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

Frederic B. Jennings Jr.

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Abstract: These essays were originally drafted 30 years ago between 1988 and 1990, and then they were filed away and rediscovered just this year. They represented an attempt to offer a simple and unadorned version of fundamental issues in economics pertaining to our urgent need for a realistic concept of choice on which to found our constructions. The first essay introduces the notion of ‘opportunity cost’ and our use of *caeteris paribus* in the process of partial analysis. The second essay offers two metaphors for economic behavior: the ‘neighborhood store’ where virtually all neoclassical choice occurs; and the ‘chessboard’ that opens three issues simply ignored in orthodox settings. The third essay addresses the problem of interdependence, since choice in this setting confronts our range of awareness as bounded where outcomes spread forever with externalities everywhere, ruling out additivity.

Keywords: choice, cost, neoclassical, competition, ethics, planning horizons

Introduction

These three essays were originally drafted 30 years ago between 1988 and 1990, and then they were filed away and rediscovered just this year. They represented an attempt to offer a simple and unadorned version of fundamental issues pertaining to our urgent need for a realistic concept of choice on which to found economic constructions. So, these essays serve as a precursor to my subsequent work, including six previous papers in the *Journal of Philosophical Economics*[1].

The first essay introduces the notion of ‘opportunity cost’ and our use of *caeteris paribus* in the process of partial analysis. The ‘marginal’ notion of adding one unit of output dodges the complex array of managerial choices involved in producing goods and services, so oversimplifies students’ grasp thereof. An inherent ‘problem

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of invisibility' – that we can never know nor test the impact or value of foregone options – supports a case for open-minded discourse in economics, as does the selective focus – so the restrictive blindness – of theory. As we have no choice about choosing, we must act on incomplete knowledge; our relations of cost and demand are subjective projections of forsaken choice that we cannot know with certainty in our realm of personal understanding.

The second essay offers two metaphors for economic behavior: the 'neighborhood store' where virtually all neoclassical choice occurs; and the 'chessboard' that opens three issues simply ignored in orthodox settings. In this shopping analogy, options are known, time is absent and no one else is involved, while in chess alternatives shift through a series of moves shaped by rivals' reactions. So a chessboard is a more realistic context of action than neighborhood stores, although actuality is still underserved in a totally interdependent domain of irreversible time and unbounded effects.

The third essay addresses the problem of interdependence, since choice in this setting confronts our range of awareness as bounded where outcomes spread forever with externalities everywhere, ruling out additivity. Here economic connection occurs in two forms and not just one: tradeoffs are offset by mutuality; conflicts by concerts of interest; scarcity by abundance; and substitution by complementarity. A 'transport network' captures such a balance to open neglected institutional questions of competition or cooperation as means to well-being. If all we do affects everything, then the bounds of reason, conscience and ethics – our planning horizons – shall matter. To the extent that complementarity – concerts of value – reign as supreme, competition undermines and does not enhance social welfare; cooperation is sought. This story entails some meaningful links into an ethical theory of planning horizons in economics.

Essay 1: Cost and invisibility

We economists tend to think of our subject as 'scientific,' in its substance and mode of analysis. In other words, economics is seen as a logical process of inference from *observable* facts 'out there' in the world, devoid of personal elements and the observer's own beliefs. If only we had better data, a more precise model, faster computers, etc., we could determine the policy measures sure to resolve our ills. So, we attempt to improve our statistical inputs, our processing frameworks and tools, ignoring issues suggesting that economics is not so objectively grounded.

Indeed, economists seem well-rewarded for promulgating the myth that economics is scientific prediction; we are, after all, 'professionals' serving a market desirous of foresight (but cf., e.g., Jennings, 2015c). It is not surprising, in light of all this, that any misgivings are slighted: our clients – students, business and government – are in the market for *answers*, not for doubts or intractable questions. There also is safety in numbers; if our predictions stray from results, we have something to blame ('inadequate data').

