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*Economic essays (part two): toward
a realistic concept of choice*

Frederic B. Jennings Jr.

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Abstract: The previous three essays (Jennings 2019) and the first in this second series were originally drafted 30 years ago in 1988-1990. They aimed to present a more realistic concept of choice in economics. These four essays serve as a precursor to my subsequent work.

The first three essays (Jennings 2019) addressed these issues. Essay One started with the notion of ‘opportunity cost’ and the ‘problem of invisibility’ as a case for open discourse. The second essay introduced two metaphors for economic behavior: the ‘neighborhood store’ and the ‘chessboard’, to raise issues of incomplete knowledge, time and social process. The third essay focused on interdependence: a ‘transport’ metaphor shows a balance of substitution and complementarity, opening institutional questions of competition and cooperation. These three essays set up an ethical theory of planning horizons.

The fourth essay outlines a theory of ethics based on rational bounds. The endless interdependence of choice makes rational limits essential; surprises show the border of prior awareness of radiant outcomes. Our ethics align private with social incentives; wherever relations show affinity, competition is self-defeating; cooperation is more efficient, especially in education. Learning extends horizons, suggesting the failure of rivalrous systems. How incentives shape planning horizons is central to social well-being.

The fifth essay develops this view with regard to institutions. Where substitution is not the basic character of our relations, competition fails. We see rivalry as productive and think ‘collusion’ is suspect, on an assumption of opposition with no room for consilient aims. But am I discomfited by your success or enriched thereby? Substitution may not be so general, if cooperation expands our horizons in a complementary way.

The sixth essay poses a horizontal research agenda. How incentives shape behavior is central to well-being. Substitution and competition lead to fragmentation, when nothing complete can be understood through isolated design. Everything connects, so we must approach understanding thus. Economics – severed from honor, ethics, civilization, climate and ecological loss – cannot grasp these horizontal issues. Our short attention spans bring harm;

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competitive frames support a myopic culture in self-destruct mode. This is where substitution has failed; a cultural evolution is needed, starting with realistic concepts of choice.

Keywords: realism, choice, competition, cooperation, substitution, complementarity, planning horizons, institutions, ethics, conscience, bounded rationality

Introduction

The previous three essays (Jennings 2019) and the first (Essay Four) in this second series were originally drafted 30 years ago in 1988-90, and then filed away and rediscovered just last year. The essays involved an attempt to offer a simple presentation of fundamental issues pertaining to our urgent need for a more realistic concept of choice in economics. These essays serve as a precursor to my subsequent work, including six previous *JPE* papers. [1]

The first three essays (Jennings 2019) covered the following issues. Essay One addressed the notion of 'opportunity cost' and the related 'problem of invisibility' as a case for openminded discourse in an economics based inherently on subjective projections of foregone options. The second essay introduced two metaphors for economic behavior: the 'neighborhood store' and the 'chessboard,' to address issues of incomplete knowledge, time and social process, in which even chess oversimplifies the realities of actual choice. The third essay focused on the problem of interdependence, introducing a 'transport' metaphor where economic relations show a balance of substitution and complementarity (conflicts and concerts of value), opening unresolved institutional issues of competition vs. cooperation in which conscience and foresight matter. These essays offer some meaningful links into an ethical theory of planning horizons in economics.

The fourth essay outlines an ethical framework for economics, based on the notion that planning horizons serve as a means to formalize Simon's concept of bounded rationality, where the process of learning is seen as programmed for pleasure in humans unless stifled by fear and defensiveness. The full interdependence of choices we make – where impacts spread outward forever – requires the range of our rationality to be bounded by what we expect; surprise sets the limit to prior awareness of our radiant outcomes. Specialization demands that each of us hold to the deals we make; capitalism bases social linkages on both honor and trust, as the glue which keeps them whole. Here ethics entail an alignment of private with social incentives, supplanting conflicts with concerts of value when systems cohere in our

plans' consistency. If our economic relations show concord over rivalry, assisting each other is in our interest: this suggests that discord through competition is self-defeating and that cooperation is more efficient in nurturing social well-being. Where understanding – conveying information – engenders mutual gain, joining forces brings success while opposition fails. Learning is how our horizons extend, divulging the limit of rivalrous systems. Such horizontal impacts spread contagiously outward aligning our aims, social and private alike, combining in a dynamic balance sensitive to many things. The whole matter reverts to one of how we design our systems for broader (or lesser) horizons, greater (or smaller) conscience and large (or narrow) perspectives by encouraging cooperation, engagement and learning (or not) through social milieux. How we frame our institutions – the way we think about economic process with a more (or less) realistic concept of choice and growth – is central to whether civilization will advance (or retreat).

The fifth essay develops this view with regard to institutions and how they adapt to unbounded interdependence. If substitution is not the defining characteristic of human relations – if we are joined through a concert (and not a conflict) of interests – then competition is failing us badly. Trained to rivalry as 'productive' – viewing competition and economic efficiency as synonymous – we see 'collusion' as suspect, a way to cheat consumers. But such a conception assumes scarcity and opposition of values as central, with no place for common goals and consilient aims. Why would I not take joy in your gains, without dismay or resentment? Do we not share reflections and joy? Am I discomfited by your advantages or enriched thereby? This is a critical issue regarding how we do economics: substitution may not be central, if cooperation is the prime means to grow planning horizons. In the totally interdependent domain of social process, coherent private decisions allow economic cohesion and peaceful life as the key to a healthy economy.

The sixth essay outlines a research agenda for economics along the lines of horizontal theory. How our social incentives structure and shape behavior remains central to our well-being in diverse settings. Substitution assumptions have framed our energies in opposition, as if our rivalrous systems succor us through some sort of 'invisible hand'. This will lead to abortive fragmentation in knowledge of holistic contexts that demand an equally integral learning for apprehension. When no relations are independent, nothing complete can be understood through isolated disciplines; all these sundry aspects should be analyzed together through an interdisciplinary analysis focusing on essentials, whatever their relevant nature. Everything is connected in cause and effect, so we must approach things that way.

Only then might we have a chance to understand the complex problems that we face in our time. Economics – severed from honor, ethics, civilization, climate and the rapid decline in our ecological health and integrity – is simply unable to wrestle with the essential issues of the day; indeed, this incapacity underlies many oncoming crises that we have denied too long. All these matters are at their base horizontal in nature and source: we set too many ongoing impacts in motion without knowing (or caring) about them until it is far too late for their reversal or remediation. Our immediate spans of attention instigate many ills, including ethical and ecological loss. Substitution assumptions and their resulting competitive frames spawn and support a myopic culture in a dangerous self-destruct mode that is invisible to economists due to the absence of any horizontal theory. This is where rivalries serve us so ill, leading us into a posture of opposition where social cohesion is sought. The cultural evolution needed is daunting and may be impossible within the time frame open to us. All will turn on whether we use a realistic concept of choice.

Ours is a risky and difficult Age calling for instant adaptation by a species used to denying such trends instead of facing them outright. Our institutions – social and theoretical – are resistant to change; we must evolve our routines and habits, so to adjust to emergent demands. We have no other options – short of extinction – for our survival as civilized human beings. The question turns on whether we will act soon enough for the need. Economics should stand for social improvement and not a defense of mistakes, but the latter are hard to admit or reveal.

Essay 4: A horizontal theory of 'conscience'

The notion of 'conscience' has no place in orthodox economics. Indeed, the foundations of formal theory act to exclude the concept. The claim is made that people are *independent* in deed and desire; 'externalities' sometimes appear, but only on special occasions. Standard treatments suppose that if we arrange for each other's well-being, it is because we have something to gain. Assumptions of 'substitution' then translate those selfish aims into public amenities so long as we stay apart. This scenario even invites suspicion if firms adjust for their impact on rivals in taking decisions; with oligopoly, any collective accounting of interdependent effects is seen as (implicit) 'collusion' and therefore regarded as 'anticompetitive'. I best serve others in this understanding by acting alone for myself. Market forces, if free, effectively merge egoistic with social advantage.

My previous series of essays (Jennings 2019) shows such hypotheses should be questioned. The first declared that the role of projection in choice implies that decisions are made among *incomplete images* and not known outcomes; thus our *representations* of options structure responses in action. This is so at individual and *theoretical* levels, as shown in my next two essays on choice, which offered three metaphorical models: the 'neighborhood store,' the 'chessboard' and the 'transportation network.' Conventional arguments structure all choice as like that in 'neighborhood stores,' where options are known and totally open as well as socially unencumbered. The 'chessboard' turns our attention toward unstable and irreversible realms subject to rivals' intrusion; 'transport' analogies add a more general image of complementarity. Each sheds light on the others, as well as on how we engage in decision. All extend understanding of action beyond any singular representation (cf. Jennings 2009).

The problem of interdependence suggests some major revisions are needed too in economists' standard deductions. If every act initiates outcomes spreading outward forever, reason cannot divine their full impact. Our ranges of vision – in all their emphatic commitments – shall influence how we develop and design our endeavors, along with their radiant tradeoffs in time and on others. If we imagine narrowly, our reactions shall differ from what they would be when opened to larger perspectives. *Myopic* conceptions are very unlike concerns exhibiting *conscience* and *foresight*. How changes in 'planning horizons' shift our behavior is surely important: the bounds of our rationality matter (Simon 1982-97). This concept deserves exploration and more elaboration.

Planning horizons and personal learning

We enter squalling into the world devoid of all understanding, a bundle of feelings and needs simply expressed and often not comprehended. The process of growth is a gradual articulation of causal effects: 'If I do this, then Mommy will come. ... If I add that, the answer is "3" ... If I assemble these components thus, I may discover "cold fusion"!' The process is one of framing an image of 'how the world works' in response to actions; such shall advance or regress as our ventures encounter reward and defeat.

Learning ought to be *fun*. After all, we humans survived the long ages equipped with only our mental acuties. We lack claws, sharp teeth, thick hides and cannot outrun our predators. The only advantage we have is intelligence, and the ability

to act together in the pursuit of our aims. Were an expansion of understanding not apprehended by humans as pleasure, *homo sapiens* surely would not have advanced to a dominant role.

Alas, such is not the whole story. As we developed in organization, so did our inner resistance to change. Indeed, as societies shape to needs in generally stable but diverse settings, sanctions supporting tradition against innovation appear as well, for good reason: most mutations seem maladaptive as systems slowly evolve. 'If it ain't broke, don't fix it!' A fear of new methods and untried approaches is rational in a subsistence economy. Interdependent procedures are often destroyed through 'partial' enhancements.

So we end up at war with ourselves, since learning is risky but tempting. A lot of our history illustrates shifts in the balance between these two outlooks: every human improvement involves a rejection of former routines. Alterations always engender resistance from other conservative forces serving established demesnes. So we inherit two opposite attitudes – one of fulfillment, the other of fear – in our educational outlooks. Such exist in ongoing conflict throughout our institutions. How we encourage or obviate learning affects our rates of advance.

I would depict this balance as central to economic development. During Medieval times, innovation deferred to entrenched domains. Yet throughout the Age of Enlightenment, when new ideas improved human knowledge and practical life, venturesome minds were sought and supported against tradition (Bernal, 1954). The course of the world in its social and cultural livelihood turns on how institutions succor or stifle *learning* in their rewards and embedded deterrents.

Such is the focus of 'planning horizons' in their relation to growth. As we learn how things work, conceptions shall open to fuller reflection of outcomes so mental images span to encompass a larger realm of results. Longer horizons suggest a broader accounting of 'social' and distant effects, since any decision engenders some impact on others who may deflect our rewards (if we do not try to anticipate these 'externalities', shifting our actions accordingly). In sum, without *understanding* our imprint, we cannot act with 'conscience' even were we inclined to do so. Unconsidered decisions are uncontrolled in their radiant outcomes, subject to equally bold interference. Such implies a vital link between knowledge, ethics and coordination of interdependent plans (Jennings 2012ab).

'Conscience' and economic attainment

If our endeavors are all intertwined, how we anticipate our effects upon neighbors in *their* aspirations and deeds shall affect our own in two ways. First, disserving anyone else may prompt them to undermine us (or others) in 'just' transgressions to even the score. Second, to act with 'conscience' – shunning *conflicts* and fostering *concerts* of interest – calls for reciprocity: "What goes around, comes around," as people say. Each of us, if viewed thus, should be happier in such a world, where everyone acts in their own *and in each other's* interests, rather than just the first. This, a fundamental lesson of almost every religion, is surely the core of ethical conduct and theory. Only economics seems to resist its social awareness.

