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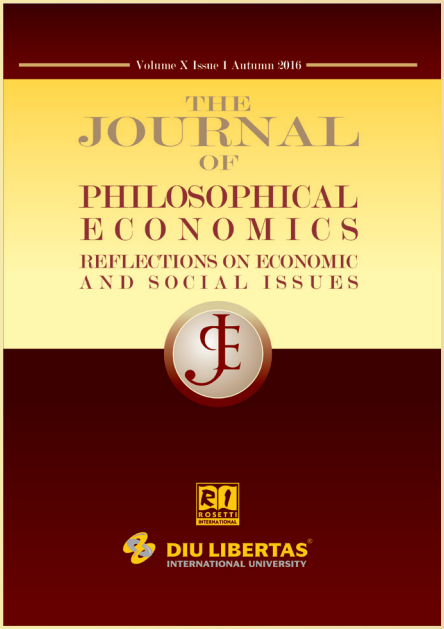

Planning horizons as an ordinal entropic measure of organization

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Abstract. Nicholas Georgescu-Roegen (1971) educated economists on the notion of entropy laws in economics and ecological process. An earlier paper by Kenneth E. Boulding (1962) asked what we might do with a measure of organizational entropy, were one ever devised. The aim of this paper is to propose the notion of planning horizons as a candidate for this role. First, the concept of organizational entropy is discussed and defined within the interdependent domain of ecological economics. Next, the character and contributions of an entropic measure of organization are reviewed, as described in Boulding's work. Third, the concept of planning horizons – and their relation to economic cohesion, efficiency and well-being – is introduced to show how 'horizon effects' (shifts in planning horizons) serve as an ordinal entropic measure of organization in dynamic complex settings of interdependent effects. Last, the promise of planning horizons as a new social research program in ecological economics shall be discussed.

Keywords: ecology, economics, entropy, organization, planning horizons, horizon effects, ordinal measure

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Introduction

The defining characteristic of institutional and ecological economics is *interdependence*: everything causally interrelates with no bound to resulting effects. Every act ripples out through social and physical space onto all living creatures, whether we know it or not. 'Time, Space, and Nature' are 'seamless wholes' without 'joints' for a 'carver' (Georgescu-Roegen 1971, p. 66). The whole System moves in concert: dynamic, chaotic, complexly unfolding in patterns seemingly of its own making, combining components in new ways selectively understood by us. 'The new biological conception ... the organismic epistemology ... is a belated recognition of the existence of novelty by combination' that 'contributes something that is not deducible from the properties of the individual components' (Georgescu-Roegen 1967, pp. 112 and 62). But complexly interdependent systems – seamless save in our scientific conceptions – show where analysis fails in the presence of qualitative variation and dialectic emergence. As Georgescu-Roegen (1971, p. 67) noted: '...The impossibility of defining formally the intuitive continuum is a logical consequence of the opposition between the essential property of numbers to be distinctly discrete and the characteristic property of the intuitive continuum to consist of dialectically overlapping elements leaving no holes.' How might we encompass such continuity in our research?

Nicholas Georgescu-Roegen (1971, pp. 128-33) offers the Entropy Law as 'the only clear example of an evolutionary law ... a proposition that describes an ordinal attribute E of a given system ... a "time's arrow"' of entropic direction. The Entropy Law states 'that the entropy [or disorder] of the universe increases as Time flows through the observer's consciousness.' Indeed, as Georgescu-Roegen (1967, p. 93; 1971, p. 194) put it, 'our whole economic life feeds on low entropy' at the cost of high entropy elsewhere: 'life speeds up the entropic degradation of the whole system.' His treatment of entropy is about order and energy, not about organization.

Kenneth Boulding opens 'Some Questions on the Measurement and Evaluation of Organization,' taking an organizational view of this entropic measurement problem. Defining 'organization' as 'ordered structure' of 'roles' in society, Boulding (1962, pp. 131-32) envisions two different processes in the universe,

entropy and evolution, where evolution also entails segregation of entropy. He adds that a measure of organization would constitute an index of evolution in both direction and magnitude, were we to craft such a yardstick. An important key to evolution lies in the teaching process, which augments organization and knowledge. Consequently, an index of organization would also serve as a metric for knowledge and learning success. As Boulding (1962, pp. 135-40) explains, economic advance is at essence organizational: it does not yield homogeneous growth but is 'an evolutionary, developmental, and almost embryological process.' He also imputes an ethical aspect to any organizational measure, as such enhances 'goodness.' The unmet challenge is to reduce 'large and complex constellations of organization' down to 'a one-dimensional scalar of "goodness,"' with a 'price system' of value weights: 'the development of a workable measure of organization would at least be a first step toward the construction of an ethical calculus' leading 'toward the solution of many problems, not only in biology and in the social sciences, but also in ethics.'

