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The case for increasing returns (2): the methods of planning horizons

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Abstract: In neoclassical economics, substitution assumptions support equilibrium models in closed systems shunning interdependence. On these grounds an array of frames show outcomes as stable, efficient, unique and determinate. Heterodox economists say equilibrium models sidestep practical knowledge and the rich reality of economic behavior. Rigor or realism, mainstream or radical, ecological, institutional, socio-cultural: economics invites a wide diversity of assumptions, once short-term models of substitution are opened to question. The answers are blurred by applications; there is clarity in a simplicity shielded from mundane detail. This paper addresses the methodological impact of planning horizons, increasing returns and complementarity, and their proper representation in economic constructions. Horizonal economics can be construed as extending orthodox standards into a realm of time, but for its subtler ramifications. Increasing returns make our relations complementary and not substitutional, loosening the tight deductions from mainstream models of choice. The horizonal extension of our received theory of price applies time to cost and demand curves, showing Marshallian scissors (supply and demand) cut outward and downward with expanded horizons. Static conceptions appear in horizonal groups, suggesting complete theories of price should specify agents' horizons, with no further radical impact: the trouble emerges with increasing returns and complementarity. Horizons stem from unbounded causality; if all we do ripples outward forever in nature and society, the relevant field of inquiry for economics is interdependent: this is the case for bounded

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rationality as an analytical limit to economic conceptions. In turn, interdependence suggests a use of network constructs to frame complex systemic cascades, and networks open a door to complementarity and increasing returns in transport and information exchange. The gaping maw of increasing returns and complementarity opens, swallowing down neat traditions such as stability, equilibrium, marginalism, partial analysis, supply and demand depictions of price, etc. The methodological lesson of this shift to network contexts and dynamic complex systems supersedes some of our favored doctrines and the analyses on which they stand. Without decreasing returns and substitution, neoclassical arguments simply do not work. Heterodox approaches – and their intelligent application – are required in this setting. The paper offers a few guidelines to an unexplored domain of fundamental departures.

Keywords: complementarity, methodology, increasing returns, planning horizons.

Introduction

The practice of any discipline is largely based on habit, drawn from years of experience and patterns of thought imprinted deep in our minds. Standard techniques and doctrines are applied to events or acts subconsciously; only the novel aspects are attended with any care. The expertise that we achieve from all the years spent doing these things shall obviate the need for any closer regard to detail. Only in the presence of a radical loosening of assumptions or a profound change in demands will we then directly investigate the differences and what they mean. This sort of fortuitous circumstance shows our intellectual limits, shaking us out of boxes we may not have known we were in, to the extent we allow it to happen.

The shift away from substitution assumptions in economics is very much of this ilk. Conceptual habits of thought that rely on these suppositions suffuse skills and techniques used throughout economic analysis, such that we are often unaware of all the ways substitution assumptions shape how we think and do our research. Any system of thought derives from basic concepts structured together into an organization of

findings and deductions so intertwined that the longer it lasts, the harder it is to change or even to tease apart. The elements are so interdependent that any alteration threatens the whole intellectual edifice.

Substitution, tradeoffs, scarcity, all are so deeply embedded into our mindset that their ramifications spread throughout to infect the fabric of everything that we 'know.' When these matters are opened to questions – such as suggesting 'abundance models' as an alternative frame – many economists shun the idea as rejecting what defines economics (or worse, as simple ignorance thereof). And so we endure, unable to venture outside the box in which we enclose ourselves and our research. Assumptions we use should be open to challenge (or relaxation at least) if only to know our restrictive foundations. Solely by emerging can we see our own amaurosis.

This paper reports on an intellectual history and a perspective, facing implications of fundamental lacunae in economics. Substitution assumptions – seen as so essential to the field that it is often defined as a study of 'scarcity and tradeoffs' – are not the universal or even general principles that we think: complementarity 'is far more important for an understanding ... of the economy than the substitution aspect' (Kaldor 1975, p. 348). How could this be, and where does it take us? Such is the topic to be discussed.

But first the history must be explored; The second part will address planning horizons and horizon effects as a simple extension of orthodox standards into time for pricing decisions. Second, in the third part, a more radical case is made for increasing returns and complementarity as general phenomena. The analytical implications of this upheaval are limned in the fourth part, regarding how increasing returns and complementarity impact some of the favored 'tools of the trade,' when no equilibria or any balancing forces save us from open domains. The methodological limits shall be explored in the fifth part, in terms of techniques and models serving us in these unfamiliar realms: what types of frames subsist in open dynamic complex systems of fully interdependent elements interacting in unpredictable ways subject to wide diversities of reaction to starting conditions? At last, the sixth part will conclude with a few summary observations.

The origins of horizonal theory

Horizonal theory (Jennings 2008a) emerges from a query about time: if long-run and short-run models are different – indeed, if large scales stray from small – how might we incorporate this in a unified theory of price? The question has been addressed in the past by many great economists. Marshall looked at dynamics, saying that rapid short-term adjustments can be distinguished from long-term trends and cycles (Frisch 1950). Knight (1921, pp. 186-87) defined the problem as one where conditions and data alter radically based on the time period being considered: 'different changes take place at different rates.' Stigler (1939, pp. 306, 311-12, 320-21) ended his discussion showing the problem as methodological: 'a complete presentation ... involves a third axis, time, and the marginal and other cost functions become surfaces. ... But ... it is no longer possible to handle the problem ... by the use of plane geometry, since future prices are now important variables.' J. M. Clark (1940, pp. 246-48) considered the same problem, with the same result: 'the whole functional relationship is probably so complex as to defy mathematical plotting.' Returning to this knotty issue 15 years later, Clark (1955, p. 459) concluded that: 'This complex of variables would overload any possible system of graphic presentation. A family of three-dimensional surfaces – the third dimension being time – ...would still be a simplification.' But Turvey (1969, pp. 285-87) called the standard (first derivative) definition of marginal cost 'too simple to be useful' because 'both cost and output have time dimensions, and both may be subject to uncertainty.'

So how do we deal with the issue of time and knowledge in pricing decisions? I called the problem methodological on the basis of Simon's (1981, p. 103) suggestion that cost and demand curves in neoclassical theory were framed 'as part of the outer environment' instead of addressed as subjective, as the Austrians would have preferred. Treating cost and demand curves as 'part of the inner environment' makes the issue horizonal, about the perspective of the price setter or analytic observer. But time horizons are not sufficient; the way to extend one's view ahead is through improvements in knowledge. Only by understanding causality in all its subtle dimensions might we project our results further in time: planning horizons are the relevant topic to be addressed. Margolis (1960, pp. 531-32), in a little-known paper, had it exactly right: 'The greater the uncertainty ... the shorter will be the planning horizon and the greater will be the ... costs... The implications ... are that the greater the

ignorance of the market the higher will be the estimate of the costs and the more inelastic the estimate of demand.' But Margolis sees this astonishing insight only in narrow terms, as a means to gain information: 'The higher the price the greater the expected short-run profits... The lower the price the more information [the firm] gains about the future market possibilities.'