Adam Smith (1776, p. 423) arrested our understanding with his 'invisible hand,' that opened the door to rapacious acquisition untempered by conscience. 'Smith's sanctioning of self-interest without any qualifying or restraining force completely eliminated the moral problem in human action' (Lux 1990, pp. 87-89). Indeed, this moral philosopher reassured us repeatedly on the concurrence of egoistic with public concerns, much like Ayn Rand (1964) two centuries later, although Smith (1776, p. 128) also warned us against undue price hikes from collusion. There is a point to his teaching, in its original ethical context. However, the lesson discounts a vast span of distance between '*enlightened*' *self-interest* (tuned to one's impact on others) and *narrow selfishness* (simply uncaring for others). This distinction is usefully seen as a difference in *planning horizons*.

Adam Smith (1776, Book I, Chapter 3; also cf. Stigler 1951 and Kaldor 1972, p. 1245), once again, understood; *specialization* allows an increase in efficiency only constrained by two things: our willingness to work together and by the volume of product demand. 'The division of labor is limited by the extent of the market,' he said. If so, in teamwork – cooperation – does all our progress subsist. That economics sees 'substitution' alone as our primary interdependence – implying that *disintegration* increases output and not the reverse (cf. Jennings 2016a, pp. 15-16) – suggests some vital lacunae in 'market' theory (e.g., cf. Warsh 2006).

If value increases with specialization – as long as subprocesses synchronize – 'substitution' is not the whole story. In Essay Three (Jennings 2019, p. 90), I alluded to coordination with this example: I cannot eat rubber tires, and they are worthless to me without trucks. I must count upon others' agreements – set through markets or contracts – otherwise specialization does not proceed as far as it otherwise should. Here *reliability* is the essence of all advance; *uncertainty* in any market decreases

the range of feasible gain from decomposition of output technologies. *Specialization and coordination* need to go hand in hand. The latter results from learning, where externalities are internalized into decisions by conscience and planning. Both are required for economic growth and social advance, showing why each should develop in concert with the other (through complementarity).

Institutions and growth

Specialization and complementarity make efficiency a result of firms' successful coordination of interdependent plans. Such is achieved through market transactions, contracts (short and long term), ownership (property rules) and other controls or incentives in the real world. The networks of interaction involved depend totally on people's *conscience*, on an alignment of values accounted for in their every decision (e.g., cf. Jennings 2012b). Anyone trying to capture rents or take undue advantage of others – where each can nullify everyone's gains within a cooperative frame – means that 'the next time' managers shall not specialize in that same degree. A 'public goods' problem of trust develops, where real economic efficiencies stay out of reach whenever agents opportunistically try to exploit this game. Many examples should come to mind where rampant selfishness shuts out options.

Such failures show a ubiquitous struggle of 'private' and 'social' aims as a problem of *planning horizons* in choice. With ambitions set on myopic concerns, short term benefits supersede longer run, more interactive and complex strategies in need of patience and planning. Coalitions only succeed where returns stay balanced to members, if each can negate the arrangement for all. This is our 'tragedy of the commons' (Hardin 1968, 1980) seen among organized groups. *Trust* is the glue which holds them in place, cemented by active foresight along with a jointly shared understanding. To reap potential gains from meaningful long-term productive endeavors stems from agents' *planning horizons*, sustaining an ethical level of fairness in their reward distribution. This is why equity matters.

The point develops into a linkage of growth and *learning incentives*, since short term myopia obviates otherwise socially advantageous arrangements. Such is an *institutional* question of how we design our systems so as to foster additional learning and a broader range of perspective. *Understanding* invites an extension of planning horizons in choice, and therewith a better internalization of interests in the coordination of plans. Fewer resources are lost to conflict or unexpected events, when anticipations are better aligned. Designs – if framed to a closer fit with actual

operant tendencies – allow improved deployment of inputs (time, attention, energy, money), yielding a better result. The 'opportunity cost' of an action is only revealed in comparison; if an unexplored option appears superior, we incur loss.

Furthermore, learning endeavors – in their reliance on *information* – depart from orthodox 'substitution.' Information, exchanged, is strange; nothing is lost and each party gains more than either reveals to the other, as something unknown to both is often discovered during the process (Boulding 1962, pp. 133-34). Such is a paradigmatic case of complementary efforts: social incentives structured for *rivalry* and to forestall linkages serve to stifle learning endeavors. That is surely the situation in our educational systems; supported by orthodox standards, students *assisting* each other to work on assignments are often construed as 'cheating!' We all lose in this setting, if learning is strengthened by cooperation. Education is not well advanced, defined as a lonely quest. This is why the nature of human relations matters so much.

Competition among complementary units is the reciprocal of a monopolization of substitutes: each involves an undue restriction of output over its converse; institutions should try to *integrate complements* and assure *rivals compete*. Given that virtually every decision entails some indeterminate tangle of *both* substitution and complementarity, any attempt to impose this standard on regulatory incentives, however, encounters intractable limits. Maybe the best we can do is to balance inducements to competition and cooperation in each application and try to examine the impact on output. But these static connections are not the whole issue in any event; one must deal with *horizontal* linkages, which are more readily opened (Jennings 2012ab).

The interdependence of planning horizons

The notion of planning horizons is virtually absent from 'mainstream' economics. One might thereby infer that horizons are indeterminate or unimportant. This would be serious error; I would argue our primary image of choice as occurring in 'neighborhood stores' subverts any view of attention as scarce and treats it as a 'free good'. The 'chessboard' deservedly overturns such information assumptions as untenable in the face of variant tradeoffs subject to rivals' intrusions. Here every outcome moves along contingent trajectories shifted by others, such that none are really controlled; if fellows' reactions to choice cannot be projected, planning

horizons shorten. Knowledge of rivals' psychologies – such as in chess – allows surer planning.

Comprehension of *others' approaches* and *worldly causal relations* spreads our planning horizons as anticipations stretch to frame more results. Whenever responses are rightly assessed, then near-move contingencies shrink, condoning greater projection ahead in the same way that Chess Masters study opponents' styles to cull their unlikeliest tradeoffs. Myopic contestants are not as predictable, in that dumb moves cannot be ignored; there is an *interdependence of planning horizons* suggested in this: the less shortsighted are agents in my environs, the larger the ranges of vision that I can achieve in my actions. The better my understanding of outcomes – spanning unseen disturbance by others – the more far-reaching can my expectations become in the process of choice.

Shall longer horizons of fellows suggest that these others become *more or less predictable* elements in my decisions? Such is important because it defines our interhorizontal linkage. I contend that neighbors' horizontal lengthening causes a likely *extension* of my horizons as well, and not a *retraction* of planning perspectives: if so, then our relations show *interhorizontal complementarity*. In other words, our planning horizons shrink or spread together; *they move in concert* (more often than not). This pattern of interhorizontal complementarity is a critical part of economic behavior (Jennings 2009, pp. 46-47). Economists seem to ignore horizon effects since the 'neighborhood store' regards all learning as optimal and complete; time is simply excluded (Jennings 2019, pp. 75-76). So we have formed no real understanding of how regulations shape planning horizons. Such is an 'opportunity cost' of mainstream models of choice.

Institutions and planning horizons

Planning horizons shift at each moment depending on numerous factors. So they adjust to each other responding to inner and outer inducements. The point is that *they exist* a range of perspective vests every action, through a projective framing of outcomes. Such are represented – for better or worse – in models of thought that turn on how well 'essentials' are first identified, then inferentially structured in their relation to our results. Planning combines induction with deduction, art with science. Any theory ignoring applicative value is simply irrelevant to its primary aim of focusing thought on appropriate tradeoffs in action. Essay One explored the need for realistic constructs in choice (Jennings 2019, pp. 66-74).

How we decide when to act, i.e., that sufficient attention has gone to projection of outcomes so we are ready to *choose*, cannot be exact or explained. That decision is subject to both immediate and distant tradeoffs, inner reserves and outside demands, prior learning and current distractions. At each moment we must decide where to look and how to apply our resources: sometimes we act impulsively, if in a quandary on our next step; at others we hesitate until lost in unresolved doubt and dissembly. Any attempt to articulate an attention span is futile; it also violates philosophical precepts such as the Law of Induction. We cannot know what is 'best' in advance of – or even *ex post* – pursuit. All we can do is 'as well as we can,' with theory attempting to guide us.

So how do institutions promote or resist our planning endeavors? Wherever rules increase uncertainty or disrupt our control over action, demands on attention are raised and risky adventures in learning constrained: instability undermines long-term commitments in favor of flexibility. This is but one of the many ways that incentives shape planning horizons. Simon (1983, p. 107) described our need for theories of ethics well in his Stanford lectures on *Reason in Human Affairs*:

Reason ... is instrumental. It can't select our final goals... All reason can do is help us reach agreed-on goals more efficiently. ... It would be quite enough to keep open for our descendants as wide a range of alternatives as our ancestors left for us... In accomplishing [this] more limited goal, will an appeal to enlightened self-interest suffice? ... Success depends on our ability to broaden human horizons so that people will take into account, in deciding what is to their interest, a wider range of consequences. It 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.

Competition and cooperation

It has been argued in Essay Three and above that substitution and complementarity – as opposite types of interagency interdependence – call for inverse social structures: the first demands *competition*, the second *cooperation*, to motivate effort. Monopolization of substitutes – like competition among complements – serves to *reduce* our productivity in equivalent ways. So I maintain that transactions of *physical items* are unlike exchanges of *immaterial or informational goods*, knowledge, shared with others, is simply not lost to oneself as are things.

The orthodox image of economic activity – in which utility comes from material acquisitions – squanders attention on only one facet of a two-sided actuality. As a result our relation to others is grossly misrepresented thereby. These 'substitution' assumptions – supporting our emphasis on 'competition' throughout our institutional-legal environs – subvert the case for *cooperation* in complementary realms. Indeed, economists' stress on 'scarcity' yields this shortsighted view. Once we open to 'chessboard' and 'transport' analogies – so address *planning horizons* – our eyes open to show abortive failures stemming from *competition* where *cooperation* is sought.

As noted already, this problem mistakes a poison for a cure in these settings: strengthening competition to bring up performance in complementary realms serves in fact to reduce it! The 'Problem of the Invisibility of Unexplored Alternatives' – and the fact that 'selective focus' entails as well an 'exclusive blindness' – shows that a tragic confusion has steered us to implement counterproductive incentives in certain important transactional contexts. The question devolves to one of appropriate application here: how essential is 'complementarity' in different types of endeavor? If *substitution* describes our dominant form of interdependence, then my concerns seem much overrated. Where *complementarity* is more important and *competition* directs our resources, something is terribly wrong, however. Which is the case, in what domains, should be our central concern.

Static and horizontal complementarity

Perhaps the first thing to note in asking where complementarity overrides substitution is that they are *both* intermixed in virtually every instance. It is nearly as hard to identify cases of pure rivalry as it is to find examples of unalloyed complementarity in economics. Recall my discussion in Essay Three of beer vs. wine as substitute drinks, but complements in a decision to party (cf. Jennings 2019, pp. 83-85). Interdependencies, being context and purpose specific, are also resistant to simplistic classification based solely on physical attributes.

Another way to address the point is through *externalities*; how often do my successes spill only *losses* on others? If I have friends who welcome my triumphs, we are linked in a 'concert of interests'. Substitution assumptions state that benefits do not align, they *conflict*, this is sometimes (but not always) so. Indeed, one could argue – from more expansive views than we normally hold – that profits are usually joined, not opposed, in a world where teamwork contributes to output.

There are two patterns of interdependence here which warrant distinction. The first is *static* 'complementarity vs. substitution', where acts are related *for given horizons*. Such should not be confounded with *dynamically* interactive horizons that tend to be complementary. If longer planning horizons *of anyone* operate to the advantage *of all*, that '*horizon effect*' infuses some mutual gains into rivalrous states to shift traditional links. In other words, longer and broader horizons shall alter the balance of interdependence away from substitution in favor of greater complementarity, tipping connections away from 'conflicts' toward 'concerts' of interest.

Extended horizons – strengthening the *alignment* of interaction – call for an *organizational theory of learning* in a process of growth. This may help us to understand how social incentives may shorten horizons, so allowing us – by refining our rules – to foster more rational action. That, in turn, should work to *everyone's* social and private advantage, in more efficient use of resources and better coordination of plans. The research agenda implied thereby assumes sufficient potential improvement in our institutions to warrant development of 'horizontal' theory. At least one aspect thereof unfolds in a nicely accessible way.