So Georgescu-Roegen's entropic concept turns on energy usage and its service to purposive human enjoyment. Boulding's view is more institutional, linked to organizational theories of learning and human activity. Yet both are in need of a unifying conception of entropic change. The interrelation of planning horizons with pricing, growth and efficiency offers a novel look at the entropy problem and our need to assess it through an organizational lens. Some of the most important dimensions of entropy in our relations appear within a horizonal outlook. Starting with interdependence and the challenge of economic analysis in a complex systems setting, the Entropy Law – with respect to energy and organization – can be interpreted as a horizonal measure of organizational 'slack.' In this way, 'horizon effects' shift us on an entropic continuum, measurable with respect to improvement in Boulding's ethical sense.

The entropy law with respect to energy and organization

Nicholas Georgescu-Roegen along with most ecological economists see entropy as energy use: production and consumption decrease entropy in our locality, at the cost of higher entropy elsewhere. The sole reason we can afford the

unsustainable economic consumption patterns seen nowadays is due to a stock of exhaustible low entropy, including coal, gas and oil as available energy assets. Renewable energy, on the other hand, is sustainable (theoretically), yet these options must be exploited in nondestructive ways, so other resources are not endangered thereby: expanding hydroelectric power at the expense of salmon runs serves as a useful example of conflicting conservation effects.

But Georgescu-Roegen's stress on energy – although important – does not directly address social activity and its organizational limits, beyond some mention of factories and diminishing versus increasing returns. He does connect the issue of nonlinearity to qualitative adjustments lurking behind the quantification of 'sameness' in analytical models, saying: 'We have to recognize once and for all that sameness is an internal affair of a single mind' (Georgescu-Roegen 1971, p. 75). Thus he sees increasing returns as 'essentially evolutionary ... necessarily irreversible and perhaps irrevocable' (Georgescu-Roegen 1967, p. 107; 1971, p. 321). He does acknowledge two other measures of evolution in biology – "'complexity of organization" and "degree of control over the environment'" – but dismisses both as unsatisfactory as 'the suggested attributes are not ordinally measurable' (Georgescu-Roegen 1971, p. 128). It may be sufficient to note that 'horizon effects' circumvent this problem: 'organizational complexity' in itself need not be progressive (as it could shorten or lengthen horizons), while longer horizons allow us more control of environmental forces through an understanding thereof.

Boulding's approach to evolution through teaching and learning as organization is closer to a horizonal view, where every action we take creates effects spreading outward forever in a totally interdependent domain of complex causal relations. The organizational literature relates to incentive design, tying Boulding's (1956) and Simon's (1981) work on rational limits to ecological economics through management theory. A way to think of organizational entropy in this sense is as a 'measure of fit' of theoretical models to realms of application, by the realism and essentiality of their assumptions. For example, as Pylyshyn (1984, p. 251) noted:

> It is my view that there is only one empirical hypothesis responsible for the productive success of the entire range of imagery models...: When people imagine a scene or an event, what occurs in their minds is, in many ways, similar to what happens when they observe the corresponding event actually happening.

The realism of our assumptions, by improving the fit of theory and truth, allows an extension of planning horizons.

The point is that, as social arrangements become more complex, organizational linkages grow in importance for economic advance. Social systems – when unfit to requirements – shorten horizons: such is what we see today in the contradictions of competition in a new economy of informational complementarity as opposed to industrial substitution (Jennings 2008a). The shift to informational content from material output is profound for economics, as it entails a change of interdependence from substitution to complementarity, exemplified by a reversal of the relation of value to scarcity. Information economies do not suffer from the same problems as industry; information is reproduced 'at near-to-zero marginal costs. The "new" economy, thus, has entered a stage of informational abundance which bears little resemblance to the conventional mainstream economic assumption of scarcity' (Elsner 2004, p. 1032).

Substitution – derived from materialistic conflicts of interest – does not apply among complements in ecology and education; here positive feedbacks are the rule and trade-offs seem the exception. Thus, abundance in networks stimulates value where rarity undermines worth; the more ubiquitous the connections, the higher will be the demand. As Angus Matthew (2001, p. 2 of 7), writing on 'The New Economy,' put it:

> In the networked economy, the more plentiful things become, the more valuable they become. ... In a networked economy, value is derived from plenitude, the concept of abundance. ... Abundance is everything. Ubiquity drives increasing returns in a networked world. In fact, the only factor becoming scarce in a world of abundance is human attention.