For any price setter in any context, the profit-maximizing P^* is expressed as $P^* = M^* \bullet E^*$ where $M^* \equiv MR = MC$ at $Q = Q^*$ and the markup term over unit cost is $E^* \equiv \varepsilon^*/(\varepsilon^*+1) > 1$ for own-elasticity $\varepsilon^* < -1$. Margolis' claim is that $dP^*/dH < 0$ because both $dM^*/dH < 0$ and $dE^*/dH < 0$. (For completeness' sake, since $P^*, M^* > 0$ and $E^* > 1$, $d^2P^*/dH^2 > 0$ with $d^2M^*/dH^2 > 0$ and $d^2E^*/dH^2 > 0$.) But that pertains to an individual product – or even just one transaction – in an interdependent domain of many agents and deals. So how do we analyze settings of interactive firms and trades? The standard dodge in micro theory is aggregation by industry, packing the answer into its frame. An industry is a population of firms selling substitute products, so – on the basis of substitution – we like competition to keep prices low and output higher than with collusion. Hayek (1948, pp. 99-100) considered the answer, but dismissed it as too complex and daunting:

> We shall probably learn more about ... the competitive process if ... we ... ask whether competition would be any less important if ... no two commodities were ever exactly alike. If it were not for the difficulty of the analysis of such a situation, it would be well worth while to consider in some detail the case ... where we had to deal with a continuous range of close substitutes... The result of the analysis of competition in such a situation might ... be more relevant to the conditions of real life...

This is what Chamberlin (1933, 1951) tried to do with monopolistic competition, despite his fatal error with oligopolistic grouping. But even Hayek conceived the 'continuous range' as 'of close substitutes'; Richardson (1959, pp. 233-34; also cf. Earl 1983, p. 29) noted the role of complementarity, but turned away:

> 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 <u>complements</u> (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.

Richardson had the right idea, although he did not pursue it. The network case subsumes substitution and complementarity into a non-decomposable bundle of interdependent effects that cannot be dodged. Transportation networks are rife with both forms of viable links, and one agent's substitute ties (or parallel lines) are another's complementary (or end-to-end) junctures (Jennings 1985, 2006). In networks, substitution cannot be isolated from complementarity: both appear together in an inextricable lump, posing questions of focal limits in economists' standard approach. The interdependence of pricing decisions can be analyzed thus.

On Hayek's suggestion, consider a group $\mathbf{I}$ of firms composed of various substitutes and complements, all affected by a single member $\mathbf{j}$'s pricing decision, as a general formulation and method of aggregation. The net interdependence within this group $\mathbf{I}$ of firms with respect to any individual member $\mathbf{j}$'s pricing decision is $\mathbf{S_I}$, where $\mathbf{S_I > 0}$ indicates substitution and $\mathbf{S_I < 0}$ reveals complementarity. Now look at the difference between $\mathbf{P_j^*}$ (set by an individual price setter $\mathbf{j}$ without taking into account its impact on other $\mathbf{i \neq j}$ firms) and $\mathbf{P_j'}$ (arising from a compensation process that internalizes the profit effects on others), where $\mathbf{P_j' - P_j^* + S_I}$. $\mathbf{S_I}$ expresses the impact on $\mathbf{P_j^*}$ of internalizing its profit effects on the rest of group $\mathbf{I}$. In sum, $\mathbf{S_I}$ is a combinatorial of all $\mathbf{s_{i \neq j}}$'s which equal $\mathbf{(Q_{i \neq j}/Q_{ij}) \bullet (M_{i \neq j}^* - P_{i \neq j}^*) \bullet (\varepsilon_{ij}^*/\varepsilon_j^* + 1)}$, an expression of the individual profit effects on an $\mathbf{i \neq j}$ member of group $\mathbf{I}$ with regard to $\mathbf{P_j^*}$, firm $\mathbf{j}$'s pricing decision. The standard tale of substitution is $\mathbf{S_I > 0}$ so $\mathbf{P_j' > P_j^*}$ and collusion raises price, although with net complementarity, $\mathbf{P_j' < P_j^*}$ and cooperation, not competition, is seen as efficient. The welfare implications of market structure flip 180° with complementarity.

For information networks, complementarity also overrules substitution due to increasing returns and mutual gains from network effects: scarcity and exclusivity undermine value, rather than raising it as in the old 'water-diamond paradox' story economists tell. In the presence of complementarity, abundance augments worth; the relation of value to scarcity inverts to favor *inclusion*. As Matthew (2001, p. 2)

explains: 'In the networked economy, the more plentiful things become, the more valuable they become. ...Value is derived from plenitude, the concept of abundance.' As Elsner (2004, pp. 1032-33) reminds us, scarcity is irrelevant to information economies; equilibrium models of maximization no longer apply. In network contexts – and most especially in the presence of complementarity – openly unbounded domains shall lead to another dilemma.

Georgescu-Roegen (1971, pp. 213-14) noted the role of boundaries in economic analysis: 'No analytical boundary, no analytical process.' He added that a boundary has 'two distinct analytical components,' one that distinguishes figure from ground – 'the *frontier* of the process' – and 'temporal ... *duration*' which we can call the time horizon. But defining the frontier and duration of a process is in part a matter of scale (Jennings 2008b), either of the problem addressed or of the view adopted. 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; they are both the frontier for our analyses and an implicit duration in the temporal length of perspectives on which we base all our plans.