The notion of 'Cost'

One of these underserved areas is in our representation of *costs*. Early on in our theory courses – especially at introductory levels – the notion of 'alternate' or 'opportunity' cost is introduced (cf. Robbins, 1934; Buchanan and Thirlby, 1981). In choosing an option, its 'cost' is the *value* of what would have been pursued otherwise, namely, the worth of the 'next-best foregone alternative'. If we choose well, the value of what we select exceeds that of what we forego: we 'profit' when 'worth' outweighs 'cost'. This notion of cost is centered on *choice*, a dynamic ongoing *process* (Buchanan, 1969; Simon, 1976).

The problem is, when we get to supply and production, dynamic concepts of cost are reframed to adhere more closely to what *the accountant* treats as 'cost', i.e., as the value of inputs consumed in production, measured at their market prices. This is presented as an 'opportunity cost': the value of inputs consumed in production equates to their worth in some 'next-best' activity through a process of free market bidding for use and disposal thereof. Appreciate, though, that this is a much-narrowed definition of 'cost.'

For 'marginal' output decisions – whether to sell one more unit of output or not – this method has certain appeal: it does not require a study of features unchanged at the 'margin' defined. The problem arises when this simple picture – of how output levels are set at some 'margin' – displaces all other more complex dimensions of entrepreneurial action: then the approach oversimplifies the process of real-world decision. Managers have a more difficult task than deciding on output in otherwise stable and well-defined business environs. That legions of students over the years have absorbed so naïve a portrayal of business decisions has surely affected their understanding and views on the freedom or regulation of firms in market economies (e.g., cf. Friedman, 1962). Sometimes even advanced economists seem to exhibit these same misconceptions.

The caeteris paribus assumption

Some of the trouble lies in our use of the *caeteris paribus* concept. The actual world is far too complex for examining all of its aspects at once in a model or representation thereof. [2] Alfred Marshall a century past introduced the method of 'partial' analysis, in which a subset of relevant tradeoffs stands as our object of focus, stating explicitly 'all other things' to be constant or 'equal' to their prior state. Though 'partial' analysis so conceived is inherently incomplete, it allows the economist to identify (in isolation from other effects) certain relations seen as *essential*. Its original aim was not to avoid, but to *focus* on fundamentals.

Before the output of firms was shown to involve an equality at the margin (of 'marginal cost' to 'marginal revenue' at 'maximum-profit' sales across a wide range of market conditions, namely, $MC = MR$), the output of firms was quite properly deemed an essential question to be understood. Now, when its answer is so well established – *too well* established, detractors suggest [3] – there is a growing and urgent demand to expand our vision of entrepreneurship, if not of all human action in general, beyond this simple conception. Managerial effort involves so much more than determining firms' output levels (*caeteris paribus* for their production techniques, product designs, marketing plans, etc. *ad infinitum*), that to treat this simplistically as $MC = MR$ for maximum profits seems irresponsible in its neglect, if not overtly unscientific (e.g., cf. Nove, 1969, pp. 850-52; Malmgren, 1961, p. 419).

The complexity of management choices

Even the briefest synopsis of a much larger range of issues assailing – at times exhausting – management talents shows how neglectful economists' textbook treatment of firms appears in such light. In any production process a set of techniques and procedures evolve into place which – once properly learned (or not, depending on training and hiring quality) – are not easily altered once systems and work habits seep into practice (cf. Nelson and Winter, 1982). The same applies to organizational forms and management styles; routines and designs are most readily changed *before* their implementation (e.g., cf. Jennings, 1985). Plant location, their numbers and scale; the decomposition and specialization of functions; assuring supplies and markets; all of these matters involve initial commitments with lasting effects. What types of product effectively match firms' specialized skills to the needs of buyers, now and into the future? How might consumers' awareness be nurtured, and complementary goods be developed, to open and capture a niche in the market

against all rival contenders (cf., e.g., Richardson, 1959, p. 234)? What is the proper balance of current profits to future sales, or stockholder payouts to capital needs? Every one of these problems and tradeoffs is solved in some particular way by every market transactor, with outcomes unclear in advance so requiring constant attention and adaptation. To represent firms without any sense of these subtleties seems to ignore their essence and misstate vulnerabilities. The notion of 'opportunity cost' means more than additions to output.