This supplants a correlation of scarcity and dearness with a new inverse relation between them in a 'public goods' setting: connectivity augments worth in any networked economy! Yet economists still see competition as an efficient design in the presence of complementarity, while blithely ignoring its lack of applicability to this setting.

If models unfit to applications are used to guide decisions, then planning horizons shorten due to uncertainty and surprise. '...The only *raison d'être* of theory is economy of thought,' where 'the choice of relevant facts ... is the vital problem in economics' and 'a "simple-minded" model may ... be the more enlightening representation of the economic process' (Georgescu-Roegen 1971, pp. 15 and 340-41). This is why essentiality is as important as realism when matching assumptions to applications: if models steering our actions do not fit the settings in which they are used, inefficiencies – including conflict and wasted resources – result. These are not dismissable methodological issues in any event: they underlie some serious problems in economics today.

Entropy is disorganization as much as usable energy loss; if economic incentive structures are ill-designed to their realms, entropy rises more than expected: efficiency is lost. The question is how we express such effects in a simple ordinal measure, by distilling 'large and complex constellations of organization' into 'a one-dimensional scalar of "goodness"' through a system of value weights (Boulding 1962, p. 140). The matter of how we measure entropic cultural attributes of an economy in terms of energy, organization or planning horizons seems severely intractable, until the methodological issues surrounding it are addressed. Designs must fit to purpose and context; this is where we start to make a case for entropy as *horizonal* in economic society.

Toward a horizonal measure of entropy

First we must recognize *interdependence*: systemic complexity is the centerpoint of horizonal theory. Economists see 'the market' as an organizational process through which all our conflicting wants are reconciled by a system of prices. Smith's 'invisible hand' is said to work efficiently in the presence of substitution

and rising cost, though all bets are off when increasing returns are introduced to this scheme, as they make complementarity 'far more important' than substitution (Kaldor 1975, p. 348). In this setting, cooperation is the efficient solution to economic organization, not competitive fragmentation. The economic conundrum of increasing returns and complementarity is that we lack any quantitative framework of arithmomorphic constructions suited to this scene, as Georgescu-Roegen has shown. Nonlinearity is symptomatic of a dialectic (qualitative) variation behind the 'sameness' supposed in our models. A different economics is needed for increasing returns systems of positive feedback, cumulative causation and dialectic emergence of 'novelty through combination.' This is our primary problem: measuring evolutionary advance or retreat through horizonal links.

In one elementary aspect, the entropy of economic communities is the inverse of their efficiency: using resources without more regard to their social effects stands at the center of ecological economists' story of 'full cost' pricing (Hawken 1994). Most of us say, 'if prices are right, then private individual choice will lead to efficient outcomes,' so resources seek their best use (though representation of future generations should be included too). When all decisions are interdependent across space (social and physical) and through ongoing time – moving the 'seamless Whole' of our Universe so unpredictably in its spinning complexity – any evolutionary understanding appears so intractable as to tempt economists into an Age of Denial about increasing returns and their economic effects. As Boulding averred, a measure of organizational entropy and evolution is crucial in this setting.

Georgescu-Roegen (1971, pp. 213-14) notes the role of *boundaries* in our process analysis: 'No analytical boundary, no analytical process.' He adds that 'a boundary must necessarily consist of two distinct analytical components. One component sets the process against its "environment" at any point of time. ...We may refer to this component as the *frontier* of the process. ... The boundary must also contain a temporal component, the *duration* of the process.' But total interdependence suggests such 'slices' are imposed by us on the 'seamless Whole' of the Universe, so on what basis should we do that? How might we set the 'frontiers' of an integral process, and determine 'duration'? In part, this is an

issue of 'scale' in ecological economics (Jennings 2008b): the scope of the analysis should reflect the scale of 'essential' effects within our range of vision, over a time that fits their resilience. But these are matters – centrally – of *perception*, not just of fact, in a world where everything ripples outward forever without any end to its impact.

This is where planning horizons serve to 'bound' awareness and conscience: effects spread outward forever, but prior knowledge of them does not. The rational limits of human intelligence stand as a 'boundary' between anticipation and surprise, showing a way to deal with interdependence. With no seams out there in the world, the only slices are those we impose: our rational limits seem an appropriate choice of frontier for our analyses, with an implicit duration in the temporal length of planning perspectives.