So now we return to interdependence – substitution and complementarity – armed with a planning horizon. How will horizon effects – ordinal shifts in planning horizons ($\mathbf{H^*}$) – affect economic connections? As it turns out, this is a key question with a general answer, because private horizon effects are socially contagious. Personal horizon effects – for better or worse, by extending or retracting – exude their impact on others, altering social horizons in the same direction. If so, longer and broader planning horizons shift our relations in any context in favor of complementarity and away from substitution. Any extension of $\mathbf{H_j^*}$ will likely extend other $\mathbf{H_{i\neq j}^*}$'s, yielding further reductions in the magnitudes of $(\mathbf{Q_{i\neq j}/Q_j}) \rangle \mathbf{0}$ (as a weighting scalar) and markups on price $\left|(\mathbf{M_{i\neq j}^* - P_{i\neq j}^*})\right|$, and increasing own-demand elasticity $\left|(\boldsymbol{\varepsilon}_\mathbf{j}^* + \mathbf{1}) \langle \mathbf{0}\right|$, while cross elasticities ($\boldsymbol{\varepsilon}_{\mathbf{ij}}^*$) shift away from substitution ($\boldsymbol{\varepsilon}_{\mathbf{ij}}^* \rangle \mathbf{0}$) to complementarity ($\boldsymbol{\varepsilon}_{\mathbf{ij}}^* \langle \mathbf{0}$) as social horizons extend. So regardless of the sign of $\mathbf{S_I}$ (as a combinatorial of all $\mathbf{s_{i\neq j}}$ within group $\mathbf{I}$), $\mathbf{S_I}$ will decline in response to greater horizonal length. The

process of economic development, viewed through a horizonal lens, says our institutions should adapt by progressively emphasizing cooperation, not competition, as our relations shift through development toward complementarity, or that growth process is stifled (Jennings 2011).

Once we admit the planning horizon (**H***) into our repertoire of economic concepts, some meaningful lessons appear. The fixed horizons and frozen durations in neoclassical theory open onto a third orthogonal axis showing how alterations in **H*** – horizon effects – shift traditional cost and demand curves, moving the pivotal (**P***,**Q***) point downward and outward with longer (and inward and upward with shorter) horizons. The length and breadth of our planning horizons can also be seen as the engine of growth (Jennings 2011), implying – as information, knowledge and learning are complementary goods – that competition is slowing economic advance with a myopic culture reinforced by our rivalrous systems. The only reason economists see competition as efficient is their reliance on substitution assumptions to the exclusion of complementarity. Once substitution is seen as special and complementarity general – as Kaldor (1975, p. 348) long ago explained – the nature of economic analysis shifts to a less dismal mode. This adaptation will now be explored, first in terms of the case for increasing returns and complementarity, second on its analytical lessons and third with regard to its methodological implications.

The general case for increasing returns and complementarity in economics

The pricing model above, with planning horizons and interdependence, ignored increasing returns and complementarity, except for contagious effects called 'interhorizonal complementarity.' But the pricing model, with diverse firms and sloped demand, is a monopolistic competitive frame. If entry is open – with 'imperfect' substitutes – equilibrium is at a tangency point with falling costs, so will imply increasing returns. As Arrow (1969, p. 442) explained, a theory of monopolistic competition 'is forcibly needed in the presence of increasing returns, and is superfluous in its absence.' So what is the case for increasing returns?

Kaldor (1972, 1975), referring to Young (1928) but not Pigou (1927, 1928), related increasing returns to complementarity and Myrdal's (1978) circular cumulative causation. In systems language, these are positive feedbacks, though whatever one calls them models of equilibrium are not tractable in this setting. Increasing returns are the bane of orthodoxy in economics, since they undermine neoclassical tools. Equilibrium models will not close with increasing returns, so they fail 'existence conditions.' This is why an Age of Denial arose over increasing returns after twenty years of debate. These arguments should be reviewed. [1]

Clapham's 1922 paper opened a Pandora's Box by addressing the 'empty boxes' of increasing vs. decreasing return, which cannot be observed. This led to responses by Pigou (1922), Robertson (1924) and Knight (1924); then Sraffa (1926) added that these 'laws' of increasing and decreasing return were related to aggregation and time. Pigou (1927, 1928) at this point offered two papers on cost and supply, endorsing increasing returns and wholly excluding increasing costs. Schumpeter (1928) raised stability issues, short-run rigidities and invention; Young (1928) claimed disequilibrium meant growth was self-propagating and cumulative. A 1930 Symposium on increasing returns addressed many issues, including the aggregation of firms and industries, internal and external economies, (dis)equilibrium models, and the role of time, making a general case for the 'economies of large-scale industry' (Shove 1930, p. 116). Harrod (1930) and Viner (1931) attempted to rescue rising costs for short-run theory; Harrod (1931, 1933) later returned to falling costs, suggesting supply and demand are interdependent due to marketing.

Soon after, Robinson (1932, 1933) and Chamberlin (1927, 1933) posted theories of 'imperfect' and 'monopolistic' competition, with equilibrium outcomes on declining cost and demand curves. Kaldor (1933-34, 1934) wrote two papers showing equilibrium and competition to be incompatible; then Keynes (1936) appeared on the scene, starting another related debate on macroeconomics and cumulative change. Lange (1938, p. 54) entered the fray with a political claim for socialism as a route to efficiency, yielding an open door to what I call 'The Hicksian Getaway.' The whole discussion during the late 1920s and throughout the 1930s, at least in microeconomics (Keynes ignored increasing returns), was centered on falling costs in production: the larger the scale, the cheaper each unit. That view was simply a given in the late 1930s. Socialist theories spread and

flourished, despite the Austrian (Mises 1920; Hayek 1935, 1940) counterclaims, while Europe plunged into war.

Enter Hicks (1939, pp. 83-85), saying any surrender of perfect competition 'must have very destructive consequences for economic theory': we should just assume rising costs – against the entire thrust of debate during the 1930s – and treat the system as perfectly competitive. 'At least, this get-away seems well worth trying' although it may be 'a dangerous step...' Period. End of discussion. After World War II, Samuelson (1947) took up the Hicksian frame, and then Arrow and Debreu (1954) developed general equilibrium (GE) theory on this foundation. So would orthodox economics enter into an Age of Denial over increasing returns from which it has yet to fully emerge, in spite of a moment during the 1960s sabotaged by 'The Hirshleifer Rescue.' Also recall that during this period Stigler (1939) and Clark (1940) commented on the relation of cost to time as being too complex for analysis.

The abortive resurgence of falling cost started with Alchian's (1959) nine propositions meant to incorporate time as a relation of firms' 'equity cost' to output volume, rate and run length: in sum, more rapid output rates for a given volume increase its cost, whereas more time reduces its total and marginal costs of production. The key to Alchian's explanation is that a faster rate of output for a fixed volume reduces run length. Margolis' (1960) paper appeared at this juncture, redefining time as horizonal and so resolving the issue. Hirsch (1952) and Arrow (1962) also published on 'progress functions' and 'learning by doing,' extending Alchian's story. This is the intellectual context of The Hirshleifer Rescue: the general belief was that time itself is simply insufficient to represent economic decisions, based on expectations of future prices and other diverse risks.