If our planning horizons are raised through *personal learning endeavors* – and by environmental stability or inspiration from other role models – then a study of how rewards are arranged in our *educational system* might be of value in showing the way our rules and procedures shape perspectives. The primary aim of schooling is surely to open our minds to options and theories of 'how the world works' in response to choice. So, with almost all of us socialized through many years in this setting, educational learning incentives embedded in habits should have a decisive effect on how we relate to each other.

Competition in higher education

In our educational system the dominant type of transaction is of *information*, not physical goods. So, I contend, this situation exemplifies *complementarity*: indeed, the process of trade is productive; knowledge increases with more interaction. Here, if anywhere, *cooperation* is needed for optimal learning. Yet our education is riven throughout with rivalrous social incentives. No brief essay is able to offer more than a cursory explanation of how competitive values sum to a counterproductive effect in this setting (cf. Jennings 2008b): competition in complementary realms is self-defeating.

There is scant doubt our institutions of learning are mostly competitive. Students vie with each other for rank, under relativistic criteria; the impact of grading them 'by the curve' in Essay Three was held to encourage *pretense, fear of failure, minimal learning* and – often – *avoidance* (e.g., cf. Kohn 1986). A competition of faculty members only strengthens such patterns: a dedication to teaching is seen as signaling improper research priorities: the last thing any department desires is permanent tenure to teachers so able that senior members look bad. Despite a pretense for students and service, *research is all* in promotion decisions (so long as neglect of these other criteria is not too blatantly on display). Again, a connection between hypocrisy and competition appears in this setting, where education – if anything – ought to be founded on *honest expression*.

Also the impact of competition on knowledge has not promoted development of economics *or* the economy. One must distinguish in this regard 'junior' from 'tenured' faculty, as seniors seldom (if ever) encourage initiates to open unexplored issues: such are hard to publish in dominant journals supporting conventional views (not to be questioned therein). Instead, empirical applications of already understood themes are reviewed, or further ramifications of well-worn debates are introduced, before a progressively narrowing audience shaking each argument down to its last detail. In this situation, any synthetic critique of established doctrine is ignored or dismissed as 'superficial' in its summary view.

Younger faculty cannot afford to be either ignored or dismissed. The optimal strategy is to work within mainstream models and question nothing, and then – if tenure is finally won and any novel ideas remain – one can explore them to one's delight. This scheme entails an unrealistic concatenation of patience and pretense: 'practical' people abandon their early ideals – if ever embraced – and never look back, committed to orthodox standards. Such sure retreats seem better rewarded than questioning current traditions (cf. Earl 1983a, p. 121). Senior researchers seldom adjust their initial orientations; once with tenure, most have vested too much in established approaches. To shift imperils one's prior research, which few have the courage to do.

What about *interdepartmental* linkage, as a source of ferment? Darwinian arguments certainly influenced sociology, economics, psychology and social theory. Yet even a cursory look at interdisciplinary adventures shows that established departments have long resisted infusions of 'foreign' ideas as a threat to their own territorial aegis. Such is an offshoot of the competitive principle in this setting: avid turf wars seem antithetical to any system based on cooperation or genuine learning.

The latter requires an open-minded embrace of multiple outlooks, something quite alien to academic concerns. Indeed, I would trace the cause of our rigid, dogmatic, compartmentalized defensiveness – in its seemingly stolid defiance of new ideas through the ages (a good example is the initial reception of 'chaos theory' in physics; cf. Gleick 1987) – to our imposition of a *competitive frame* upon *complementary* yields with tragic, counterproductive results in our educational system.

The way to unleash our creative energies is to encourage *cooperation* and not competition throughout education. To my view, this is all it would take: success should develop its own momentum, opening up progressive forces against the fears and dodges that bind them. After all, *learning is fun!* Only due to the inappropriate organization of these institutions have we come to perceive as threatening what we don't understand. I cannot think of anything more unfortunate than that. The lesson is, *theory matters*; fundamental lacunae in our image of choice are costing us dearly in numerous social engagements. Our emulous educational system produces stress at all levels; shifting to *cooperation* will augur relief for learning and socialization.

Indeed, the lesson does not appear restricted to education; consider its application to politics. Our rivalrous selection of representatives, who are thereby appointed to organizations surviving and thriving (or not) on members' *cooperation*, is similarly ineffective. Any arrangement designed to choose *successful competitors* should not disclaim their resulting *inadequate teamwork!* Recall my auction of ten-dollar bills described at the end of Essay Three (Jennings 2019, pp. 92-93). Other examples come to mind of counterproductive ventures stemming from maladaptive incentive frameworks, including those with competitive values smothering complementarities. Such shall lead to waste, stress, stagnation, frustration, denial and doubt. An optimal balance of cooperation and rivalry ought to be seen as the key to efficient organization of economic and social affairs. Its absence suggests some meaningful opportunities for reform.

Systems design for longer horizons

The issue reverts to how we encourage *engagement* through social incentive design. Planning horizons suggest a welfare rule, where research should analyze systems' effect on personal learning. An easy example is how authority – in taking choices from individuals – serves to preempt the amount of attention devoted to those decisions. Such shrinks private planning horizons in particular realms; only if

public perspectives stay large are resources saved thereby. I hasten to add that our representative processes seem to assure that public policies stay myopic, concerned with the latest poll or the next election instead of with long-term effects. Such shall not move voters long inured to – if not defensively ignorant of – our organizational limits. Any observer can see how woefully hidebound political leadership is.

What we need is an intellectual lever and fulcrum for change. Ubiquitous substitution assumptions – in all their rampant destruction of ethics, ecology and economics – suggest that problems in our institutions arise from improper incentive designs, where rivalry actually works as a *drag on* instead of a *goad to* efficiency (Jennings 2017a, ch. 12, pp. 147-60). In turn, this competitive view rests on an incomplete image of choice; 'shopping' analogies simply ignore important decisional attributes. Uncertainty, irreversible time, others' intrusions and complementarity, all are refused attention despite their relevance to our reactions. Such has circumscribed economics; selective focus is necessarily blind to its sundry exclusions. A mind receptive to multiple outlooks serves as our only escape, but this style of openness stands in stark contrast to extant attitudes in academics. I have suggested the reason for this: competition in complementary realms, just like collusion of rivals, subverts success in this setting. Our often noted antipathy to innovation (technical or scientific) – in spite of its salutary effects – seems to result directly from *our own* intellectual error. In sum, a vital lacuna in our economic concept of choice has shaped our representations and organizations to our great disservice.

The only way out of this mess, I contend, demands a new research program based on a broader image of choice where *how we think* gets central attention. The notion of 'planning horizons' – as a means of framing a range of phenomena: externalities, foresight, time, decisional margins, ethical conscience, learning incentives, etc. – offers a standard for studying institutions in terms of human well-being (claiming that more understanding and greater cohesion is 'socially advantageous'). *Longer planning horizons are 'good'* is the premise I would advance; more practical knowledge shall open new options and augment economic achievement through a closer alignment of all our interrelated decisions. Though unexplored avenues stay unseen, except through a hypothetical lens, this one is well worth pursuing.

As economists slowly adapt to epistemological theories of choice – a trend underway in a 'cognitive' view – the harmful effects of competition ought to become more apparent. Thus psychologists and educational theorists are needed to work on this scheme, because economists still in current training are totally ill-equipped to address subjective phenomena (Jennings 2015a). Yet interdisciplinary activities

shall not thrive in dogmatic contexts: one must be able and willing to wrestle with unfamiliar regards as a means to embrace new ideas. Since every choice we make in the world is entangled with everything else, no single profession will ever suffice to guide us through real decisions. Still the problem is *structural*: the right design for education – where trades are mostly immaterial – is *cooperation*. Until we understand this, all lesser reforms shall be ineffective.

Cooperation and learning

These essays started with models of thought or representations shaping decision. Economists – seeing all choice as simple (like that in 'neighborhood stores') – have long resisted the notion of incomplete knowledge. Our rational bounds sunder the argument that our responses are tied to constraints and intentions without being consciously apprehended through *individual outlooks*. As such, Essay One intended to move *philosophical* issues into the center of all economic analysis, something consistently favored by some but directly opposed by established dogma. [2] Appreciate, though, that a mechanistic construction of human decision is so incompatible with this cognitive view that orthodoxy *ought* to be threatened! Of course, were the aim *understanding*, unexplored theories would be encouraged: this is the fateful legacy of our rivalrous education; we cannot know what we're missing without developing *cooperation*, to learn.

An obvious way to study how organizations advance or impede our planning is through their members' behavior. There are two ways to greet surprise: one either resolves to *learn* its source or *resists* its threat to one's standing. *Fight* or *flight*: there is no other way. When, how often, where and within what settings whichever reaction is seen defines one's horizontal limits. For example, avoidance of others unlike oneself – instead of finding in them an occasion for new understanding – is a confession of sorts about planning horizons and personal learning incentives. Indeed, the prevalence of such attitudes offers some insight to how widespread is the impact of improper representations suffusing our organizations: symptomatic of our myopically anti-educational outlooks is an exclusionary resistance to unfamiliar ideas and encounters. Avoidance of 'foreign intruders,' social diversity, or other races, cultures and doctrines shows an aversion to opportunity and not a thirst for renewal. The question is how we ever internalized such a pervasive fear of learning. One good answer is by imposing an improper model of substitution upon a realm of complementarity, where it cannot but fail and produce symptoms of social pathology.

Conclusion

This series of four essays has sketched a theme much in need of extension. Problems of *invisibility* and of *selective focal awareness* show how hypotheses structure endeavors. Any model of choice shunning essentials apparent in every decision tends to divert attention away from matters of vital importance. Such are the inescapable 'opportunity costs' of any one theory, its tradeoffs staying unseen if never revealed through alternative frames. That is the strongest defense I know for an *openminded* approach to ideas; it also implies an unyielding critique of 'denial' in our society. Any institutional system promoting conformity at the expense of diversity undercuts learning. 'Avoidance' stunts human growth, if *flexibility* yields survival: children attest to the obvious fact that discovery entails *pleasure* and *joy* unless subverted by fear.

When theories are all incomplete, then multiple outlooks seem essential. Opening up our image of choice in 'neighborhood stores' to 'chessboards' and 'transport' tenders a new way of framing our interdependence and practical learning. The notion of planning horizons allows an assessment of our institutions and policies in their effect on *knowledge*. Any model ignoring relevant tradeoffs shortens horizons, so will manifest its myopia in denial and disintegration. Signs of organizational stress show up in a fragmentation of effort or losses of 'conscience', kindness and teamwork. Conventional economics sees atomization as a competitive virtue which shields a current dilemma: our rigid dogmas are coming apart in a process of paradigm shifts. Systems of thought and behavior react to collapse in *defensive* ways (cf. Fleck 1979, Kuhn 1970, Blaug 1976). Such is a field worth study itself, full of fruitful lessons.

Planning horizons in interdependent domains link 'conscience' to social cohesion, improving adaptive vitality. Only when models are fit to their realm may intentions stay well-directed and their outcomes unfold to expected effects, at least to a greater extent over space and through time (measured by 'planning horizons'). If frameworks suit their requirements, then our reflections and ethics show better results. One implication is that our incentives should be designed to their needs. The use of competitive values in education is counterproductive: failures are remedied by institutionalizing *cooperation*. But this solution demands adopting a more realistic concept of choice. Such a change will open new doors to unexpected developments and opportunities spanning well beyond our range of imagination (Tannenbaum and Hanna 1985). Are we ready for this?

Essay 5: Institutions and interdependence

The nature of interdependence is a critical issue at the core of human relations and structures. Orthodox economics has framed these systems in terms of tradeoffs and conflict, for reasons addressed in more detail below: static equilibrium models call for forces in opposition counteracting each other. Scarcity is taken to be the essence of economic concerns; stepping outside this restrictive view blocks us from meaningful understanding of how societies work, at least according to mainstream proponents.

As human nature is ineluctably selfish, acquisition is normal; people do not look out for each other in typical life situations. So we structure social arrangements to convert egocentric concerns into general public gain through an 'invisible hand' (Smith 1776, p. 423), transforming private to social advantage (but cf. Warsh 2006). This view entertains only one face of a two-sided coin, emphasizing substitution while ignoring complementarity (e.g., cf. Richardson 1959, pp. 233-34). The latter raises conclusions starkly at odds with this standard doctrine. Many economists see a rejection of scarcity models as a departure from economics itself, abdicating its subject matter. Here we explore this untraveled path.