Adding a unit to output is so straightforward as to be trivial in comparison to any one of (much less the full complement of) these decisions, whose central aspect is that they are *irreversible*. In such realms our *personal* influence – which is too widely ignored in this 'science' – seems to appear with a special intensity. Once our world is seen as embedded in irreversible time, where every decision ramifies onward forever affecting all subsequent choices (as binding constraints or allowing conditions), our actions cannot be abstracted away from their agents' uncertainly held preconceptions. We do not choose between outcomes but only among *imagined projections*, we always act on *belief* about the results of what we might do and their value (Jennings, 2009b, p. 35, 2015a, p. 594). A proper recognition of this shall affect our image of economics in its 'scientific' endeavors.

The problem of invisibility

When choices are made among complex entities, simple models of output fall short as do nicely reversible graphs. Indeed, the process of choice is more properly seen as a consummate act of *projection*, a stretching of theoretical inference drawing on all one's imagining skills and knowledge of how things work. A definition may help: *the process of choice is a normative process of multidimensional causal projection* (Jennings, 2009b, p. 38). Its central traits are imagination and evaluation thereof. To choose involves a commitment to one's understanding of *how things work*. 'If I do this, then that will occur.' It also requires a proper assessment of *how one feels* about outcomes: 'This result I will like a lot better than that one, in terms of my goals.' Knowledge of self and the world are a part of effective planning and action.

But in a seamless world of complexly interdependent relations (Myrdal, 1978), specialized training carries a price. The impact of action is general and radiates outward through every dimension. Only our vision is bounded (Simon, 1978, 1979, 1982-97; Jennings, 2006b, 2008cd). We cannot see what awareness is needed for choice in advance of effects. If so, we should not be confined to

prefigured disciplines; often the latter's restrictions seem more of a problem than any advantage. The causal impact of action is never so kind as to work within predisposed bounds. One must stay open to everything, and expect to be surprised (Shackle, 1953).

Worse, if the 'costs' of whatever we do are the 'value' of *what we choose not to pursue*, we are doubly barred from their measure. First, we cannot directly *observe* the results of actions shunned; foregone outcomes are simply untestable in their projected effects. Second, even an 'arm's length' observance would not be enough for measuring 'cost': one must also intuit what each projection would 'feel like' *to wear*. Assessing the 'cost' of our actions sensibly accesses every personal skill; it brings into play all of our understanding and normative expertise. We must be right in our causal relations *and* their emotional impact. This is a very tall order.

So we have an ongoing problem: whatever we do, we do at the cost of everything else we might do, in all its potential unpursued 'value.' We only 'profit' when we choose the 'best' of all conceivable options; otherwise 'value' will not exceed 'cost'. But we cannot see – nor 'feel' – our costs, since foregone options only 'exist' in the mind of the choosing agent, at the moment the choice is considered. That makes 'cost' ineluctably *personal* and wholly *unobservable*.

This is an insurmountable limitation: I call it 'The Problem of the Invisibility of Unexplored Alternatives.' If we never see what we miss, we lack any data for measuring costs. Costs – in this sense – are only imagined, as theoretically-based projections appraised in normative terms. The point is, there remains infinite room for confusion and error in making decisions.

The necessity of choice

One might object to all this complexity, arguing that were it really so hard as I claim we would never make choices at all! But we do not have that escape. We have no choice about whether we choose; we choose on an ongoing basis. Indeed, whatever we do – and while we continue, we 'do' all the time – we impose 'costs' on ourselves (and neighbors, perhaps) of all other foregone options. We cannot choose 'not to choose', and do not avoid 'opportunity costs'. The only thing we can do is *to try* to make choices as well as we can. We never have 'perfect foresight', as so many economists seek to presume. Indeed, in a totally interdependent world of volitional action, it is precisely our *limits of vision* that direct and channel our choices (Simon, 1982-97).