Hirshleifer (1962, pp. 235-38, 246) read the Alchian article as a threat to orthodox science, since it appeared to reject The Hicksian Getaway and equilibrium theory. Expressing his goal explicitly as one of 'rescuing the orthodox cost function' with decreasing returns, to show that 'the classical analysis is consistent and correct,' Hirshleifer claimed that marginal costs turn upward eventually for *fixed run lengths* in the limiting case, based on this slight change in Alchian's schema. Oi (1967, pp. 590, 594), in a paper on 'progress functions,' saw them as a dynamic concept with 'no place ... in the static analysis of neoclassical theory,' asserting that technical change and

learning were already in the Hicksian framework, confirmed by Alchian and Hirshleifer as inter-temporal production functions, so they can both be ignored: 'To attribute productivity gains to technical progress or learning is, I feel, to rob neoclassical theory of its just due.' Alchian (1968, pp. 319-20) then took Hirshleifer's argument as an established truth, declaring decreasing returns 'a general and universally valid law.' Turvey (1969, pp. 285-88) offered a useful summary of this series of papers, saying time is important and that marginal cost is multi-dimensional.

Next, Shubik (1970, pp. 407, 413-15) castigated the Hicks/Samuelson equilibrium model as sterile and 'a dead end,' calling for 'a new microeconomics.' Then came Kornai's (1971) *Anti-Equilibrium* and Phelps Brown's (1972) address, setting the stage for a series of papers by Kaldor (1972, 1975) rejecting equilibrium and endorsing a general case for increasing returns and complementarity, advocating 'a major act of demolition ... destroying the basic conceptual framework' in order to 'make any real progress' (Kaldor 1972, p. 1240). Hahn (1973, 1981) defended GE theory as supporting a case for its falsification, while Arrow (1974, pp. 26-29) lamented the inability to change course when needed. Hicks (1977, pp. v-vii) stated his own view of The Hicksian Getaway as 'nonsense' and 'an indefensible trick, which ruined the dynamic part of *Value and Capital*.' If Oi's confirmation of orthodoxy is founded on both Hicks' dynamics and The Hirshleifer Rescue, where does this leave the exclusion of technical change and learning from economics? During my own dissertation research, I encountered The Hirshleifer Rescue as the only *technical* argument I could find for decreasing returns, so I examined it very closely. Here is what I learned.

Alchian's original argument derived increasing costs *for a given volume* produced more quickly, which shortened the time of production. Hirshleifer's change – which he deemed trivial – fixed the *run length* so making rate and volume move in proportion, claiming these costs would eventually rise. Curiously, Hirshleifer in his 'Successful Reconstruction?' (1962) framed cost as a function of volume and output rate, thus combining stocks and flows in a confusing mix. So I recast the Alchian-Hirshleifer model in terms of volume and time to show that all of the rising cost elements stemmed from Alchian's shortening time for a given volume of output; it had nothing to do with the rate. This made Hirshleifer's inference false, based on much stronger assumptions than Alchian made or intended. My Ph.D. dissertation, after reviewing a cumbersome version of the proof in Jennings (2015b), said this (Jennings 1985, pp. 99-101):

> The upshot of this grievous mistake is that any incorporation of learning by doing or technical change into cost and price theory has been deferred. The point lies in fifty long years [now seventy-five] during which we have painted a 'well-behaved' world, forestalling development of our conceptions in the direction of proper behavioral science. ... The limits of Hirshleifer's central contention could not have been checked very closely. The carelessness thereby implied is appalling, with how much we rest on this claim. After all, the error is not well-concealed to any skeptical eye. Its impact stretches well beyond sight, if his proof has diverted attention from learning. We cannot doubt that it has.

There is a methodological lesson here in need of attention. With our rationality bounded, with our attentions selectively focused – since selective focus is also and at the same time restrictive blindness – how we frame a problem matters (cf. Arrow 1982, pp. 5-7). The very first step in Hirshleifer's argument, framed in terms of volume and time, shows that time is key, implying that this formulation was not even checked. Popper (1959, pp. 278-79; 1963) saw a self-policing 'conjecture and refutation' process as sufficient to catch any errors in academic research. Popper's fanciful view was that beliefs are not 'dogmatically upheld' but rather 'we try to overthrow them.' Mueller (1984, p. 160) offered the contrary view that 'neoclassical economics reigns supreme, not because it refutes challenges to it, but because it ignores them.' To claim 'no credible rivals' (Hahn 1973, p. 129) or 'no satisfactory alternative to neoclassical theory' (Hart 1984, p. 189) is unacceptable on its face. Simon (1979, p. 510), in his Nobel lecture, referred to 'an embarrassing richness of alternatives.'

Popper's benign depiction ought to be overthrown or replaced. The real facts show errors and intolerance in control, with orthodox science ignoring alternative views, so we have to revamp Popper's naïve version of science into Polanyi's (1966, pp. 78-79) less fantastic conception of how research is conducted. Polanyi calls the 'ideal' of value-free 'dispassionate' science

> ...not only contrary to experience, but logically inconceivable. The surmises of a working scientist are <u>born of the imagination seeking discovery</u>. Such effort

> risks defeat but never seeks it; it is in fact his craving for success that makes the scientist take the risk of failure. There is no other way.

The arguments over increasing returns supply a good illustration of the problem mentioned here. A glimpse at the real world in which economists practice is sufficient to show why Polanyi is right.

For one example, Waldrop (1992, p. 18) portrayed the reaction at U.C.–Berkeley to Brian Arthur's research on increasing returns, when the department chair 'stared at him with a kind of deadpan look. "But – we know increasing returns don't exist."' Then another professor joked: '"Besides, if they did, we'd have to outlaw them!" And then they'd laughed.' The chilling effect on Arthur's psyche and motivation then is described. Reder (1982, pp. 17-19) reported on how the Chicago graduate program manages with respect to any student's departure from perfect competition: 'Whatever their merits, such suggestions undermine the authority of neo-classical price theory ... answers that violate any maintained hypothesis of the paradigm are penalized as evincing failure to absorb training,' an attitude Nobel Laureate Wassily Leontief (1982, p. 105) described thus: 'The methods used to maintain intellectual discipline in this country's most influential economics departments can occasionally remind one of those employed by the Marines to maintain discipline at Parris Island.'