Horizons are multidimensional, though; we ground imagined projections – on which all decisions are made – upon knowledge of relevant theory, which involves selective focus on discretely-asserted 'essentials.' Certain contingent tracks are projected outward further than others, because of familiarity or ranking. The point where reality then departs from prior expectations sets the *ex post* horizon for that decision: this is the role of surprise in defining the actual length of horizons, since we may deem our horizons long until we learn they were short. For example, psychotics may see themselves with broad ranges of vision, when they are really abstracting away from many other confounding effects: selective focus is also – at the same time – restrictive blindness.

But this story only encompasses single agents' horizons; the organizational issues stem from the interdependence of planning perspectives in the horizonal realm. Planning horizons shift together: if you are in my decision environment, your behaviors shape my own; *horizon effects are contagious*. When you become more predictable, lengthening your horizons, I can plan better too: horizons move in concert, more often than not, in the most general case. So 'interhorizonal complementarity' is the rule and not the exception, though 'interhorizonal substitution' can be imagined as well – such as in jealous reactions to neighbors' success – but these effects select themselves out in any open economy, being counterproductive in their rewards. So we can assume, in general, for all agents i

= 1,...,n, that $dH_{i\neq j}^*/dH_j^* > 0$. If so, horizonal lengthening creates a local decline of entropy, in which choices become more aware and better aligned to each other. The integration – therewith efficiency – of economic coordination is strengthened by longer planning horizons. Such implies a horizonal index of entropy ought to be useful as a means to resolve vital lacunae in economic constructions.

Horizon effects as a measure of 'goodness': social welfare ramifications

So what has been shown thus far? First, there is a planning horizon (H^*) inherent in every decision, based on the range of imagined projections on which choices are made. But H^* is a complex variable: *ex ante*, it can be seen as an 'average' of all contingent projections, though *ex post* it is set where anticipation is overcome by surprise. The closer the fit of theory to fact – the better aligned our assumptions are to the extant truths of their application, in both their 'realism' and the 'essentiality' of their selective focus – the longer can our horizons stretch for any (given) level of effort. This last is important, as Boulding (1962, p. 134) explains, since learning is not just teaching (or 'printing') but 'inspiration' as well. The greater our level of faith and confidence – in ourselves and those surrounding us – the more time, money, attention and energy will be invested in choice, so the broader our range of projection. In this sense, social planning horizons serve as a measure of economic cohesion and efficiency in an interdependent economy of independent decisions. Socially, economic coordination is the whole game, but our models must fit to the facts for any assurance of value in outcomes.

Second, 'horizon effects' – shifts in planning horizons for individuals – are contagious as well: longer horizons infect those of proximal others in nearby space. We are role models for each other, and learning is mostly imitation. Horizons stretch or retract together in any social group: *interhorizonal complementarity* yields some meaningful lessons for economists' system designs and their welfare ramifications. For those implications, the interrelation of planning horizons to pricing and economic advance should be sketched.

The barest summary of the relation of pricing decisions to planning horizons can be outlined thus: for all prices, $dP^*/dH < 0$ with $d^2P^*/dH^2 > 0$. The basic idea is that $\mathbf{P^* = M^* \cdot E^*}$, with $dM^*/dH < 0$ and $d^2M^*/dH^2 > 0$, and $dE^*/dH < 0$ and $d^2E^*/dH^2 > 0$; so $dP^*/dH < 0$ and $d^2P^*/dH^2 > 0$ (Margolis 1960, pp. 531-32). On the assumption that the proportional growth rate of sales is $g^* \equiv dlnQ/dt$, we can also infer that $dg^*/dH > 0$ and $d^2g^*/dH^2 < 0$. The expression for P^* is derived thus: formally (in deductive terms), $M^* \equiv MR=MC$ at Q^* (the maximum profit condition), where $E^* \equiv [\varepsilon^*/(\varepsilon^*+1)]$ with $E^*>1$ because $-\infty < \varepsilon^* < -1$ [where demand elasticity $\varepsilon \equiv dlnQ/dlnP \equiv (dQ/Q)/(dP/P)$ is the percentage response of Q to a one-percent increase in Pl. The basic expression emerges from the definition of MR as dR/dQ (where $R \equiv P \cdot Q$) with respect to Q or P, which can be written simply as $P = MR \cdot [\varepsilon/(\varepsilon+1)]$, yielding $\mathbf{P^* = M^* \cdot E^*}$, which price is adjusted until actual Q^* and g^* are as expected for a given horizon H^* (Jennings 2008a, 2009, 2012). Also all cost and demand relations – subjectively held – depend on diverse factors mostly unknown to a price-setter: there is no 'perfect knowledge' assumption of 'full information' here. The price-setter does the best she can to imagine unexplored options – such as other possible $P \neq P^*$ and their likely outcomes in Q – but demand and cost curves are not observed; they are projected theoretically, and so have epistemological – and not ontological – status (Simon 1981, p. 103).