The contours of interdependence

As noted in Essay Three of this series (Jennings 2019, pp. 88-94), economic interdependence comes in two flavors, not one; substitution is not the only relational form we enjoy. All are not disserved by your success; we will rejoice in it too. You and I need not be rivals; we can be lovers and friends. The basic character of our relations underlies institutional theory and how we organize social effort, for better or for worse. Here the price of selective focus – and of its sister, restrictive ignorance – stifles output and welfare, while leaving us blind to the loss.

Nicholas Kaldor (1975, p. 348) reported that: 'The principle of substitution ... ignores the essential complementarity between ... different types of activities ... which is far more important for an understanding ... of the economy than the substitution aspect'. Complementarity – if 'more important' – demands some major revisions in how we do economics. Kaldor (1972, p. 1240) addressed the implications: 'Without a major act of demolition – without destroying the basic conceptual framework [of orthodox equilibrium economics] – it is impossible to make any real progress'. These are revolutionary ideas in need of attention.

The methodological implications of planning horizons and complementarity – not to mention increasing returns – were explored in Jennings (2016a). First, in virtually every case, substitution and complementarity join in a nondecomposable mix, so requiring commitment to their relative value in each application.

Furthermore, this balance of interdependence is contingent: 'horizontal lengthening moves our interrelations away from substitution toward more complementarity and a horizontal shortening does the reverse' (Jennings 2009, pp. 45-46). Because such connections are purpose- and context-specific, they cannot be identified in an objective way, or disentangled to judge their comparative weight.

Planning horizons also coexist in an ongoing, dynamic balance since private horizon effects interact across social links: 'interhorizontal complementarity' yields some behavioral lessons for us, since such adaptations are contagious in their public effects. So the way we assemble our understanding of how society works structures our relations. Do we share conflicts or concerts of interest? The question arises since we only get one institutional form at a time. How we choose must turn on how we frame economic connections.

Institutional implications

As we know, with substitution, output declines with cooperation; here competition is seen as efficient: deemed a standard of optimality wherein tradeoffs abound. Economics is often defined as a study of choice against scarcity, where resources flow either here or there or elsewhere at the cost of the others. This 'either-or' posture is compared with the 'both-neither' relations serving complementarity; the distinction is seen in transport, where parallel routes are rival while end-to-end ties are reciprocal.

These two forms of interdependence call for opposite institutions: substitution demands competition, as combinations stifle output (with otherwise-external losses from *price hikes* captured through collusion). The opposite case with complementarity means that otherwise-external losses from *price cuts* are regained through alliance, allowing greater output. The nature of our interdependence shapes how rivalry or integration impacts social welfare. Whether economic connection is substitutional (either-or, akin to parallel lines in transport) or complementary (both-neither, akin to end-to-end ties) stands as central to what sort of organizational forms we should adopt. The issue is one of importance.

A question of fundamentality

As noted above, our relations in any context turn on nonmaterial as much as physical goods. Even a transport metaphor reflects this substantive variation: one agent's rival options serve as another's sequential links (cf. Jennings 2019, pp. 84-85). The case of 'beer vs. wine' offers a second example: for quenching a thirst they are substitutes, but for parties vs. some other amusement they are complementary (as I purchase both or neither). The contours of our interdependence are not objectively set; they are contingent on contexts and goals. The lay of this land is subtle.

But which form of relation rules is central to institutional choice, although in nearly every case both types are in play, transforming the issue into relative terms. How we assess these static connections stands on a shifting ground of value, erasing objectivity. All of our social linkages are *horizontal* as well.

Horizon effects shift the balance of social interdependence between substitution and complementarity: broader horizons turn conflict to concord, myopia does the reverse: 'This is the key to horizontal theory: longer planning horizons – social or private – change economic relations in favor of complementarity and away from substitution' (Jennings 2012a, p. 11). If so, then static connections are insufficient to frame our social links; we must know the horizon effects of our institutional goals. Indeed, the latter reveal a way to assess social organizations in their impact on planning horizons. For interdependent domains, coherence of individual acts is central to how efficient our systems are in avoiding conflict and discord. Horizontal range shapes social well-being; horizon effects supply a welfare standard for institutions.

They also imply an important institutional lesson for us. If planning horizons – as they extend – transform the balance of interdependence from substitution to complementarity, then the general efficiency characteristics of social systems shift away from competition in favor of cooperation as well (cf. Jennings 2005). Indeed, *not* to adapt these structures stifles horizontal growth, reinforcing a myopic culture. One could describe the current state of the world in these terms, given many observable trends including conflict, discord, disengagement, disruption, division, denial, loss of faith and hope, political opportunism, malaise, strife, violence, etc.; each is on the rise, signaling fragmentation and dissolution of organizational linkages, social cohesion and peaceful lives. All this sundering can be traced to rivalrous social arrangements, so we will look again at competition and its harmful effects.

The impact of competition

In mainstream models, efficiency arises from competition, based on substitution in human relations: tradeoffs abound, scarcity rules, and the challenge is *choice* among options. Such defines economics, and this scenario is seldom questioned. Economists' training is standardized within this self-contained box, with its suppositions never relaxed; indeed, they are rarely identified.

We need the courage to do so. As Earl (1983a, p. 121) explained (in line with Kaldor's 'major act of demolition'): 'If a mature scientist is to undergo a personal scientific revolution she will have largely to ... [suffer] nothing short of a scientific nervous breakdown'. Relaxing these substitution assumptions – mandated by increasing returns (cf. Jennings 2015b) – suggests a shift from mainstream models to open systems standing on complementarity and abundance.

To frame an economy as an unbounded ecology in perpetual flux is seen as daunting by an economist trained to static constructions of ever-reversible options in equilibrium. Social systems stagger along irreversible paths spinning complexly into surprising emergence. Here all our tinker-toy tricks of the trade demanded throughout academics show no relation to our realities: suggesting competition is serving us ill is summarily ousted from attention as outside the realm of scientifically-acceptable discourse. The horizon effects imposed by institutions are also rebuffed, seen as an indeterminate threat to ratiocinative viability.

The chief failure of competition inheres in its horizontal impact. That calls for understanding horizontal theories strongly incommensurate with established truths. To assert that competition is spawning a myopic culture in self-destruct mode is alien to our apprehension unless we examine the actual world in its cultural life. The signs of the problem are everywhere, revealed in ethical and ecological loss, climate decline, endless wars and persistent political strife, falsely accepted as symptoms of 'human nature' and not from maladaptive institutional frames. If there is a balance of substitution and complementarity in every instance, we initiate external losses and gains in all that we do. That balance is *horizontal*: the larger our ranges of vision, the more attention devoted to radiant impacts, so the better aligned our endeavors. The distance of conflicts to concerts of interest turns on horizon effects.

The question becomes one of how we organize systems for longer horizons. Sadly, I am unaware of similar research in economics though there are insights in other

disciplines. [3] Organizational theorists study alignment of private with corporate goals (e.g., cf. Jennings 2009, pp. 60-67); psychologists (e.g., Frederickson and Losada 2005, pp. 678-81) show how positive affect builds more accurate cognitive maps, making us more effective (Jennings 2005, p. 595). Such views suggest that systems stressing cooperation encourage learning, cohesion and personal growth. These are routes to renewal through redesigning our institutions.

The unexplored dimensions of cooperation

Though I began my work on horizons many decades ago, I did not claim complementarity as the general nature of social linkage until 2005 (cf. Jennings 2008a). Only after I had discovered the 'Hicksian Getaway' and disproven the 'Hirshleifer Rescue' (cf. Jennings 2015b; also 2017a, ch. 3, pp. 58-104) was I ready to argue for complementarity as "far more important" than substitution (à la Kaldor 1975, p. 348) in economic relations. That was a huge revelation for me. It implied that cooperation was the source of efficiency, not competition. I wondered how I might break this news to my economic colleagues (back when I thought they would listen or care). I knew it would take time and effort.

The reason competition is failing us needs more explanation. If learning is a complementary process, so teaching benefits all (cf. Boulding 1962, pp. 133-34), then we should open our schools to anyone eager for education, as everyone will gain. This speaks for cooperation on social welfare grounds: for mutual gain, we work together; that rivalries stifle learning is an 'elementary' lesson (Georgescu-Roegen 1970, p. 9).

The point is that, among complements, we need cooperation. If so, imposing improper incentives spurs symptoms of stress seen as stemming from 'human nature' and not due to wrong systems. But Argyris (1971, pp. 262-63, 268-69) said conventional management treating adults like kids shall lead to 'frustration, failure, [myopia] and conflict' yielding 'competition, rivalry, [interpersonal] hostility' and organizational breakdown. McGregor (1971, pp. 310-11; also cf. Maslow 1954, 1968) added that deprivation of higher-order human needs produces 'passivity ... hostility, or ... refusal to accept responsibility', not due to 'human nature' but as 'symptoms of illness' associated with poor systems design. With these social needs thwarted, people become materialistic (cf. Jennings 2009, pp. 65-66). Such patterns abound in our social culture.

Why? This behavior results from maladaptive incentives spawning pathologies so deeply embedded in our routines that we cannot see them as such. We learn to compete too well, at the cost of cooperation. This socialization process supports an aversion to difference, challenge, and learning, caused by competitive forces in education and elsewhere. Kohn (1986, pp. 108, 110, 123) noted that: 'Whereas cooperation ... contributes to high self-esteem, competition often [has] the opposite effect. ... In competition ... self-esteem is conditional. ... The security ... so vital for healthy human development is precisely what competition inhibits' (also cf. Rosenau 2003). The urgent need is for economics to move beyond substitution into a network analysis of irreversible dynamic complex systems. Substitution appears, but in a lesser role; acknowledging complementarity, especially in all learning, carries a case for cooperation. To work together requires a common code of ethics and trust that we all live up to and honor.

In joint undertakings any one party can disrupt the entire arrangement; cooperation gives anyone a veto over the whole. The 'myopic individualism' promulgated by competition is a large part of the problem. Restoring trust throughout our social systems is an urgent matter, especially in the United States. We must turn away from authority toward truth in our systems (Boulding 1968, pp. 234).

Toward a healthy economic society

Fundamental losses in ethics, ecology and education arise from our horizontal limits (Jennings 2012b). Economists share a heavy burden for our relentless adherence to substitution spurning all other approaches. A due recognition of complementarity augurs – indeed demands – a network conception where all is connected in (too often) unknowable ways. Here, every decision has spreading effects that grow over time. The case for increasing returns sets up planning horizons as a border on a seamlessly open domain of uncontained effects. This analytical boundary – framed by Georgescu-Roegen (1971, pp. 213-14) as central to all scientific concerns (Jennings 2016b, pp. 64-65) – is a key to economic construction due to cumulative circular causation (Myrdal 1978), where everything unfolds forever on endlessly irreversible paths without attenuation.

Boulding (1968, p. 234) characterized the implications of ethical loss: 'If capitalism is to work successfully, there must be defenses ... against dishonesty' especially through 'the internalization of these moral standards ... by ... example' because 'dishonesty tends to perpetuate itself through the teaching process which it

develops'. When cultures erode into 'general ... cynicism and the overt acceptance of a dishonest covert system – a society is doomed'. He shows how role model effects – through 'example' and 'teaching' – infect the cultural ethos. Organizational systems cannot thrive in the absence of moral limits socially understood and adopted; otherwise 'cynicism' brings an abortive fragmentation of viable links and institutional function. No such concerns should be trivialized; they jeopardize social civility.

All this stems from planning horizons, from how myopic or inspired we are in our ambitions and dreams. Each of us shapes our neighbors' horizons by the examples we set. If fully interdependent, all we do affects everyone else; there is no final end to our results or ramifications. Any analytical outlook casts shadows beyond our reach of vision that we cannot see *ex ante*; only after-the-fact can we conjure realms of surprise at the horizontal edge of foresight (which by then is outdated through action). We might think our horizons long until our results show otherwise. Surprises set the horizontal limits of prior anticipation; we are bounded by our range of awareness of foreseen effects.