The 1930s debates were all about how to deal with increasing returns as an empirical truth. The Hicksian Getaway, in its time, was an outrageous ploy, yet it framed the basis of future research by Samuelson, Arrow and many others. Still economists seek to deny and dismiss increasing returns; such was the impact of Hicks and The Hirshleifer Rescue on economics. Pigou's, Young's and Kaldor's remarks were recognized but then ignored; the incorporation of learning and knowledge into research has still not occurred in any essential way. The whole idea of planning horizons and horizon effects shows some of the costs of this shunning. Yet the case for increasing returns – and therewith of complementarity – is virtually impregnable, in spite of economists' stubborn denial thereof in orthodox circles. So what are the implications? What tools still work, and what do not? There is also warning here; as Earl (1983, p. 121) put it, the opening up to an unfamiliar regard demands some major reframing of thought or worse, a 'scientific nervous breakdown.' But the point is to know our assumptions and how they affect our vision. Horizonal theory may open our eyes...

The analytical limits of increasing returns and complementarity

There is a reason economists shun increasing returns and hardly ever refer to complementarity: these subjects suggest their human capital, laboriously accrued, is not the treasure they sought. The rigid denial is understandable, if not justified as science. Second best theories signified that any one violation of the conditions for optimality is sufficient to obviate the rest; then all bets are off (Lipsey and Lancaster 1956-57). As Stiglitz (1985, p. 21) said, the theory of competition cannot tolerate any easing of its sundry assumptions. Increasing returns and complementarity are not a minor retreat from the rigid deductions of orthodoxy; they are a nuclear weapon deposited under the bed where economists sleep. Perhaps a look at analytical limits shall lighten these slumbers.

Krupp (1982, p. 388) posits a close relationship between substitution and independence, that complementarity opens a door to total interdependence. But how we think of demand in the presence of interdependence – with my desire related to others', as with snob and bandwagon effects (Leibenstein 1950; Herpen et al. 2005; Drakopoulos 2012) – is not in any way obvious. Substitution allows us to assume an independence in which my wants are not contingent on others' participation. Complementarity overrules this sort of analysis. But that is a general problem in an unbounded domain of rational limits, and why a horizonal theory is needed in this situation. Interdependent demand curves are only one piece of the puzzle.

The relations of cost and supply are radically changed by increasing returns, and by complementary inputs. Stigler (1951, pp. 140-44)) asserted that input factors were rival, implying that firms – as they grow – will subdivide into specialized parts. But Nelson (1981, pp. 1053-55) argued they were complementary in most cases, which has at least two implications: first, on their individuation in economic analysis; and the second about their expansion. Nelson explains that: 'If factors are complements, growth is superadditive... The growth of one input augments the marginal contribution of others. ... In short, there are not neatly separable sources of growth, but rather a package of elements all of which need to be there.' As Toner and Butler (2009, p. 47) put it,

'complementarity in production' is related to 'indivisible factors' and 'technical change' as 'a product of learning' where 'each type must be supplied jointly for the productivity potential of each to be realized.' So the first implication is that marginalism fails with complementarity: the whole system of firms' productive variables should be seen as a whole that cannot be treated discretely. Nelson compared this to 'dividing up the credit for a good cake to various inputs,' which 'makes little sense.' Secondly, as Stigler argued that firms disaggregate as they grow, an implication of complementarity is that they coalesce instead, developing greater reserves of market power, implying again that competitive frames cannot be maintained due to increasing concentration.

What about qualitative variation such as Chamberlin studied? Economists seek quantification to the detriment of understanding. A good example is the 'excess capacity' argument tied to monopolistic competition, that Lange (1938, p. 54) cited to claim that socialism was more efficient than competition in the real world. There are at least three errors in the case for excess capacity – that monopolistic competitive output falls below minimum average cost on the U-shaped AC curve due to sloped demand curves and open entry – each of which should be explained. First, the assumption behind this conclusion is that entry is profit- and not price-sensitive (which would make the long-run demand curve flat in a 'limit pricing' model), though prices are more observable than firms' internal profits (Bain 1965; Jennings 1968, ch. 3). Second, the argument tells a long-run story about demand (by moving a short-run demand curve) while leaving a short-run cost curve fixed (and tangency with a long-run cost curve would not be deemed inefficient, suggesting again the importance of *time*: cf. Shove 1933, p. 121). The third problem is the most telling, as the claim ignores the effect of product diversity on demand, though unlike goods *define* this case. If free entry yields more variety for which consumers are willing to pay, the welfare ideal in this situation no longer appears at minimum cost but (arguably) at the tangency point due to brand loyalty issues (cf. Dixit and Stiglitz 1977). This is why Chamberlin (1951, pp. 56-57) said that the excess capacity argument 'indicates nothing so much as a complete misunderstanding of the problem' because consumers' 'general desire for diversity ... embodies sloping demand curves.' The point is that, where qualitative variation is relevant, the exclusive focus on quantitative variability yields some mistakes that may have vital effects on decisions such as Lange's socialist argument.

Models based on deduction from asserted axiomatic claims are also a part of the problem. Indeed, the notion of planning horizons was spawned through an inductive analysis of the British canal system (Jennings 1985), which was shouting myopic behavior at me until I addressed the issue. Within a transportation network – confronting anomalous states such as increasing returns, public goods, complementarity, interdependence, poor regulation, durable capital, local and national links – I realized the market theories that I was taught did not apply in this setting. Casting about for another approach, I studied theories of organizational systems seeking a way through the maze. At some point, I asked the right question: how would changes in planning horizons (**H***) affect the balance of substitution and complementarity in network contexts? The answer, as shown in Part II above, is universally applicable: the longer our horizons, the more important is complementarity relative to substitution. The role of inductive inference in economics is so undervalued that we economists should develop better regard for this approach. As Rescher (1979, p. 83) reveals: 'Induction ... is a search for order – in short, for system.' Induction fuels our awareness, whereas deduction just sorts it out.

Take the pricing analysis set forth in Part II above, for example. Simon's suggestion that cost and demand curves be placed in the inner environment, into an agent's or observer's psyche, opens a door to Margolis' subjective view of planning horizons, sidestepping Oi's exclusion of learning and knowledge. Suddenly, a question of how cost and demand are *perceived* comes up along with the run-length involved (despite that the time-frame may be unconscious). The important thing is that every imagined projection carries some sort of frame which has a frontier and duration that I am calling the planning horizon (**H***). If we examine the pricing decision from an inductive vantage, then naming a **P*** fixes the locus of **Q***s onto one line (**P** = **P***). Somewhere beneath the (**P***,**Q***) point is a unit cost (**M***) marked up to **P*** by a percentage (**E***). It does not matter a whit whether we call this 'full cost' or 'marginal' pricing, or how the agent decides on this choice – which we may never know – what is observed is that a **P*** is set and the market delivers a **Q*** and if the established **P*** remains at that level the agent deems it as 'best.' [2]

That (**P***,**Q***) point is what we observe in the market. If it is stable for a time, we infer a price setter's satisfaction, so **P*** = **M*** • **E***, subject to horizon effects and other unspecified changes. That (**P***,**Q***) is floating within a multidimensional lattice of

variability, influenced by all else. Economists seek to identify shifts along and of supply and demand curves as if these relations were stable. Are these tools simply illusions of understanding in this sense? They are not written unambiguously on the face of reality, as economists seem to claim; they are imagined projections of an alternative world that is not pursued and cannot be known with certainty. If their reality is not ontological but epistemological, this status suggests that they may not be stable at all. Economists may indeed be comforted by an illusion of knowledge, but as science such should be questioned. As Polanyi (1958, pp. 191-92) quipped: 'A fully axiomatized deductive system is like a carefully locked gate in the midst of an infinite empty area.' We ought to start with reality and try to induce what we know.