But to understand the reaction of prices to horizon effects, we must move beyond individuals into a system of interlinked choices. The primary form of interdependence subsumed in neoclassical theory is *substitution*: the aggregation of firms into 'industries,' the interaction of factory inputs (e.g., Stigler 1951, p. 140-44 vs. Nelson 1981, pp. 1053-55), and the chary attitude of consumers to each other's well-being amount to a rigid dismissal of common aims for rivalrous strife. Factually, it remains open whether *conflicts* (substitution) or *concerts* (complementarities) of interest dominate human affairs. This is an issue of vital concern to social organization.

For any group I of firms, we compare *individual* with *joint* profit-maximizing prices to form a measure of net interdependence (S_I) with respect to each member. This supplies economists with a broader rule of composition (Krupp

1963) than the 'industry' concept, within a Chamberlinian frame (Chamberlin 1933 and 1957; Jennings 1968). Our measure of interdependence (S_I) can also be seen as a Hicks-Kaldor (1939) compensation process, in which *substitutes* for a given product j would pay to raise P_j yet must be recompensed for reductions. Firms selling *complements* seek a lower P_j, as its rise threatens sales. This is closely related to what Earl (1983, p. 29) called 'The Richardson Problem' which Richardson (1959, pp. 233-34) explained thus:

> A situation of general profit potential can be tapped by one entrepreneur only if similar action is not intended by too many others... In general, a producer will need to know both that the production of complements (such as raw materials) will be adequate and that the production of substitutes will not be in excess. For the sake of brevity, however, we shall ignore the existence of complementarity...

Shapiro and Varian (1999, p. 10) give an informational version of the same issue:

> Traditional rules of competitive strategy focus on competitors, suppliers, and customers. In the information economy, companies selling complementary components, or complementors, are equally important. ... The dependence of information technology on systems means that firms must focus not only on their competitors but also on their collaborators. ...The need for collaboration, and the multitude of cooperative arrangements, has never been greater than in the area of infotech.

So we define net interdependence by comparing P_j^* (from own-profit maximization) with P_j' (from joint-profit maximization) – as an alternative to substitution assumptions stemming from industry groups – where S_I is the difference between them, such that $\mathbf{P_j' = P_j^* + S_I}$. S_I operates as a 'feedback term' expressing net interdependence within group I with respect to j, which captures the external profit effects of the setting of price P_j^* as either net substitution (the orthodox story with $S_I > 0$) or complementarity ($S_I < 0$). S_I is a combinatorial of individual profit effects, where each $s_{i \not\sim j} \equiv (Q_{i \not\sim j}/Q_j) \cdot (M_{i \not\sim j}^* - P_{i \not\sim j}^*) \cdot [\varepsilon_{ij}^*/(\varepsilon_j^*+1)]$. $S_I \equiv \Sigma s_i$ only with all s_i's independent, which cannot be assumed in

the presence of fully interdependent phenomena. S_I is derived from maximizing joint profits for firms in group I with respect to P_j, while ε_{ij} is the cross-elasticity of $Q_{i\neq j}$ with respect to P_j, and ε_j is the own-elasticity of demand for Q_j. This is a method of grouping not defined or restricted by substitution, or tied to a concept of 'industry'. But why do 'industries' not suffice as a general case of firms' interdependence, showing rivalrous substitution in a competitive frame of rewards?