The planning horizon offers an ordinal index of ethical, ecological and social conscience, swimming in an open domain of irreversibly ongoing cause. This is an economics in which ethics shapes social welfare, where immediate-term myopic concerns savage peace and tranquility: social learning is central to our resilience and diversity. Undertaking a new economics shall offer a route to redemption in an age of uncontrolled change.

A biological illustration [4]

Adapting our economic conventions shall not be a straightforward task. I became an economist over fifty years ago, and have spent 40 years on planning horizons – to little avail thus far. People in academics seem to resist departures instead of seeking them out as a chance to learn. We lock ourselves into a self-contained box if we are reluctant to question assumptions supporting guarded domains. Our only escape is by roads untraveled, and to examine the real world beyond theoretical models.

The story of Lynn Margulis in biology offers some inspiration, in a strangely parallel way to my own (aside from her ultimate triumph). A rebel who reveled in her own apostasy, Margulis shifted thought in biology into a new frame putting cooperation at its center – reducing the role of competition – in theories of evolution. The slow emergence of her ideas offers some meaningful insights into

academic change and the painful process of paradigm shifts. Some people viewed her ideas as crazy and total nonsense at first. 'Nevertheless, she persisted'. [5] Today a view of symbiosis in all life has secured dominance in biological science.

The story of evolution begins with Darwin's 'survival of the fittest' through 'natural selection' as a competitive struggle through which only the best will reproduce. Then Darwin was married to Mendel in neo-Darwinist thought; all life was seen as an active vehicle for DNA (cf. Dawkins 1976), in a story of random mutation through reproductive variation. Also 20th century neo-Darwinists stifled dissent, taking control of the conversation; this was what Margulis confronted in her own research, which proposed that the difference between bacteria (prokaryotic cells without nuclei) and eukaryotic cells (in her other four kingdoms of protocists, fungi, plants and animals) originated through a process of symbiotic connection. This symbiogenesis said evolution occurred in discrete leaps with species-specific combinations emerging on novel lines. Such was seen as heresy!

The notion of evolution as a competitive process reflected a 19th-century view of capitalism; Hobbes saw nature as a war 'red in tooth and claw' (as Tennyson put it and Dawkins saw it); Margulis felt these metaphors went beyond what Darwin meant. She also thought that applying competition and cooperation to natural processes was too anthropocentric, cautioning against the use of such metaphors in place of close observation. She urged us all to step out of our books and look at the natural world.

But her ideas had antecedents that carried her into a view of life formed by deeply-collaborative bacteria working closely together. This idea was stridently ridiculed until confirmed by evidence, after which it was slowly accepted. Her view would evolve from Wallin's speculation that mitochondria formed through bacterial symbiosis; such was the seed of a new way of framing our theories of cellular evolution.

Margulis defined symbiosis as 'the living together of unlike organisms' so is not cooperation (which can occur within species). She saw symbiosis everywhere throughout natural life. For example, lichen involved a fortuitous juncture of fungus and algae. The entire relation of forest roots to mycorrhizal fungi shows the potential of symbiosis; trees signal to each other through a hidden network. So plants are not discrete; they are plant-fungal consortia, as are corals with plants and algae. Cows cannot digest cellulose save for internal bacterial symbionts, and even we humans are wholly inhabited by such colonies too! The point is that we are all ecosystems symbiotically linked.

Margulis spawned a new way of thinking in which all life forms are holobionts, complex ecological systems seen through a new analytical lens supposing interdependence. So DNA is no longer in charge; cells control all life in a self-forming process of autopoiesis. Such a view raises a question of how cells structure their genetic content; epigenetics studies how genes are used in cells shaped by their surroundings.

Free will has supplanted determinism, both in genetics and human activity; we invent our own futures. So random mutation and natural selection are seen as an oversimplified story of how life formed in its awesome magnificence. Cells repair their own DNA; genetic change is an active process; the genome is not a read-only but a read-write memory system: sentience is more widespread than we think. As Margulis said: 'All life on earth that is not bacteria is a product of symbiogenesis'. She taught her field to see symbiosis as central to evolution and life.

A striking case of this phenomenon in all its stunning importance is that of butterflies moving from caterpillars through a wondrous transformation. How might this have evolved? Don Williams (1922-2016), a British biologist and Margulis colleague, thought this behavior resulted from a symbiotic concatenation of two independent life forms in a sequential hybridization turning one into the other. Williams' theory is harshly debunked; John Feldman asked why. His answer is found in a book review which complained that 'if Don Williams is correct, then our current understanding of animal evolution is fundamentally wrong, and many scientific careers have essentially been wasted'. It would be nice if the real world always conformed to preconceptions; when it does not our theories should change and not dig in against new ideas. Such denial is the bane of intellectual growth; it is a clear result of an improper institutional system imposed upon education. These errors stifle learning and disfigure research as well. We can do much better than simply acting on fear and defensiveness, especially in any temple of learning.

Conclusion

This essay began with a discourse on the nature of interdependence: substitution is not its only form; complementarity counts. Indeed, Kaldor (1975, p. 348) deemed the latter 'far more important' to our understanding. He called for 'demolition' of the established approach (equilibrium models) in order to make any progress (Kaldor 1972, p. 1240). But the balance of interdependence in every case is also horizontal: longer horizons shift relations away from substitution and in favor

of complementarity, while increasing myopia does the reverse. So we confront a dilemma of choice: substitution wants competition; complementarity mandates cooperation for social advance. The wrong institutions shall lead to malaise and further social loss. In this sense, horizon effects call for adaptation to reduce symptoms of organizational stress.

So which relational form must we use for social design? Is substitution or complementarity a more effective foundation? If both always occur together, what is their resolution? These questions become more vexing once we learn that their dynamic balance is shaped by planning horizons. Is there an answer or do we just 'wing it', especially when we cannot define our relations in an objective way? The contours of preference cannot be mapped in the absence of context and purpose; here one person's substitutes may be another's complements.

So we address the case indirectly: economists see competition as equivalent to efficiency, where rivalry is optimal (almost by definition). The claim is based on substitution as an implicit premise seldom mentioned or ever rebutted. The impact of competition in the presence of complementarity, though, can be addressed and described. We know that competition depends on assumptions of substitution that define where it applies to raise efficient production and welfare. We also know that complementarity calls for cooperation as the proper route to social advance. The implication is that imposing a wrong system of social incentives in a realm where it does not belong reduces satisfaction and creates systemic distortions. But what do these stresses entail?

Let us look at the impact of competition in complementary settings to see the effects we observe. First, the purest example of complementarity is education, where exchanges almost exclusively involve transfers of information. Other realms of almost purely complementary interaction include love, faith and many other intangible goods. So what is the impact of competition on all learning activity? If exchanges of information are – in their essence – complementary, then competitive forces stifle learning and understanding, causing organizational stress due to wrong incentive designs.

Pathological symptoms show up in the organizational literature as signs of failure including instability, conflict, materialism, myopia and denial. All of these behaviors suggest a shrinking of planning horizons, due to improper incentives. Competition in complementary realms cannot but fail; longer horizons stem from learning in a cooperative frame.

Understand that any extension of planning horizons serves to align private with public goals in the presence of cooperation, while positive feelings open our ranges of vision by improving the fit of our cognitive maps to the world. The stresses stemming from competition narrow our rational limits. Its failures occur within a horizontal lineage still unknown to economists. There is a very urgent need for further research on this subject.

But this sort of inquiry is starkly impeded by the arrant dogmatism of mainstream proponents. The fierce opposition to chaos theory in physics (Gleick 1987) is similar to what Margulis encountered against her radical views. Neo-Darwinists saw rivalry everywhere in our living environment, while Margulis saw symbiosis at the core of all life. Her struggle to place cooperative forces ahead of competitive frames was successful at last. This quest in biology parallels strikingly mine in economics: the novel linkage of planning horizons to welfare theory unfolds into a sweeping case for cooperation. Understanding the argument demands a closer regard to reality.

Symptoms of failure abound throughout our social and economic cultures. We wallow under relentless ethical and ecological losses, runaway population growth, uncontrolled climate decline, unending political chaos and conflict, and widespread denial of these crises in their threat to all life. One would think such conditions would provoke calls of full emergency, but these alerts seem mostly ignored, due to a helpless sense of futility. Our role in the systemic cause of these problems is far too rarely acknowledged. A horizontal research program in economics is sorely needed.

Essay 6: A research program for economics

This series of essays argues that complex interdependence comes in two flavors. In every instance, substitution and complementarity join together in a nondecomposable mix, suggesting an absence of guidelines for institutional choice. The difference in these two forms of relation is also context- and purpose-specific, with one person's substitutes another's complements (cf. Jennings 2019, pp. 84-85). The issue matters since wrong incentives spawn social losses. When substitutes collude, allowing abuses of market power, restrictions of output damage consumers. Separation of complementary inputs is equally ill-advised, due to its psychological impact on learning and social relations. But if we cannot disentangle them – if their balance is not observable – how we structure institutions revives an issue we thought was resolved.

Though Kaldor's findings were largely ignored, he called for 'a major act of demolition' in orthodox economics (1972, p. 1240), saying the role of complementarity is 'far more important' than substitution due to increasing returns (1975, p. 348). When I encountered his seminal work, I had crafted a microeconomic case to a like conclusion (Jennings 1985), though it took Kaldor's stunning claim to give me confidence in this story. [6] Oddly, Kaldor ignored the implication that cooperation was more efficient – either because it was obvious or too controversial – but the point was clear to me: generalized complementarity meant our rivalries serve us ill. In time I understood that symptoms surround us of organizational stress, and that these pathologies show up in the form of horizon effects.

As I researched planning horizons, I learned that – since substitution and competition were not a general case – there was no way to justify interpersonal opposition. But that did not leave us without guidance; planning horizons measure efficiency, where the broader our range of awareness the more effects of choice we account. In this sense, planning horizons give us an ethical gauge of conscience, and of how well our radiant impact is subsumed in decisions. So horizon effects serve as an organizational welfare standard; we can examine institutions on how they shape planning horizons. Such impacts can be observed in social behavior as well as in ethical and ecological loss.

Horizon effects as a welfare standard

To use horizon effects as a standard, one must see their impact. I have analyzed this in great detail over the past two decades in many papers both here and elsewhere (e.g., esp. cf. Jennings 2008a, 2009, 2010, 2012ab, 2015ab, 2016abc, 2017ab). The basic concept emerged from a study of British canals, a capital-laden network characterized by public goods, increasing returns, massive initial investment in durable plant with high fixed and low operating cost. This setting made all of our product market demarcations irrelevant. The problem was more like an ocean ecology than the nicely-defined domains of rigorous scientific analysis seen throughout economics. Where were the analytical boundaries spoken of by Georgescu-Roegen (1971, pp. 213-14; also cf. Jennings 2016b, pp. 64-65)? How do we think about openly interdependent systems of full interaction? What are the implications of increasing returns and network effects? Transport systems are public goods, shaping all other decisions based on their infrastructural legacy. How does one deal with all that?

The history of the British canals shouted an answer at me, in an unmistakably obvious form that I could not see at the start. The development of this system occurred in three sequential stages: initial construction; operation; and then collapse and decline. The construction phase endured two periods of 'Canal Mania' investment booms, after which the early canals fought network expansion through the Canal Bill approval process (though a larger system might benefit all), so restricting new entry. In operation, canals exploited their local monopoly power with high prices and shoddy upkeep, provoking ire from merchants. So when the railroad appeared, the canals used these well-worn tactics to force new railways to buy out their routes. In three short years in the mid-1840s, fully one-third of the waterway network cascaded into railway ownership until that game petered out. The Age of British Canals was over; rails and roads assumed dominant roles.

The message was clear: for long-lived durable capital like canals that influence subsequent choices, the planning horizons shaping options should be as broad as reason can reach, to quell conflict and spur growth. The history was screaming at me: myopic concerns were ruling the day. I asked why and unfolded a public policy story with stunning conclusions: full laissez-faire or nationalization would have worked a lot better. Instead, a Carriage Restriction based on toll roads sanctioned British canals from owning or running boats or selling transport services. This regulation divorced them from any integrated development options; being unsure that price cuts would hold, they became local monopolies seizing whatever returns they could.

They also bickered and fought with each other; their rivalrous strategies stifled any expansion that might have occurred. Under a laissez-faire rule the overall network could have consolidated to grow their own and each other's trade, to the same end as nationalization (due to increasing returns and these systems' complementary nature). But this was the age of Adam Smith, with competitive forces standing supreme over policy choices and views. Seeing potential friends as rivals spawned discordant behavior, restricting planning horizons and placing cooperative values out of reach.