The role of increasing returns and complementarity yields some other restrictions on neoclassical language. Externalities can be ignored with substitution assumptions since these spillovers simply attenuate as they emanate outward; this is how independence and substitution are related. With complementarity, these effects accumulate as they spread to others: here partial analysis simply omits important developments sitting beyond the narrowly focused deductions in neoclassical theory. In a totally interdependent domain of complementary acts, spilling consequence onto others at every turn of the wheel, there is a need for greater horizonal conscience: an ethical economics is required in this situation (Jennings 2009, 2010).

Marginalism is also open to question in this setting; complementarity argues for integration and inclusion. Nelson's comments on inputs show that parsing credit for cake to ingredients is no different than tying wages to workers' 'marginal products': among complements, superadditivity yields a role for redistributive power in compensation; this is why executive salaries are out of line with employees' wages. There are no balancing forces here to equilibrate payment to contribution; the role of economic power here must be considered. Indeed, the benign notion of free exchange as leading to mutual gains should be challenged as well, in the presence of myopic crises and limited information. The knowledge basis of orthodox schemas shall be adjusted through planning horizons to matters of degree: in this sense, $\mathbf{H^*}$ is a formalization of Simon's (1982-97) theory, addressing the range of anticipation as an index of rational limits. With competition encouraging a myopic culture restricting growth, some meaningful lessons arise about the reach of good sense in decisions. Such may yield

disturbing qualifications on the knowledge assumptions subsumed in neoclassical claims, suggesting a greater role for ethics and power abuse in our work.

Competitive failure attributed to horizon effects should concern us all: the issue is of particular relevance to the media, education, politics and ecological losses swimming in complementarities (Jennings 2015a). Some organizational pillars subject to rivalrous systems are reeling toward collapse due to myopia. A horizonal view addresses social incentives in their learning effects as an engine of growth. This is ironic: competition in neoclassical eyes is efficient – defined as such by substitution – despite its catastrophic effects on organization across the planet. Do economists simply not perceive what is happening here? Or is it willful ignorance spawned by intransigence? Selective focus is also and at the same time restrictive blindness. Only by opening up presumptions to inquiry might we escape persistent traps that otherwise shackle us.

The methodological implications

Theory is a guide to attention in the process of choice: we act not on known outcomes but on imagined projections thereof, framed theoretically in our minds. The realism of our ideas – since we apply them every day to our goals – stands at the center of our results, sifting good from bad, triumph from disappointment. The fact that attention is selective says we must be cautious; selection is restriction so our vision is ineluctably blind to whatever we opt to ignore. Every analytical outlook carves symbolic constructions selectively out of a seamlessly-integral field, driven by asserted essentials, which are only endorsed by using that theory and cannot be proved (Jennings 1999, pp. 24-25, notes 88-89).

The orthodox standards set in The Hicksian Getaway and erroneously reinforced by The Hirshleifer Rescue are wrongly guiding our actions in numerous situations, due to substitution assumptions imposed in complementary applications such as education, ecology, politics and the media (Jennings 2015a). As a result, a 'dumbing down' of discourse is occurring in an increasingly myopic culture with effects destructive for all. The question to be addressed is not these effects, but what sort of framework can we adopt to rescue us from mistakes embedded in current doctrine. As any particular outlook, singly used, directs our attention to whatever it deems essential and away from

everything else (seen as unimportant), the selective focus of any approach involves an exclusive amaurosis to all other regards. This implies an epistemological justification for openmindedness and the use of multiple models as a test of each, in terms of our analytical limits of vision. [3]

In consequence, several lines of argument are pursued in this section, taking a pluralistic approach where each sheds light on the others. The primary problem here is not increasing returns and complementarity, but interdependence. Simple mechanical models cannot deal with interdependence. As Bertalanffy (1968, p. 45) explained: 'In the world view called mechanistic ... causality was essentially one-way ... this scheme of isolable units acting in one-way causality has proved to be insufficient. ...We must think in terms of systems of elements in mutual interaction.' Rescher (1979, pp. 46-49) observes that 'the network model of cognitive systematization ... dispenses altogether with axiomatic supports' and replaces 'stratification of theses into levels of ... *fundamentality* by a conception of *enmeshment*' thus 'shift[ing] the perspective from unidirectional dependency to reciprocal interconnection.' Shubik (1970, pp. 407, 413-15) called equilibrium models sterile and 'a dead end,' but there are other approaches set up to deal with interdependence, such as social, ecological and institutional economics, organizational and complex systems theories, and the like. As Simon (1979, p. 510) noted, 'there is an embarrassing richness of alternatives' if we only would entertain them.

Social economics addresses cultural issues in economics, and criticizes any individuation of values and wants. In this, social economists are aligned with institutional theorists, though more focused on moral and philosophical aspects of culture. Their embrace of interdependence stems from a view of individuals as social beings swayed by cultural norms and trends. Social economists seem more receptive to complementarity arguments due to their reliance on nonmaterial aspects of behavior.

Ecological economics is steeped in interdependence; interactions in nature reveal a system based on complementarity except in narrow realms of vantage where rivalry can be observed, thus showing the scale aspects of our horizons' impact on relations (Jennings 2008b). Ecological economics should be distinguished in this regard from 'environmental economics,' which only applies neoclassical tools to environmental problems. Ecological economics subsumes a much broader approach, embracing a wide

array of analytical tools to address substantive issues such as: valuation of nature's services; implementation of full cost pricing to incorporate external losses; use of entropic conceptions as a means to examine energy balances; and many other research endeavors to address systems in motion. Again, the essence of ecological economics is interdependence and how research should be conducted to understand dynamic complex systems evolving and changing through time in a manner resistant to our understanding.

