.

Koppl, Roger, et al. 2015. Economics for a Creative World. *Journal of Institutional Economics* 11(1), 1–31.

Lewis, Paul. 2012. Emergent Properties in the Work of Friedrich Hayek. *Journal of Economic Behavior and Organization* 82 #2&3 (May), 368-378.

Marsh, Leslie. 2011. *Hayek in Mind: Hayek's Philosophical Psychology.* Leslie Marsh (ed.). *Advances in Austrian Economics* 15.

McQuade, Thomas J. 2007. Science and Market as Adaptive Classifying Systems. In: E. Kreke, C. Kreke, & R. G. Koppl (eds.), *Advances in Austrian Economics* 9 (*Cognition and Economics*), 51-86.

__. 2018. Organization, Anticipation, and Closure in Markets and Science, ms.

McQuade, Thomas J. and Butos, William N. 2003. Order-Dependent Knowledge and
the Economics of Science *Review of Austrian Economics*, 16 (2/3), 133-52.

__. 2005. The Sensory Order and Other Adaptive Classifying Systems. *Journal of Bioeconomics* 7 #3,335-358.

__. 2009. The Adaptive System Theory of Social Orders. *Studies in Emergent Order* 2, 76-108.

Scheall, Scott 2016. A Brief Note Concerning Hayek's Non-Standard Conception of Knowledge. *Review of Austrian Economics* 29, 205-210.

Vanberg, Victor J. 2017. The Knowledge Problem as the Integrating Theme of F. A. Hayek's Oeuvre: an Introduction to *The Sensory Order*. In *The Collected Works of F.A. Hayek*, v. 14: *The Sensory Order and the Other Writings on the Foundations of Theoretical Psychology*. Viktor J. Vanberg (ed.). Chicago: University of Chicago. pp. 1-111.

Weimer, Walter B. 1982. Hayek's Approach to the Problems of Complex Phenomena: An Introduction to the Psychology of *The Sensory Order. Cognition and the Symbolic Processes*, vol. II, W. B. Weimer and D. Palermo (eds.). Lawrence Erblaum, pp. 241-85.