The reason is a horizonal one. First, the question about the essential nature of social relations is obscured by industry aggregation; Chamberlin opened doors to recognizing complementarity, but did not venture through them. Richardson (1959, pp. 233-34) came a lot closer, but balked at complementarity (as quoted above). It took Kaldor (1972, 1973, 1975), many years later, to claim increasing returns suggest the importance of complementarity over substitution in economics, even without horizon effects. The point here – regardless of Kaldor's claim – is that horizon effects, with interhorizonal complementarity, act to mimic complementarity and increasing returns, even under fully orthodox substitution and rising cost. In other words, *as horizons lengthen, net inter-dependence (S_I) always shifts in favor of complementarity, away from substitution,* if horizon effects are contagious. If so, then $\mathbf{dS_I/dH_j^* < 0}$: an increase in H_j^* yields (through its contagious effects on $H_{i\neq j}^*$) a shift of S_I away from substitution in favor of complementarity. For any $i\neq j$ element of S_I, namely $s_{i\neq j} \equiv (Q_{i\neq j}/Q_j) \cdot (M_{i\neq j}^* - P_{i\neq j}^*) \cdot [\varepsilon_{ij}^*/(\varepsilon_j^*+1)]$, an extension of H_j^* will likely reduce the magnitude of both $Q_{i\neq j}/Q_j > 0$ (as a weighting scalar) and $|(M_{i\neq j}^* - P_{i\neq j}^*) < 0|$, while increasing own-elasticity $|\varepsilon_j^* < -1|$ and thus the negative magnitude of $|(\varepsilon_j^*+1) < 0|$, while the cross-elasticity (ε_{ij}^*) is shifted away from substitution ($\varepsilon_{ij}^* > 0$) toward complementarity ($\varepsilon_{ij}^* < 0$), such that $d\varepsilon_{ij}^*/dH_j < 0$ as well. So regardless of the sign of S_I (as a combinatorial of $s_{i\neq j}$ across any group I around member j), $\mathbf{dS_I/dH_j^* < 0}$: a mutual lengthening of horizons shifts our interdependence away from substitution ($S_I > 0$) in favor of complementarity ($S_I < 0$) in our relations (in all economic contexts). If economic connections are horizonal in this sense, then Kaldor's case for complementarity as our most general relation – under increasing returns, anyway – is strengthened dramatically by introducing horizon effects to the story.

In this regard, horizon effects should be seen as shifting organizational entropy and cohesion. In a complex society, coordination of goal-seeking activity ought to be seen as a key yardstick for individual choice. When net interdependence is substitution, rivalry is efficient: that is well-known to economists. When net interdependence is complementary, it is cooperation we want and not competition, which is doomed to fail in this setting. Any fragmentation of effort – in the presence of complementarity – undermines economic efficiency and social welfare. Realms of positive feedback (complementarity) can be found in both ecology and education, where competition has harmful effects. Indeed, there is a case that competition not only is counterproductive in complementary settings (which Kaldor believed was the general case), but also that competition is keeping our (private and social) horizons short, with learning a complementary process. This is an obvious corollary to the efficiency of integration under complementarity, which our horizons surely reflect. If longer horizons serve as a measure of organization and negative entropy – and so evolution as well – then neoclassical economics stands in the way of advance, by wrongly extolling competition in every instance as socially optimal. Substitution assumptions shall lead us astray in theories wrongly applied to complementary settings.

A horizon effect – the extension or retraction of planning horizons – should be seen as an ordinal shift in a complex balance of framed projections, where resultant time horizons are only a simple scalar responding to internal and external forces. Others' planning horizons have a major effect on one's own, as will environmental stability, information and knowledge, learning activity, energy and attention, encouragement, hope, self-confidence and other factors. Most of these are ignored in mainstream models of economics, so introducing them through horizon effects is an advance in itself. Furthermore, all economic systems – in their efficiency, equity, ethics, ecological health, and organizational evolution – are driven by social planning horizons: this strengthens the claim for complementarity into a general case, making cooperation – not competition – our means to social advance (Jennings 2011).

There is an ordinal measure of entropy underlying horizon effects, with *all* human-caused ecological losses seen as horizonal. The problem is not just that

every decision generates lasting effects, but rather how well we anticipate them before acting. If all we do has irreversible impacts spreading outward forever, and everyone chooses individually in their pursuit of value, it is solely the *quality* of our decisions – and their organic cohesion – that protects us from disappointment (or worse). The role of social horizon effects – as inferred from patterns of action – open new ways to assess economics. And even the merest glance at current affairs suggests the value of viewing things through a horizonal lens, in an increasingly myopic world torn asunder by competition. Horizonal theory invites some major revisions in how we do our research, showing elementary errors in what we think we know. As Georgescu-Roegen (1970, p. 9) has said: 'the history of every science, including that of economics, teaches us that the elementary is the hotbed of the errors that that count most.'

Horizonal economics as an emergent social research program

Two insightful economists have looked to Smith's seminal work; Kaldor (1972, pp. 1240-42) opined that:

> ...economic theory went wrong ... in the middle of the fourth chapter of Volume I of The Wealth of Nations ... [where] Smith ... gets bogged down in the question of how values and prices ... are determined. ... As a result, the existence of increasing returns and its consequences for the whole framework of economic theory have been completely neglected.