Margulis said we should look to the world for the novel lessons we need to explore, to unearth the answers to ranging questions in any inquiring context. This was certainly true here; the British canals show the havoc caused by wrong institutions, where invisible options stayed unexplored. The role of planning horizons is central in determining growth and development. All of our organizations should

be examined in their horizon effects; planning horizons serve as the engine of economic activity. They also provide a new welfare standard.

So we economists should evaluate institutional systems with regard to their impact on planning horizons, knowing that everything will work better – regardless of other details – if we are able to implement systems that encourage learning in every endeavor. But there has been no economic research on how to design for longer horizons; such is an urgent need. There are some meaningful lessons here that blaze the start of a trail; learning and information – much like any intangible goods – show that the route to horizontal growth (through cooperation) calls for rigorous systems of social ethics and trust.

A new perspective on social incentive structures

We economists seem to take competition as efficient without any question about assumptions. Also, reframing the issue in networks – so embracing interdependence – opens a view into 'human ecology' as a way of thinking about an open, dynamic process. Simply adopting increasing returns shatters the neoclassical lens and demands an alternative frame: our rigid doctrines have failed to address social reality here.

Each of us inhabits structured incentives in all that we do. Take a football game, for example: there are rules and goals that place costs and gains on each option. We act through these schemes, seeking advantage. Such is the case in every choice; we learn what works and what is too costly. These systems are subtle: legality is a part of the puzzle, but morals and peers play a role. Even location matters, since my tradeoffs shift with where I am. We all learn these settings and design our actions accordingly, despite diverse external intrusions subject to scant control.

Physical laws serve as constraints along with social inducements. Cultural legacies shape behavior, inspiring us to improve or regress. Personal attitudes also move us into our own unique conceptions, though we act in a framework of final results in need of attention. Cause and effect unfold together from all that we do, radiating our impact outward onto everyone else. In this open-ended domain, our planning horizons shall matter.

Indeed, it is our range of awareness shaping how we perform, in a social setting unfolding through time. Every situation is new and different from anything else; our rationality entails selecting essentials and drawing on prior events, knowing we

cannot assess it all. We understand whatever we see and look as far as knowledge allows, doing our best at each step. The more stable our realms – social, legal and cultural – the better can we imagine our outcomes: the more supportive folks are, the more robust our motivation. This is a lot of what we are missing under rivalrous strife: vitality of fellows. Social linkages sharing positive feelings shall lift us all together. Can we not see how we injure our social fabric with competition?

Again, we must look at the world around us, beyond textbook conceptions. The theory says, if learning is complementary, cooperation is the route to longer horizons. This implies that competition is spawning a myopic culture riven by organizational stress. Symptoms of 'frustration, failure, short time-perspective and conflict' yield 'competition, rivalry ... hostility' and dissolution (Argyris 1971, pp. 262-63, 268-69). Such deprivation of higher-order needs will lead to 'passivity, hostility' and irresponsibility, yielding materialistic concerns since that is the only thing left to control (McGregor 1971, pp. 310-11). If we consider reality, our myopic culture is simply ubiquitous, swamping us in malaise. Surely we cannot be blind to this scene.

Swimming within our own matrix of values, each of us acts in an alien network of vital losses and lures, shifting with each moment and move. When upstairs, I have far more options in that realm than down below. If I have friends nearby, I enjoy opportunities for entertainment that I lack in a deep dark wood, where different choices apply. Whatever my state, the better my understanding the further my options extend. This is the realm of horizon effects.

Reintegrating our fragmented knowledge systems

We live in a complexly interdependent world of endless consequence spreading beyond our rational limits. There are no boundaries here; as Joan Robinson (1941, p. 241) put it so well: 'In order to know anything, it is necessary to know everything, but in order to talk about anything it is necessary to neglect a great deal'. Our educational institutions are carved up into separate disciplines, where 'never the twain shall meet' save in unusual cases. But, as Robinson notes, 'in order to know anything, it is necessary to know everything'; the separation of fields of inquiry interferes with our understanding of any interdependent domain where everything connects. This is the nature of human ecology and the risk of selective focus (and its sister, restrictive blindness). The only escape is an interdisciplinary openness here.

The point is, competitive frames support division and opposition in many endeavors including science, while choices are not so contained: they draw on knowledge from every field, where we need to know it all. Selective focus is unavoidable; specialization allows efficient production, when trusting in others for needs (cf. Jennings 2019, p. 90). But nothing occurs in isolation or remains within bounds; specialists should be in touch with each other across these separations.

Competition isolates us into divided domains, both in science and social milieus; connections are not explored across these intellectual lines. Stress – stemming from failed designs – shows in territorial battles and doctrinaire rigidities since our rivalrous struggles supersede truths in need of fellows' support. Thus we defend against diversity instead of fostering it, to learn. 'Rubbish!' we say to alien thoughts, seeing a threat to what we know. This is not – in any sense – a scientific commitment to learning; it involves an egocentric guard on entrenched ideas.

The solution to this sticky enigma is cooperation, as said. Within a truly cohesive frame, people deal with each other respectfully and do not dismiss their ideas and opinions without due regard. The complementarities of education imply that integration – not dissolution – is how we advance. Knowledge should be shared and not hoarded like hidden treasure. The widest spread of information is socially beneficial, looking beyond our noses to global effects. Stupidity and ignorance subvert democracy and ecology; they also risk a lot more...

Environment, ethics, civilization and climate

These are the matters at stake: competition, upholding a myopic culture, ramifies into climate decline, ethical and ecological losses and threatens civility. Some may see this as overstated, but look at the world opposition has wrought. Assigning the problem to rivalry may be a bit too simplistic, though it is central to what we are seeing. A way to represent the issue is with the complementarity of intangibles and ecologies. In ethics and moral behavior, as Boulding (1968, p. 234) has so well said: 'dishonesty tends to perpetuate itself through the teaching process which it develops'. Such patterns spread contagiously, infecting us all through interdependence. Myopic cultures sink into denial about the outcomes of action, when they are found discomfiting, causing ethical and ecological loss, climatic catastrophes and declines in peaceful human relations. Conflicts emerge that could be averted through institutional cooperation, teaching us how to act together. Horizontal theory yields a way to revitalize civilization.

Consider the ecological crisis as a result of rivalry. To address systemic collapse calls for an integrative vantage: sundering private demands from public concerns can never reconstitute discordant and dissonant trends; a holistic view is required. Furthermore, a widely-expansive vision of how a system performs is needed to fix its shortcomings. This is why a myopic culture is so unable to remedy or resolve ecological loss, which calls for a larger regard. Egocentric concerns are antipathetic to ecocentric cohesion: here lies the crux of our economic conundra over climate decline, ethical and ecological lapse, and threats to life on this planet.

Am I overstating the problem? The more we learn about the intransigent interdependence of everything, the greater our need for holistic conceptions. We have frameworks set up and designed to address systems, if we would use them (e.g., cf. Bertalanffy 1968; Churchman 1971, 1979). But their ready adoption has been fought by orthodox science; separate disciplines strive for attention to their own turf at the cost of all else. But no discrete dilemmas exist, as Myrdal (1978, pp. 772-74) explained so well in documenting his own intellectual growth:

...I came to see that there are no economic, sociological, or psychological problems, but just problems, and they are all mixed and composite. In research, the only possible demarcation is between relevant and irrelevant conditions. ...Our study must take into account the entire social system ... [whosel dynamics ... are determined by ... circular causation ... There is no one basic factor; everything causes everything else. This implies interdependence within the whole social process. And there is generally no equilibrium in sight.

Decreasing returns support substitution, competitive values and equilibria. Kaldor (1972, 1975) related increasing returns to complementarity and instability, without mentioning cooperation. My Ph.D. dissertation (Jennings 1985) crafted a justification of Kaldor's claims into a theory of planning horizons based on interdependence.

Horizontal economics opens to ethics, ecology, social cohesion, and other behaviors still undeveloped in their economic connections. So why do we not debunk competition as a source of virtue? Do we not question our beliefs, or are we unwilling to do so? Is substitution so essential we cannot let it go (Tannenbaum and Hanna 1985)? Economics is stuck in a box, which should open to new options in both theory and practice.

The social failures of competition

Perhaps the best way to pry off the cap is to look at the impact of competition. We have examined the educational legacy of our rivalrous systems, so there is no need to say more on that beyond this summary statement: if learning and sharing of information is a complementary process, competition does not promote but narrows our ranges of vision, spawning a myopic culture whose symptoms surround us. This shortsightedness spins out ethical and ecological loss, along with other social ills.

Economists see privatization as our route to efficiency through rivalry in all endeavors. But wherever complementarity rules, separation of efforts shall fail: integration is needed. This is an elemental lesson taught by our two forms of interdependence. Any ecological system is also wholly interactive, with each part a key to the whole. As Nelson (1981, pp. 1053-55) explained: 'If factors are complements, growth is superadditive ... there are not neatly separable sources of growth, but rather a package of elements all of which need to be there'. Rivals in opposition, driven by greed and acquisitive values, striving against each other for instant gain, will not be stewards of anything other than their own narrow concerns. This is the world that we support through rigid doctrines holding to only one side of a two-sided tale.

We need to see how pervasive are the attitudes stemming from our institutions. Recall my story of British canals' opposition to rivals in their own network, despite that an expanded trade would have favored them all. These advantages stayed out of reach; they saw their relations as rivalrous, shutting questions of mutual gain dramatically out of frame. A Carriage Restriction kept them apart at the cost of a much more productive path.

Substitution assumptions, acquisitive values and competitive forces have fatally undercut natural instincts for human affinity (cf. Jennings 2015a, esp. pp. 593-96). Indeed, these symptoms support themselves. Believing 'that people are motivated by self-interest and by ... power and wealth' will lead to precisely these social traits as 'self-fulfilling' effects of organizations so designed (Senge 1990, p. 274). As Badaracco and Ellsworth (1989, as quoted in Senge) explain, we are inspired by a larger vision and can be strongly incentivized thus:

If people are assumed to be motivated only by self-interest, then an organization automatically develops a highly political style, with the result that people must continually look out for their self-interest in order to survive. An alternative assumption is that, over and above self-interest, people truly want to be part of

something larger than themselves. ... When organizations foster shared visions, they draw forth this broader commitment...

This is what rivalries have forestalled: a ready extension of planning horizons stemming from more cooperative frames suppressed by wrong institutions. If the snake is eating its tail while calling that typical for its species, something is very amiss with this story. Myopic concerns shall blind us to invisible unexplored options.

Cultural evolution and change in human societies

The primary attribute of *homo sapiens* is our resplendent intelligence. We have adapted to change as required; this is how we ascended to a dominant role on earth. The view of natural processes as our enemy instigated an attitude of opposition against things wild; they were regarded as dangerously in need of subjugation. This is how we extirpated most of the large mammalian species, seeing a hostile environment as in need of control and domestication.

Another trend truncated innovation through a perversely conservative view of any diversion from practice. 'If it ain't broke, don't fix it!' For tribes on the edge of subsistence such departures augured danger, risking instability and death. These early folks were understandably wary of variation; mutations can be maladaptive, foisting chaos on a community. So although we love to experiment, traditional legacies must be protected against disruption as well. How we balance these two inducements shapes and defines social progress.

We think countering controversy is simply a human trait, to be anticipated in any event, be it in tribal, familial, educational or scientific contexts. But this view is incomplete; defensive reactions stem from a myopic culture resistant to change and placing convention ahead of divergence. Recall learning is fun if not derailed by fear or reproof; forceful lessons shall open us up or close us against new ways. Such moves are resisted or welcomed, depending upon one's view; we either avoid these shifts or seek them out to expand our range. Competition thrives on a fear of falling behind in a race against rivals; cooperation nourishes us together with ethical bonds (Jennings 2015a).

A mind open to new ideas seems so atypical in academics that one must ask for reasons here. A university yearns to be a sacred temple of learning, a community eager for knowledge and truth. That is what I expected at the start of an aborted

teaching career. What I saw was quite the reverse: there were creative folks, but they were that way in spite of and not because of the institutional setting. Competition – the 'publish or perish' syndrome – meant that everyone had to write papers and get them to print, at the risk of a tenure rejection. This stressful pressure eradicates rumination on well-trod paths and alternative frames; such entails too slow and careful a process of thought and delay. Adhering to standard doctrines is safer and gets much more reinforcement (cf. Earl 1983a, p. 121). Straying from the beaten trail is not a route to advancement; one must not challenge one's colleagues.