So many economists seem to assume attention is a 'free good' – that cost and demand curves, even all options, are known – that the burden of fallible understanding (even where information abounds) is seldom explored or acknowledged. But where attention is scarce, it is trained *selectively* which involves *choice*. In other words, we have no option but to perceive the world through a focusing lens. And our only access to what is ignored thereby is to use some alternate lens, where each has its own emphatic commitments. Just as we lack any choice about choosing, we have no escape from a specialized view. And every approach is implacably blind, outside its singular focus. With theories always selective, each has an 'opportunity cost' that is only addressed through *another perspective*. Any particular outlook is silent on what it dismisses as 'nonessential.' Unexplored options are always invisible, in both theory and fact. Our only protection from blindness is an open mind with multiple views (Jennings, 2008b).

Incomplete knowledge and choice

How does selective focus in theory affect our problem of choice? If we choose among *imaged projections* and if these images are *incomplete*, and if we never can *test* what we do not pursue in theory or action, how we *conceive* our options assumes a decisive importance in how we behave (cf. Kelly, 1955, 1963, 1969; Earl, 1983ab; Loasby, 1976). None of this is surprising except in its contrast to how economics has structured its primary image of choice: as simple maximization of 'value' with known constraints and causality. Only with human attention unbounded and tradeoffs securely perceived would this be a proper model of choice. But were such assumptions realistic, we would not need science at all! How one should choose would be obvious, and determined by our situation and wants – as much economics supposes. Incomplete knowledge is the most essential limit on human decision (cf. Hayek, 1937).

What I have said thus far is only a part of the problem of choice. It seems to me that devising a realistic concept of choice is so fundamental to all economic constructions that it should be our top priority. In its absence all other analysis in this field is suspect. The effort demands a rethinking of how our established conventions selectively banish some major essentials from view. One is that choices are made by imposing our *personal* values on artifacts of our creative *imagination* (Boulding, 1956; Polanyi, 1958). Another is that these mental constructions are *incomplete* and *invisible*, save that those which are chosen can be indirectly tested after the fact. Third, *how we think* about choices and tradeoffs is central to how we decide; our

models of thought are as much a part of the process as goals and constraints (ends and means) (cf. Kelly, 1955, 1963, 1969; Earl, 1983ab; Loasby, 1976). Without an epistemological theory of how we perceive and frame options, we end up posing a theory of action that fails to assume we are conscious at all! [4] It may be that most of our 'freedom to choose' stems from how we figure rewards.

A pricing example

An example at this point should help. What I have said is that costs are *subjective* and *personal* in their assessment. Our choices are made among imaged projections of what we believe will occur doing 'this', or if we do 'that' instead. In choosing, we make commitments to causal connections and internal feelings thereon. The only matter of choice we have is on *how well we think* about options, and on how far we project their results (Jennings, 2012ab).

Say I intend to produce a new item for sale in an undefined market. One of the earliest questions in need of response is my *scale of production*: before I fix on a plant design, I have a wide range of options. However, I cannot avoid a specific commitment to output technologies. Often the probable level of output is not my only concern: I may encounter a tradeoff between *lower cost* and *adaptability* (cf. Marris and Mueller, 1980, p. 44; Scitovsky, 1980, *passim*). (For example, a mechanized plant may produce one thousand units per hour efficiently yet cannot easily change output rates. Or I can build for more flexible sales at higher costs per unit. Which plan is chosen depends on how stable and certain my market appears.)

The probable level of output – and thus the scale of production I choose – is also related directly to *price*. All these decisions are made (if unsurely) together in my early plans. Initial sales and their potential growth are results of my pricing and product decisions, based on both my expected costs and the profits I need to survive. Do I price low for high growth, or take early profits without the expansion (Margolis, 1960)? My actions are all of a piece and they will affect my ongoing options.