Kenneth Lux, on the other hand – in a book called *Adam Smith's Mistake* – captures an ethical problem behind the invisible hand in Smith's (1776, Book I, Chapter 2, p. 14) statement that: 'It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest.' Lux (1990, pp. 87-89) says:

> Adam Smith made a mistake. ...Adam Smith left out just one little word – a word which has made a world of difference. And if this mistake is not corrected, then the absence of that word could threaten to unmake a world. That word is only. What Adam Smith ought to have said is, 'It is

> not only from the benevolence...'; then everything would have been all right.

The word 'only' appears in a previous sentence on the same point, but here is left out, treating self-interest as sufficient (without benevolence) instead of framing them both together: 'Smith's sanctioning of self-interest without any qualifying or restraining force completely eliminated the moral problem in human action.'

According to these economists, then, increasing returns and ethics should be an integral part of economics and not just cast to one side. As Pigou (1927, pp. 193 and 197) explained: '...It is *impossible* for production anywhere to take place under conditions of increasing costs' so 'cases of increasing costs ... do not occur.' The next year, Pigou (1928, p. 256) reinforced the point, saying 'supply price cannot ... increase with increases of output. Hence ... only the laws of constant or decreasing supply price ... are admissible.' The issue relates to ethics because, once increasing returns are embraced as a universal phenomenon, economic analysis also shifts from nicely decomposable entities to a systems approach, within which ethics become meaningful and important constraints on action. Here one can view the planning horizon not only as a measure of organizational learning and knowledge, but also as an index of 'conscience' in its ethical and ecological impact. The finding that – as horizons extend – human relations shift toward concurrence says that personal growth encourages sensitivity, greater maturity, generosity and a broader range of awareness, so better integration of plans. Such is why horizons serve us so well as a negative index of entropy in the organizational sense.

What we have shown thus far is how our planning horizons interact, and the effects thereof in terms of pricing and economic development. There is much to be done, however, to open knowledge of how our (individual and social) planning horizons react to various stimuli, and how to observe horizon effects in the patterns of daily life. Clearly the longer our planning horizons, the lower will be our 'time preference' or 'impatience,' so we expect declining discount rates from any horizonal lengthening (Jennings 2012, pp. 16-17). The composition of capital ought to shift to more extensive plans, while levels of ethical and ecological literacy should rise. Significant changes should be observable in

response to horizonal theory, even from merely emphasizing horizon effects in our thinking. For regulation of the economy, endless ways in which our rules shorten planning horizons should be addressed and opened to question: there are so many avenues of research emerging from this approach that their enunciation extends beyond the scope of this paper. The point is simply to indicate a few directions of thought.

The most fundamental limits in neoclassical theory are substitution and decreasing returns suppositions, safely in the hard core of this so-well-established paradigm. Kaldor rejected this standard approach, endorsing complementarity as an offshoot of increasing returns; interhorizonal complementarity yields similar findings. Static equilibrium models – severed from 'external' linkages – simply yield their refined deductions on the basis of fixed horizons. Such short-term analyses are restricted to myopic concerns, steering attention away from broadly inclusive frameworks and theories. Indeed, the effects of competition on education and ecology – as examples of complementarity – yield dramatic confirmation of the argument here: that competition in complementary settings is not only inefficient but also is destined to fail, to become mired in counterproductive fallacies and myopic conundra. Indeed, the narrowness of academic inquiry and the ubiquity of ecological losses are cases in point: these short horizons are the result of models unfit to their realms of use.

Such problems are responsible for organizational stress, showing up in symptoms of higher-order human need deprivation in Maslow's (1954, 1968) sense of that term. For example, interhorizonal complementarity means that treating grownups like children will bring immature responses. In such settings many adults exhibit pathological signs of 'frustration, failure, short time perspective and conflict.' These symptoms of human need deprivation will lead to organizational fragmentation through 'competition, rivalry, ... hostility and ... a focus toward the parts rather than the whole' (Argyris 1960, pp. 262-63, 268-69). When a wrong model is used to design an institutional incentive structure, we should expect to find pathological symptoms of organizational stress. Such symptoms seem familiar; they infuse social relations. All this suggests that dominant traits of our economic culture result from organizational stress

stemming from improper institutions, showing express psychological symptoms of ill health including conflict, competition, materialism, myopia and disruption of effort (McGregor 1960, pp. 310-11). The role of horizon effects shall open doors to significant insights on our economic behavior.

Horizon effects, in their response to organizational stress, serve as a meaningful measure of entropy, which opens to a 'horizonal' economics still largely unmapped. Too much orthodox theory abstracts away from horizon effects, supposing time perspective fixed: a way to consider planning horizons is as an index of 'run length' or 'move horizons' in chess (Jennings 2009). Our planning horizons shift in response to internal and external forces: the potential fruits for research in this realm might teach us all a great deal.