Institutional economics emerges out of Veblen, Commons and many others with a sociological orientation. The fount of this approach again is seen as interdependence, with an emphasis on distribution of power through property rights and markets. Public concerns and social values are important to this view, as an embracing conception of fundamental human concerns. As Samuels (1981b, p. 115) said: 'The primary fact of all social life is the interdependence of all variables.' If so, according to Nove (1969, p. 851), 'reasoning which abstracts from externalities cannot be applied to a situation in which they are present' because, as Malmgren (1961, p. 419) noted: 'Market information is ... inaccurate when interdependent activities are decentralized.' Externalities also raise some issues of power relations, human rights and social control, leading to skewed distributions of wealth. Scarcity is not just data, but rather results from multitudinous sources including contrivance. So ethics enjoy a role in institutional economics, where regulation often fails due to corporate power abuse. Social costs are of concern with respect to privatization, due to ever-present externalities structured by institutional rules and designs shaping outcomes. So, institutional economics offers a broad perspective on the socio-cultural processes standing behind economics. Substitution is not assumed; one of the main precepts of this approach is Myrdal's circular cumulative causation, implying complementarity is central in economic relations.

Another more general approach is organizational systems theory, of fully interactive phenomena analyzed on three basic concepts: negative (balancing) feedbacks; positive (reinforcing) feedbacks and temporal lags and delays (Senge 1990, pp. 79-80), although one could translate those three ideas into substitution, complementarity and horizons, respectively. A general prescription in systems theory is to tighten feedback loops through reduced lags and localization. This is only a sky-high view of organizational systems theory, which has many other insights starting with interdependence: 'we can

define a system broadly and crudely as *any entity, conceptual or physical, which consists of interdependent parts*' (Ackoff 1969, p. 332). But systems theory is hard to classify in its diverse array of frameworks applied in different domains. The purpose, however, is easily seen; as Bertalanffy (1968, p. 18) expressed it, systems theory is meant to transcend 'the limitations of analytical procedures in science,' in a 'holistic' approach where systems act more like an organism than any machine (Massarik, Margulies and Tannenbaum 1985, p. 10). The emphatic commitment of systems theory is not to individual units, but to a complexly open flow of associations through time.

A systems approach demands 'reorientation in scientific thinking' (Bertalanffy 1968, p. 5), because 'all systems are design nonseparable' (Churchman 1971, p. 62). The *dimensionality* of a system makes it nondecomposable, because each element is connected through the organization in a manner that transcends mere relations and depends on positions (Angyal 1969, pp. 24-27): systems are neither reductive nor additive; they are not just an aggregation of individual parts. Furthermore, these systems are open; they interact with their environment, and the nature of those surroundings can determine the optimal structure (Emery and Trist 1969, p. 253; also cf. Trist 1985, p. 171). The early ideas of organization arose from management theories stressing 'structural-functional homologies' where 'it is the *logic*, the *type* of analysis, which is pertinent' (Selznick 1969, p. 270). The emphasis in organizational theory on learning incentives, system design for growth and development, and the internal cohesion of members seems a far cry from orthodox standards; its terms stand outside that frame of discourse, 'speaking in tongues' seen as unscientific. The whole language of systems theory involves significant changes in our representation of phenomena and their apprehension.

Homeostasis (Cannon 1932) through feedback carries the role of 'equilibrium' in an organizational system, within a dynamic process of balance achieved through feedback control loops supporting self-preservation as a prime directive for organization (Katz and Kahn 1969, pp. 97-98). 'Equilibrium' mostly applies to closed and not open systems, states of rest and not dynamic continua (Koehler 1969, pp. 61-65): homeostasis involves systemic connections with the environment. The integrity of a system is important to its efficiency: if forces are misaligned, then energies shift from production of value into resolving conflict. This is a matter of feedback control loops and how tight they are; loosening connections may yield organizational fragmentation and failure in extreme

cases. Incentives should be aligned, to maintain integrity (Culbert and McDonough 1985, pp. 138-349). Localness is also important, to 'achieve control without controlling' (Senge 1990, pp. 287-88). Interestingly, Senge (1990, pp. 294-96) remarks that 'in the absence of systems thinking, local decision making can become myopic and short-term. This happens because local decision makers fail to see the interdependence by which their actions affect others outside their local sphere.'

The notion of feedback control loops, central to systems analysis, supports circular and nonlinear relations of causality. One important dimension of feedback loops surely is time: the longer it takes for responses to action, the less secure is the causal linkage – or at least our knowledge thereof – and the less stable will be the system. Three essential elements of any system, as noted by Senge (1990, pp. 79-80), are: negative or 'balancing (or stabilizing) feedback' with 'goal-oriented behavior'; positive or 'reinforcing (or amplifying) feedback' as 'engines of growth'; and 'delays ... which make the consequences of actions occur gradually. ... All ideas in the language of systems thinking are built up from these elements': substitution, complementarity and planning horizons. Increased delays loosen feedback loops and weaken cohesion, while cooperation tightens them; 'maximizing cooperation, rather than competition' might be preferred, according to Bennis (1972, pp. 221-22). The value of cooperation is central to organizational learning and horizonal growth: 'inquiry is ... a reaching out of a human being beyond himself ... we must continually think of ourselves as in a whole stream or process, constantly trying to become more and more comprehensive in our perspective' (Churchman 1971, p. 276; 1979, p. 65). All these comments suggest that the integration of organizational function is a matter of normative values shared through cooperation.

Systems theory has recently evolved to new realms of complexity, emerging from mathematical models of chaos linked to three themes: cybernetics; systems theory; and theoretical ecology. A complex system is composed of multiple interconnected parts that exhibit behavior not attributed to individual components, which is 'emergent' from the system itself and thus unpredictable. Relations within a complex system are nonlinear and its elements heterogeneous, so its behavior is not based on the actions of separate units. The boundaries of a complex system are also hard to define precisely, due to openly interactive feedback control loops with its environment. Responses can be sensitive to initial conditions or perturbations, such that minor disturbances may yield significant changes at times. Due to strong component coupling, a small failure can

cascade through a system with catastrophic results. Systems live at the 'edge of chaos,' where energy and creativity allow peak performance but also risk. These systems evolve, learn and adapt to change in unexpected ways, surprising and too often resistant to analysis or understanding.