Expectations shape the whole process: the plant I construct and commit to; what are my unit costs, markups and prices for this scale of output; how I should market this product to realize growth and investment potentials. Furthermore, each of these choices affects how every other unfolds. *Caeteris paribus* only applies after all these commitments are made, when price is the only matter at issue as cost and demand curves are already known.

Say I have now reached that stage, with a plant – thus a cost curve – and known demand. Appreciate that my sales are responsive to everything else in the market affecting consumer resources and wants. *Caeteris* still is not *paribus* save for my anticipations of price. Indeed, that is the primary context to which this method applies: the issue of what my sales should become with my price set at some other level. Unlike in our textbook conception, *I am not sure* what consumers would do in this case. I only know what occurs; the rest of my current demand curve is simply invisible, as with all unexplored options.

Cost and demand are subjective

So, what, then, is a 'demand curve'? Does it have any use in our explanation of pricing behavior? Yes, it assuredly does. In order to know what we do, we need to project alternative outcomes. Surely an estimation of how other prices would influence sales is included in my assessment of tradeoffs. Since sales affect costs and all other projections, such should be closely examined in terms of controllable causal determinants (such as marketing efforts, product design, consumer beliefs, etc.). Their relation to price is a part of the process of multidimensional causal projection involved in all choice. Setting a price involves an imagined depiction of 'market demand.'

Note, however, a main implication. This 'demand curve' exists in only one place: in the mind of the price-setting agent (e.g., cf. Loasby, 1976; Shackle, 1978). It is in no way inscribed on the face of reality or explicit. Indeed, just how it is structured by us (e.g., in the range of attention span used) is important: a far-sighted (long-run) demand curve will always be flatter (with greater responses, smaller markups) than any more myopic (short-run) demand curve (cf. Clark, 1940, pp. 241-43, quoted in Jennings, 2015b, pp. 13-14). As long as our textbooks ignore the epistemological status of cost and demand curves, they disallow any place for a theory on how these abstractions evolve. It may be that there are unexplored avenues of understanding in this situation.

Conclusion

A full recognition of what I denote as 'The Problem of the Invisibility of Unexplored Alternatives' shows a number of implications. For one, if everything other than what we are doing – especially future contingencies – must be inferred uncertainly from our understanding and feelings, then notions of cost – not

to mention demand – should not be conceived as objective in nature. They are imagined projections of otherwise wholly invisible options, stemming from *personal* views and desires (Polanyi, 1958). Also, these curves are reliant on theory, in all its selective variants; how we derive our relations of cost and demand is a part of the story (cf. Kelly, 1955, 1963, 1969; Earl, 1983ab; Loasby, 1976). Epistemological explanations are needed to probe our reactions to change (Boland, 1982, 1986); their absence from mainstream models makes such economic constructions suspect. What we need to develop is a more realistic concept of choice. This essay opens some thoughts in that vein, deserving of further extension.

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

In any established science – and certainly in orthodox economics – there exist generalized metaphors setting the style and approach of research in the subject (cf. McCloskey, 1983, 1985; Klamer et al., 1988). This is nicely exemplified by economists' image of choice. My essay argues that economics should change and develop its notion of choice in a much more strategic direction, to bring out important dimensions of action and thought.

The trouble is that *every* analogy has its specialized emphasis. If there are relevant tradeoffs beyond economists' dominant image of choice, issues of substance may be neglected over the range of its use. If these omitted distinctions affect the patterns of research endeavor, a science may thereby ignore or just not develop important dimensions of thought. Then new metaphors ought to be tried, with different emphatic commitments. Such shed light on these otherwise underilluminated details.

Choice in the 'Neighborhood Store'

Standard theory addresses the process of choice as a valuation of fully known outcomes against some resource constraint defining accessible options. Such is ingrained throughout economists' studies of consumer choice, producer supply and market transactions. The basic image is that of an individual in a neighborhood store, reviewing known options and purchasing items within a fixed budget constraint (Jennings, 2009b, pp. 36-37). The focus is on goods selected, derived from maximizing utility subject to income and prices (*caeteris paribus* for other aspects).