Conclusions and implications

Nicholas Georgescu-Roegen (1971, p. 192) introduced economists to the entropy concept as a measure of energy usage and 'sorting' activity: 'a living organism ... continuously sorts. It is by this peculiar activity that living matter maintains its own level of entropy.' But Kenneth Boulding (1962), a few years earlier, ventured some questions on organization and the use of an index thereof. Later, Boulding (1966, pp. 22-23) proposed a unit of measure for knowledge as the 'wit,' which seems so apt to horizonal theory. As Boulding put it:

> The question of what is economics can be almost as troublesome as what is knowledge? ... One longs, indeed, for a unit of knowledge, which might perhaps be called a 'wit,' analogous to the 'bit' as used in information theory; but up to now at any rate no such practical unit has emerged. ... The bit, however, abstracts completely from the content of either information or knowledge... [and] for the purposes of the social system theorist we need a measure which takes account of significance... Up to now we seem to have no way of doing this...

The notion of planning horizons – and of their adjustment through 'horizon effects' – serves as a way to think about entropy in its social and organizational

aspects such as Boulding endorsed. The nature of horizonal lengthening corresponds so closely with these views that it can be used to assess how well our organizations are doing in the pursuit of human ends, which are – ultimately, as Georgescu-Roegen (1967, p. 97; 1971, p. 18) notes – *the enjoyment of life*.

But to adopt this novel approach shall force economists out of an Age of Denial over increasing returns, and to forsake 'The Hicksian Getaway,' just as Hicks (1939b, pp. 82-85; 1977, pp. v-vii) did forty years ago (Jennings 2008a). In Chicago, orthodox theory is doctrine and is taught as such (Reder 1981; also cf. Leontief 1982). But substitution has no relevance to information network economies which are mostly complementary – as shown by their reversal of the relation of value to scarcity – nor to academic institutions or ecological settings. Standard theory in economics stands on assumptions so unfit to emerging complementarities that the recent rise of heterodoxy is symptomatic of vital lacunae in the orthodox story. Yet there is still little heed taken by ecological economics to the way our interdependence is framed in mainstream models, or in efficiency failures of competition in network contexts such as appear in ecology or education. Kaldor's claim that complementarity is the rule in orthodox settings says cooperation is efficient without horizon effects. But cooperation is surely our route to longer planning horizons, so will foster a healthier economic climate in every regard. In this sense, broader planning horizons serve as an ordinal index of knowledge, organization and entropic coordination.

As such, horizonal theory yields some more optimistic conclusions than are proffered by orthodox standards. If this approach is correct, then competition is not as smooth a solution to social organization as so many economists think: competition, in keeping horizons short, is sabotaging efficiency in a way invisible through a neoclassical lens. Selective focus in theory – as an artifact of our rational limits – is also restrictively blind to what is ignored as unimportant. Treating H* as fixed deprives us of any understanding thereof. The only protection we have from amaurosis is an open mind and a use of multiple models, where each sheds light on all others. The sad fact that pluralism is so rare in academics is simply another effect of competition where it does not apply: these pathologies so abound that we don't see them as symptoms of failure. As some wise soul once said, 'Fish discover water last' (McGregor

1960, p. 317). Myopic concerns surround us; they threaten our very lives in both their cultural and ecological impact.

Perhaps Boulding, Simon and Kaldor ought to have the last word on the scope of revision needed. At the end of Boulding's (1966, pp. 33-36) Ely Lecture on knowledge, he issued this scathing critique:

> The whole economics profession ... is an example of ... monumental misallocation of intellectual resources... We are still, like Newton, only a boy playing on the seashore, and the great ocean of Truth still lies all undiscovered before us. That undiscovered ocean is Man himself. What we discover about him, I hope, will be for his healing.

Simon's (1983, p. 107) essay on 'Reason in Human Affairs' ended thus, with horizons and social advance:

> It would be quite enough to keep open for our descendants as wide a range of alternatives as our ancestors left for us... Success depends on our ability to broaden human horizons so that people will take into account ... a wider range of consequences. It all depends on whether all of us come to recognize that our fate is bound up with the fate of the whole world, that there is no enlightened or even viable self-interest that does not look to our living in a harmonious way with our total environment.

Kaldor (1972, p. 1240) remarked that there is only one way to emerge from myopia here: 'without a major act of demolition – without destroying the basic conceptual framework [of orthodox equilibrium theory] – it is impossible to make any real progress.' As Boulding (1966, p. 36) closed his previous statement: 'To this unfinished task I commend us all.'

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