Leontief (1982, p. 105) – in an outburst of frustration on senior economists' 'tight control over the training, promotion, and research activities of ... younger faculty' – compared 'the methods used to maintain intellectual discipline in this country's most influential economics departments ... [to] those employed by the Marines to maintain discipline on Parris Island'. But teaching ideological dogma over intellectual inquiry – answers instead of questions – is indoctrination, not education (e.g., cf. Reder 1982, esp. pp. 17-19). A flexibly open mind is axiomatic to honest science. This is what competition has done to academic growth and development, due to a theory of substitution imposed on a complementary realm. Myopic cultures stem from massively consequential errors solidified in economic analysis.

We need to reorient economics into an open network configuration in which increasing returns and planning horizons are not denied. As Myrdal (1978, pp. 772-74) explained, in this situation, 'there is no equilibrium in sight'. Here we have an ecological system in ongoing flux, where our history unfolds along irreversible, path-dependent tracks. Initial presumptions set the conditions of application for results: substitution denotes one special case in a wider realm of phenomena where it joins with complementarity in a horizontal link.

Our institutions shape planning horizons, both private and social. Economists have ignored this subject, beyond my own insignificant scratches on a huge iceberg of facts. The urgency of further research is difficult to overstate, once the impact from myopic cultures is properly understood. The dangers of ethical and ecological loss, species extinction, climate decline, political impotence, spreading conflicts, stress and terror, all are results of substitution assumptions shorn from where they apply to yield deeply destructive failures.

Conclusion

Essay Six states a theory of interdependence in which substitution joins with complementarity in a nondecomposable mix. Their combination sets up problems of institutional choice since substitution needs competition while complementarity calls for cooperation. When both are entwined in any realistic case of interrelation, how we establish which should determine the social systems we set into place is important. These relations – subjectively grounded in values, goals and contexts, so one person's substitutes may be another's complementary yields – shall leave the proper design of social incentives still unresolved due to interdependence.

Kaldor (1975, p. 348) reviewed the issue regarding macroeconomic growth, and argued that increasing returns implied generalized complementarity. In my Ph.D. dissertation, I had a microeconomic theory yielding the same result based on Simon's (1982-97) rational bounds. Interhorizontal complementarity (that horizons shift together) implies that horizontal growth tips our relations toward complementarity and away from substitution, while myopia does the reverse. This view has some meaningful economic implications.

First of all, horizon effects serve as a new welfare standard: how effectively institutions support horizontal growth offers a way to assess their performance. Larger ranges of human awareness – better reasoned decisions supporting greater social, ethical and ecological conscience – show how more extended horizons are good for us all in every sense. The most significant problem is that we lack any economic research on how to organize social systems for horizontal growth, at least beyond my own work on this subject. No one else has picked up the ball and carried it any further. This is a disappointment.

The British canals suggested a way to resolve our problem of interdependence in terms of institutional choice. With both interrelations in play, neither reigns supreme as an organizational guide. The missing key is horizontal: learning – as a complementary act – thrives through cooperation; this is our route to longer horizons. The British canals – at every stage – attested to the staggering costs of myopia and its effects. The lessons apply in any context where individual actions spread their results out to the public at large. Indeed, the network conception offers a means to analyze all economic activity and its horizontal impact.

The structure of social incentives should be addressed in terms of horizon effects, since substitution joins with complementarity in the real world. As strong

arguments favor cooperation for horizontal growth, this supports some answers: if knowledge expands through integral linkages, and if action demands as much understanding as can be absorbed, then we need to work together. Recall Robinson's (1941, p. 241) statement that to know anything we must know all, though we can only address it in parts.

So the question no longer resolves by claiming substitution alone, divorced from complementarity. The balance between these two forms – being horizontal – offers solutions that open new doors for research. As social planning horizons extend, complements replace substitutes, supporting an evolution of institutions away from rivalry toward collaboration or this horizontal growth is stifled: discord triumphs over alignment as we drown in myopic concerns; such is the primary cause of ethical and ecological loss, climate decline and much other social malaise. This is the key to economists' failure: as Hayek (1937, 1948) complained long ago, we assume the prior existence of knowledge that is produced (or not) by the system, making horizon effects unseen through a neoclassical lens. The relevant issue is how our organizations shape planning horizons.

Seeing the world in terms of substitute tradeoffs suggests that we are rivals, so we act that way. Yet, if Kaldor is right that our basic connection is complementary, 'we have met the enemy, and he is us' (Kelly 1987). The canals show an example in all the bickering that occurred, defeating integration and displacing development options. Myopic cultures show adolescence, subverting growth through immature acts. How to reframe our institutions to help planning horizons is a question in need of an answer.

A mind open to new ideas and novel learning experience shall emerge from a cooperative frame, most especially in education. Imposing competitive values among complementary yields stifles output in these settings. Again, look at the harsh truths of academic communities in their rigid adherence to what is known at the cost of venturesome minds. The urgency of this situation is hard to overstate, given the issues and dangers involved. I wish I could say this more effectively, as we teeter on the abyss of extinctions (perhaps including our own). I have done what I could.

A summary of the six essays

The goal of these six essays is to present the case for a realistic concept of choice in economics. The first four were drafted three decades ago to summarize some of my thinking. In the intervening years, I have written many papers sketching a theory of planning horizons in diverse settings. I hoped to see other researchers pick up on these ideas, but to my regret this has not occurred. But these six essays seem worth sharing. Here I summarize what they say.

Essay I: Cost and invisibility

Essay One addresses the economics of cost and invisibility in its implications. The notion of 'opportunity cost' – that the *cost* of whatever we do inheres in the *value* of foregone options – has never been fully incorporated into economic constructions. Instead, an accounting concept of cost – the prices of inputs summed to a total – is claimed to serve as a proxy as such inputs compete with all other uses so will flow to their highest-valued deployment among those options. But this is not 'opportunity cost', which stands on unexplored actions so is both invisible to observation and theoretically-based. Trivializing our notion of cost even further by using it 'at the margin' – dodging all of the multidimensional issues involved in production – isolates students from understanding the actual world of decisions. *Caeteris paribus* simply ignores the fact that 'caeteris' shifts as well, leaving no theory on this. Selective focus is also – on the same order – restrictive blindness; we cannot see what we ignore outside our analytical lens.

Since we have no choice about choosing (at the expense of all we might do), we have no escape from our invisible opportunity costs. Our limits of vision are curbed because the effects of choice spread out forever, socially, ethically, ecologically and in all other ways. So if any act transmits to everything, how we frame matters. In all interdependent domains, our rational limits shape patterns of choice. Here opportunity cost is not just invisible but subjective: all cost, demand and supply curves are only imagined projections of options still unexplored. The sole point on these curves that we know is what truly occurs; the rest is speculation. This 'invisibility' is part of a realistic concept of choice.

Essay 2: The 'neighborhood store' and the 'chessboard'

Essay Two introduced two metaphors for economic activity. Standard theory addresses the process of choice as if in a 'neighborhood store', where options and outcomes are known without doubt, the passage of time is absent, and other people never intrude. We fix a budget to pay for goods to maximize our return in their use, equating the marginal value of dollars spent on each item we buy, yielding the biggest bang for each buck. That describes the result, but gives no insight to *how* it transpires. It also ignores some meaningful issues subsumed in any real choice.

First, wants and tradeoffs must be learned through confusion and error: knowledge is not just 'given' to us. Second, we live embedded in time where actions evolve from all those before and open new options ahead. Third, we do not act alone: nudged by others, reacting in turn, decisions are always engaged, dealing with outside disruption. The neighborhood store is certain, timeless and detached in these ways; it is an artificial domain in need of more realistic content.

The second analogy in Essay Two is the chessboard, driven by uncertain knowledge, irreversible options, and rivals' intrusions. So incomplete information, path-dependent temporal tracks, and social effects saturate chess in a manner absent from shopping excursions. The 'move horizons' in chess are closely akin to 'time horizons' in choice; they both consider a bounded range of awareness in terms of foresight.

But chess stops short of reality too, although less so than neighborhood stores. Its rules are more rigid than true constraints. We also rarely know what others will do, reacting to our decisions, until after-the-fact (if then); the instant feedback in chess is simplistic. Furthermore, relations in chess are rivalrous, seeking to win, unlike the usual landscape of action. Chess – though an improvement on shopping – is still unrealistic compared to real choice.

We need a unified theory including neighborhood stores and chess. We also require a fuller recognition of interdependence. Decisions' social, irreversible and uncertain nature is part of a realistic concept of choice.

Essay 3: Interdependence and choice

Essay Three looks at interdependence, where 'externalities' subsume social effects with three implications: first, that if outcomes echo forever, our rational anticipation is bounded by the scope of our conscience. Second, externalities are

ubiquitous and not exceptional; incentives should try to internalize spillovers. Third, nothing is additive, so simple summation fails. These three issues – limits of vision, externalities, and aggregation – arise with interdependence.

But once we accept interdependence, we need a systems analysis of value effects on others, spurring conflicts or concerts of interest through substitution or complementarity, akin to negative vs. positive feedbacks in that language (cf. Senge 1990, p. 79-80). With social relations subjectively context- and purpose-specific, these interactive factors are neither objective nor observed. Also, one person's substitutes may be another's complements, because of varying goals or locales. The overall frame is subjective.

The problem can be addressed in terms of a transportation network combining complementary end-to-end ties with substitutional (parallel) lines. This is like buying beer and wine for a thirst or a party in terms of either/or vs. both/neither. In transport, the nature of these relations stems from position and purpose. The difference has significant implications for institutional choice.

The question turns on the relative impact of integration and disaggregation: collusion decreases output through higher prices with substitution, while complementarity advocates in favor of full alliance. Spillover gains are also more readily captured than external losses; private incentives favor the former and try to avoid the latter. So we should design our institutions to feed back costs and trap gains, with more concern for the first than the last.

The point is one about *conscience*. There is an institutional limit to how well legality regulates social losses and gains, which spread like ripples in a calm pond. Their ramifications are also restrained by ethics in any culture. Myopic concerns – short-term selfishness – swerve from more expansive visions (such as enlightened self-interest) stemming from longer planning horizons. Any acceptance of interdependence subsumes substitution (negative feedbacks) and complementarity (positive loops), where the former recommends competition and the latter cooperation. Substitution best applies to short-term material goods, while complementarity emanates from intangibles and all long-term phenomena (cf. Jennings 2015b; 2019, p. 89).

The institutional implications are best seen in education; learning is a complementary process of mutual gain where no one loses and new knowledge results. In this setting, competition has counterproductive effects; students and

teachers suffer losses under rivalrous systems. Substitution assumptions do not pertain to complementary yields where opposition must fail.

When I was teaching, I illustrated this with two money auctions (cf. Jennings 2019, pp. 92-93). They showed tradeoffs in need of cooperation blocked by competitive forces. Students seeking gain did not see implications until too late. This situation is not unique.

Essay Three examines interdependence in terms of externalities, rational bounds, and aggregation. A transportation metaphor includes substitution and complementarity as alternative forms of economic connection calling for opposite organizational frames. Education exemplifies the latter, as do all intangible goods. The imposition of competition in a complementary setting causes strangely destructive effects on learning and planning horizons. Substitution is not our only form of economic connection; we pay a steep price for this one-sided view.

Essay 4: A horizontal theory of 'conscience'

Essay Four elaborates on a horizontal theory of 'conscience' as an ethical framework capturing our range of anticipated effects. We learn from patterns we see in the world, where understanding new things should be fun; we humans would not have survived otherwise. But novelty can be unwelcome, mutations maladaptive. These two attitudes often conflict, to urge or resist departures: understanding counts. If cooperation is best for learning, it also enables horizontal growth; our planning horizons show 'conscience'.

It is ironic that a moral philosopher such as Adam Smith (1776, p. 423) arrested development of our ethics with the 'invisible hand' taken to justify egocentric concerns (cf. Lux 1990, pp. 87-89). If value rises with specialization, trust is also required to rely upon others in trade: division of labor and coordination need to go hand in hand (cf. Warsh 2006).

The strength of conscience in a culture aligns social with private incentives, since short-term myopia obviates socially advantageous arrangements. How our systems support true learning is through cooperation. But if substitution and complementarity always occur together, we cannot untangle their contradictory organizational impetus. We need another approach.