Systems operate differently than the linear rules of orthodox science, straying far from predictable outcomes or orderly anticipation. Ecologists and weather reporters have known this for a long time, although our resistance to enter this insecure realm of feared dynamic contingencies, if understandable, is self-destructive. The issues being neglected are ecological loss and dangerous stresses across society undermining our life-support and civilization. Economists bear a heavy charge for ignoring resource depletion, treating nature's services as substitutable through unknown technology. Ecological economists say that nature's services are irreplaceable complements for economic growth, and not expendable assets. Systems based on complementarity, such as society and ecology, cannot be mistreated discretely and expect to survive. Vital living systems are like organisms in this sense; they can be abused to a point but then they fall apart. The history of social collapse (Diamond 2005) is not a pretty picture. Our rivalrous schemas are incompatible with ecological organization, to which we need to adapt. Economists' substitution assumptions solely apply to short-run things, but not to systems thereof, which are rife with complementarities showing emergent departures from expectation. At the least, a precautionary principle ought to be used. Instead, as Brown (2012) expressed impatiently, economists see 'an illustrious past' and 'a promising future' while ecologists scream in frustration.

Conclusion

The substitution assumption defining orthodox economics simply is not guiding us well. The case for competition as efficient depends on this supposition, derived from an unsupported assertion of rising cost (decreasing returns). The reality of increasing returns and complementarity opens a need for an analytical boundary in an open unbounded domain of effects spilling outward forever on everyone from individual acts. Such is the nature of interdependence, and the reason for Simon's concept of bounded rationality and the notion of planning horizons. But any embrace of increasing returns and complementarity also endorses unbounded interdependence, so excludes any use of closed-system models of (partial or general) equilibrium on

neoclassical lines. The aim of this paper is to review what changes are implied thereby in economists' tools and methods after rejecting orthodox standards.

First, horizonal theory was introduced to extend the widely-accepted (deductive) explanation of price into the realm of time. Margolis (1960, pp. 531-32) had it right, though he didn't see its significance: subjectivity is the key to incorporating temporal length into pricing analysis, as Simon (1981, p. 103) has suggested. The implication is that horizon effects shape pricing and interdependence: expanding horizons shall lower prices, spurring growth and development – both of physical and intangible output along with organizational learning – altering our economic connections away from substitutional links to complementary unions. If so, our institutions should adapt to development by evolving away from rivalrous systems into a more cooperative frame.

But all this stands on the case for increasing returns, which leads to a generalized complementarity and full interdependence in economic connections. To paraphrase Arrow (1969, p. 442), a theory of planning horizons 'is forcibly needed in the presence of increasing returns, and is superfluous in its absence,' since – as Oi (1967, pp. 590, 594) explained – learning and knowledge can be ignored in neoclassical frames. So the history of increasing returns shows an Age of Denial – starting with The Hicksian Getaway reinforced by The Hirshleifer Rescue and Alchian's (1968, pp. 319-20) dubbing decreasing returns 'a general and universally valid law' – is still infecting economics in numerous subtle ways due to unexamined assumptions underlying our work.

Consequently, the paper turns to the analytical 'tools of the trade' to see how they are affected by an endorsement of increasing returns and complementary interdependence. Starting with a 'second best' theory, a pessimistic conclusion is stated, that all bets are off with any basic assumption not met: the neoclassical theory is brittle in terms of fulfilling conditions (Stiglitz 1985, p. 21). Complementarity yields interdependent supply and demand curves, subverts any ordered tie of marginal products to wages – indeed, it challenges marginalism itself – forces greater attention to qualitative variation (the 'excess capacity' argument as an example), leads to an inductive approach in general and in pricing analysis, shows why 'externalities' are inherent to economics so cannot be ignored, and depicts competition as spawning a myopic culture with destructive effects. Standard theories in economics are serving us ill, not well.

Where do we turn? What do we do? How can we analyze economics without substitution assumptions? Which models still work with increasing returns and complementarity? 'An embarrassing richness of alternatives' (Simon 1979, p. 510) is considered. The issue is *interdependence*: an economic orthodoxy assumes separate units and agents in linear relations such that aggregation is possible and totals equal the sum of their parts. But the real world doesn't operate thus, so economists should adjust. The social, ecological and institutional economics communities all address the problem of interdependence in diverse settings. Social economists see our behavior as social, linked to cultural legacies and other relations, so we are not independent entities to be atomistically analyzed. Ecological economics' subject matter is interdependent: there is no way any ecological problem can be addressed discretely apart from the interactive vitality of the overall system. Institutional economics starts with interdependence, searching for recursive vital linkages among cultural legacies, power relations and distribution of wealth through an inductive view.

When we get to organizational theory, interdependent domains subsume managerial insights and systems analyses showing how organizations succeed (or fail) where requirements are (not) met. The primary issue – once again – in complementary settings such as the firm makes substitution appear ridiculous on its face: enterprise survives or retreats on the strength of cooperative values and their effect on planning horizons. Incentive alignment (Culbert and McDonough 1985, pp. 125-26, 138-39) is central to efficient production and long-term success, especially in turbulent domains (cf. Emery and Trist 1969; Trist 1985). Such systems are open and in contact with their environment through feedback loops to which they adapt or recoil, learning and changing as they go. In complex systems, such behavior reacts to realms of feedback that are resistant to analysis save through agent-based models simulating unpredictable outcomes showing adaptive patterns. The study of dynamic complex systems is almost wholly inductive; vital living organisms – which they either are or resemble – have emergent properties simulable but not predictable due to the nonlinearity and diversity of their relations. Orthodox standards in economics shall lend no insight to these phenomena, which are reflective of actual life and economic activity.

So where do planning horizons – and horizon effects – fit into these schemas? I have tried to indicate that the systemic conception – negative vs. positive feedbacks and

delays in time – might be addressed as substitution, complementarity and horizon effects in network constructions. Such provides a way to integrate orthodox standards (as special limiting cases) into a more general framework capturing all these other relations. Indeed, the insights supplied through a horizonal theory offer a means to understand a wide array of phenomena in and around economics. For example, horizonal lengthening is an engine of economic growth, learning and creativity: if we accepted horizon effects as a measure of social welfare – indirectly observable in the patterns of private and public investment – we economists might have a social index for how well we are doing (Boulding 1968). Unfortunately, the initial news shall likely be unwelcome: myopic cultures spawned by competitive frames suffuse our institutions, subverting growth and development though we think competition efficient. The hard truth is, we have mistaken a poison for its cure. Reforming economics is a first step on a very hard road that we are responsible for. It cannot happen too soon or too quickly: our time is fast running out.

Endnotes

[1] Much of what follows is based on Jennings (2015b).

[2] I am assuming a typical and impersonal market here, and a uniform price for this set of transactions.

[3] As Hutchison (1977, p. 4) warned: 'No kind of ignorance can be more dangerous than ignorance regarding the limits and limitations of one's knowledge.' This sentiment was also expressed by Hayek (1955, p. 92): 'It may indeed prove to be far the most difficult and not the least important task for human reason rationally to comprehend its own limitations.'

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