Planning horizons are not a part of 'mainstream' economics, due to denial of falling costs. If any embrace of increasing returns (cf. Jennings 2015b, 2016a) spins into a case for complementarity (Kaldor 1972, 1975), unbounded interdependence suggests that awareness sets a bound on choice, supporting Simon's (1982-97) theory of rational limits with 'horizon effects,' which he related to conscience (Simon 1983, p. 107). But how we organize social incentives for longer horizons is still unresolved.

Substitution needs competition while complementarity yields collaboration for social well-being. Orthodoxy has substitution as our only relation; this is one face of a two-sided tale, as complementarity also occurs. The question is one of fundamentality: how important is complementarity vs. substitution in economic affairs?

If both are joined in every instance, how do we answer this question? One approach is through externalities: substitution implies opposition, while complementarity brings alignment; rivalry or reciprocity is the relevant choice. But if learning is complementary, cooperation is needed for an extension of planning horizons. The impact of competition on education is informative.

Here rivalry, wrongly applied to realms of complementary action, can do nothing but fail. The evidence is overwhelming: a scientific community devoted to information exchange opposes new ideas. Even interdisciplinary inquiries are discouraged, despite the need for broad understanding. To see as threatening what we don't understand in our temples of learning implies an urgent need for reform.

How we encourage horizontal growth through social incentive design implies that the way we think is important in determining our behavior (cf. Kelly, 1955, 1963, 1969; Earl, 1983ab; Loasby, 1976; as discussed in Jennings 2019, p. 82). Planning horizons supply a standard for assessing institutions on a claim that more understanding and greater cohesion is good. Learning will lead to horizontal growth through a self-feeding process of cooperation.

Competition has had tragic cultural impacts on our relations. Rigid dogma is symptomatic of a larger realm of effects surrounding us in social milieu: short attention spans, stubborn denial, a fear of the unfamiliar, all arise from pathological symptoms stemming from wrong designs in our institutional systems. As McGregor (1971, p. 317) once said: 'Fish discover water last'. We are so used to this behavior, it does not seem improper.

Planning horizons shall link 'conscience' to social cohesion, improving adaptive vitality in facing change and disruption. But models unfit to their realm bring failure. Competitive frames in complementary settings are counterproductive. Economists seem unable to see the problem because substitution is so embedded in our research. We must start the reform with a realistic concept of choice.

Essay 5: Institutions and interdependence

Essay Five addresses institutions and human relations. Substitution is not our only economic connection; complementarity also occurs. Kaldor (1975, p. 348) ranked the latter as 'far more important' than the former (cf. Jennings 2015b, 2016a). But both are entwined, leaving us all without institutional guidance, save for social planning horizons that shift together (more often than not).

If Kaldor is right, then cooperation is more efficient than competition; the issue is one of fundamentality: can we find domains in which one or the other rules? In networks, such distinctions are hard to draw, as subjective values prevail. Also, relations are contingent: horizontal growth tips their balance away from substitution toward complementarity, while myopia does the reverse. The implication is that efficiency attributes shift to cooperation with longer horizons. If institutions fail to adapt, horizontal growth is smothered by a myopic culture of competition, divulging its symptoms of social pathology: discord, denial, loss of faith and hope, political opportunism, malaise, strife, violence, etc., all of which surround us. Should we not ask why?

If we look at the impact of competition on economic activity, and – if Kaldor is right – we should be able to see this cultural loss in our social behavior. Horizon effects show in myopic concerns stuck in self-destruct modes. The signs of the problem are everywhere, revealed in ethical and ecological loss, climate decline, endless wars and persistent political strife, all of which abound. They are not due to 'human nature' but to wrong system design.

How we organize systems for longer horizons has not been examined by any other economist. But there is organizational theory on the alignment of goals (e.g., cf. Jennings 2009, pp. 60-67), and psychologists show how positive feelings enhance cognitive maps (cf. Frederickson and Losada 2005, pp. 678-81; Jennings 2015a, pp. 593-96). Institutions favoring cooperation expand our planning horizons, so make us all better off.

One of the costs of competitive frames is that we are not good at cooperation. Any abuse of authority yields pathological symptoms of 'frustration, failure, [myopic and conflict] terminating in rivalry, hostility and system collapse (Argyris 1971, pp. 262-69) along with signs of need deprivation, such as passivity, irresponsibility, and materialism. These symptoms are not due to 'human nature'; they are indications of 'illness' stemming from improper institutions (McGregor 1971, pp. 310-11). Cooperation encourages an extension of planning horizons; it also requires ethics and trust in a cohesive culture: this is the very high price we pay for rivalrous systems so wrongly applied. To work together insists on a common code that we all live up to and honor via cooperation.

These symptoms of organizational stress show up in a cynical loss of function in social behavior. Boulding (1968, p. 234) said 'a society is doomed' in the presence of rampant dishonesty, yet these dangerous signs of failure range across social life. What we need is a new horizontal economics of interdependence, subsuming competition and cooperation into a human ecology.

The example Lynn Margulis supplied delivered a paradigm shift from rivalrous struggle to symbiosis in our theories of evolution. She traveled a 'road not taken' (Frost 1979), challenging neo-Darwinists on their competitive view with symbiogenesis, spawning a new way of thinking about ecology. She encountered intense hostility, but eventually prevailed by insisting on real-world attention.

Substitution and complementarity yield a theory of planning horizons as a standard of system performance. Their balance is subjective, unobservable and horizontal, where growth shifts social relations toward affinity from opposition, calling for institutions to evolve from competition to cooperation in social systems design. The symptoms of organizational stress surround us in a myopic culture rife with threatening crises and dangerous signs of social malaise. Similar issues arose in biology; neo-Darwinist doctrines supported competition in evolution until they were proven wrong. Economists should take heed; this situation is much like our own. A novel research program in horizontal economics emphasizing cooperation is needed.

Essay 6: A research program for economics

Essay Six concludes this series with an appeal for a new horizontal research program in economics. The two forms of interdependence suggest a problem of institutional choice resolved through horizon effects: the more extended our planning horizons, the more productive will organization be, regardless of other details. In other words,

if any system promotes horizontal growth, its efficiency will improve over a more myopic culture. This is why social systems design is so critical for our growth and ecological health.

The use of 'horizon effects' as a welfare standard for organization demands an understanding of their role in pricing and growth (cf. esp. Jennings 1985, 2005, 2006ab, 2008a, 2009, 2012ab, 2016bc, 2017ab). The British canals suggested this story in the anomalous situation of increasing returns, public goods, large initial investment, and high fixed but low marginal costs, within an integral network connecting the whole economy. This setting was more like an ocean ecology than any orthodox market, demanding a fresh analysis. The history opened the question of why myopic concerns stood out, slowing advance in an age of growth.

These canals were doomed from the start: investment manias segued through a Carriage Restriction that disarmed development. The abuse of approvals to block new entry yielded a quick collapse, instead of all three modes surviving together: roads, rails and canals. Seeing each other as rivals set the stage for needless strife; this story is much like our own.

We all inhabit social incentives that check and direct our behavior in diverse ways sensitive to intentions, settings and knowledge. As understanding grows, so does our range of awareness and conscience, though we all differ in how we evolve. As we grow, we are shaped by incentives surrounding us through what we see and do. How well these sundry inducements serve our ambitions shall impact our planning horizons, for better or for worse.

The route to horizontal growth is through learning in a cooperative frame promoting ethics and trust. The process of information exchange – indeed, the sharing of any intangible like joy, a smile, love, faith, and truth, for example – is self-feeding in its effects. Such is a realm for integration; division is doomed to fail. An ecological system is similar; all of its parts sing together. Indeed, any decision we make calls on everything known (though it is still never enough). This is why competition in education is so destructive; fragmented understanding closes off any open analyses, cementing us into exclusive blindness within any one view. We learn best together, when knowledge is shared and diversely encouraged.

The symptoms of a myopic culture result from rivalrous systems. They include ethical and ecological loss, climate decline, hostility, incivility, conflict, despair, rage and disappointment. Collaboration will lead to a happier realm of feeling

connected, dispelling our isolation. Mutual learning will offer renewed diversity in the knowledge we need for all the problems we face. Substitution is an exception; complementarity is 'more important'. To understand and embrace the implications will take courage and trust.

A useful approach is to examine the failures of competition. If interdependence involves a balance among consilience and opposition tuned by horizon effects, we should see symptoms of organizational stress where rivalrous systems are wrongly imposed among complementary yields. We have focused on education; enough has been said about that. Ecological systems are also inherently complementary, in which each part is important; to fragment them erodes integrity: we must treat them as 'a package of elements all of which need to be there' (cf. Nelson 1981, pp. 1053-55). This is the nature of ecology: selective focus should not distract us from exclusive blindness; no view ever reveals its shadows. Such is the case for an open mind.

These essays call for renewal through a horizontal economics standing on network conceptions of interdependence. Such implies that tinker-toy models set outside the flow of time may deter as much as enlighten. Georgescu-Roegen (1970, p. 1) noted that 'a basic requirement of science [is] to have as clear an idea as possible about what corresponds in actuality to every piece of our symbolism'. Margulis advised us to set aside books, exit the classroom, and study the world to understand its secrets. She changed a whole field to a new way of thinking grounded in cooperation. This is precisely what is needed in economics today. Our rivalrous systems in academics stand for what is known against dissent and departure, regardless of right or wrong. But as Rescher (1979, p. 102) so wisely observed: 'The proof of the theoretical pudding must, in the final analysis, lie in the applicative eating...' Horizontal theory emerged through an inductive view of history; it has been verified over and over again through personal observation in widely diverse settings. But more research is needed to understand its overall scope.

Essay Six shows how horizon effects serve as an ordinal welfare standard for complex organizations (Jennings 2016b) in the sense that Boulding (1962; also cf. 1966) called for in his seminal work. The story of British canals supports a theory applied to any network: ecology, international trade, transportation, communication and society overall. It offers some meaningful lessons about the impact of institutions on the unfolding of real-world events; substitution assumptions used where they do not belong create a myopic culture in self-destruct mode threatening civilization. If we as economists seek to improve fellows' social well-being, we must

turn our attention to what we have wrought by our narrow-minded devotion to dogma. A good place to start is with a shift in favor of complex interdependence, in a movement toward a more realistic concept of choice.

Endnotes

[1] 'Six Choice Metaphors and their Social Implications' (*JPE*, II:2, Spring 2009); 'A Theory of Planning Horizons' 1-2 (*JPE*, V:2 and VI:1, Spring-Autumn 2012); 'The Case for Increasing Returns' 1-2 (*JPE*, IX:1-2, Autumn 2015 and Spring 2016); and 'Planning Horizons as an Ordinal Entropic Measure of Organization' (*JPE*, X:1, Autumn 2016).

[2] A minor personal anecdote: many years ago, when I approached the Harvard Economics Department undergraduate advisor to propose a senior honors thesis comparing the methodological issues behind Friedman's and Chamberlin's views of competition, I was told (in my senior year) that I'd have to change my major from Economics to Social Relations, because 'Economists do not do methodology!' I encountered very similar arguments as a graduate student at Stanford when proposing to do a Ph.D. dissertation on this subject. Why is raising questions about the established approaches so unwelcome that such is forcefully being discouraged? An answer is proposed in Jennings (2015b).

[3] Many of these sources are identified in the bibliographies from my previous papers cited in the References here.

[4] Much of the discussion and insight in this section is drawn from and based on a brilliant documentary film by John Feldman (2019), which I have viewed very intensively as a superb and exhaustive source of vital information.

[5] On 7 February 2017, Senator Elizabeth Warren objected to the confirmation of Jeff Sessions as Attorney General by reading a letter written by Coretta Scott King about his repression of civil rights. Senator Mitch McConnell didn't like what she was saying and repeatedly tried to have her ruled out of order, complaining that: 'Nevertheless she persisted'. This statement has since become a feminist rallying cry in America. More about this story can be found in Wikipedia.

[6] My principal Ph.D. thesis adviser, Paul David, had been urging me to abandon this 'theory stuff' and just focus on the economic history of the British canals. But I was not willing to walk away from what was likely the most exciting idea I would

ever encounter, as the price of an academic credential that – in this event – would no longer have value to me. I saw this 'theory stuff' as important (and still do). Indeed, it all appears so obvious to me at this point, I wonder why other economists seem unable to see it in this same way...

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