Here our representations of choice involve familiar alternatives – 'Should I buy Raisin Bran, Corn Flakes or Oatmeal (given my tastes and financial resources)?' I am assumed already to know every option along with its virtues: the only matter at issue is how best to gain the most 'value' per dollar in hand. All of my wants are consistent; they are not torn by conflicting desires and do not change relative to other things, such as prices and budget constraints.

Choices – seen thus – satisfy an orthodox standard that at 'equilibrium' marginal dollars return equal value across every item bought by consumers. This is *almost* tautology in a perfectly flexible world, as were one able to get more 'bangs from a buck' by spending it differently, surely one would! Optimization assumes that we always select our 'best' option in choice; the emphasis in the analysis is on this 'equilibrium' outcome and how it changes with prices or income. Most of orthodox theory involves an unfolding of these implications.

Such is often enlightening and deserves our careful attention. However, this image's strengths have been overly touted, displacing awareness of fundamental lacunae inherent therein. To see these shortcomings, one must move from this image into a larger perspective on choice in its sundry entailments.

The limits of 'Neighborhood Stores'

Choices suggest a weighing of tradeoffs, such is undoubtedly true. Indeed, the essence of economics is often defined as a confrontation with scarcity, in the sense of frugal means to unlimited ends. But treating all choice as like shopping in neighborhood stores circumvents some meaningful lessons. So have certain things stayed undeveloped and other effects undiscovered, due to this sorely inadequate image. Three of these issues are outlined below.

First, desires and tradeoffs don't just appear full-blown and consistent: wants and effects are painfully learned, too often by facing one's self-contradictions. Shunning internal confusion and conflict denies psychological issues exist that are relevant to economics. If '*homo oeconomicus*' is not uncertain, he is unreal. Ignorance seems so widespread, to avoid it is unscientific. At best this tactic constricts our relevant applications to those of least use. After all, our need for theory arises specifically from our unsureness (Hayek, 1937).

A second topic deemphasized in the orthodox image of choice is *time*: the impact of earlier actions on current decisions along with their future effects is absent

in 'shopping excursions.' Such choices are each distinct and complete; there is no sequence, commitment or irreversibility here. Instead we are rapt in the moment, our past immutable, futures wide open, without a connection between them. There is no sense of an ongoing causal *process* in this view; as such, the analysis so construed is unalterably *myopic* (Shackle, 1953, 1978; Boland, 1978; Hicks, 1979; Currie and Steedman, 1990).

There is a third important dimension not present in 'neighborhood stores': the objects of choice are *physical* and undisturbed by human intrusions. Yes, at times goods sell out and become unavailable, but this is rare. The world depicted is safe and predictable; others' reactions do not affect outcomes. Here I get what I opt to acquire, and all our results are known. That most decisions are made in a *social* setting, with outcomes shifted by others – so uncontrolled and indeterminate due to volitional choice – is rarely acknowledged in orthodox science (Clark, 1940, pp. 451, 457). Some models seem to ignore altogether man as a conscious agent; there appears seldom much interaction of people in neighborhood stores. Social involvements suggest a different approach to the process of choice.

What we need is a notion of choice embracing each of these issues: incomplete wants, irreversible time and socially sensitive outcomes. Such shall involve an alternative view of action with its own limitations. Such outlooks need not be rivals; indeed, my endorsement of multiple views suggests their complementarity. In other words, what we've learned of choice in 'neighborhood stores' shall be usefully opened by looking at 'chessboard' decisions.

The process of choice on the 'Chessboard'

How we decide in chess is strategic and always unduly contingent (Jennings, 2009b, pp. 37-40). Unlike in real life, where rules are plastic and subject to interpretation – as all legal, ethical, cultural and institutional laws should be – chess is highly constrained by allowable moves and tradeoffs that can be foreseen. Thus, one ought to retain an awareness that chess oversimplifies action, if not as grossly as 'shopping' analogies do. Chess embraces complexity, but in somewhat too well-defined ways: it still understates the potential indeterminacy of real actions, such as in oligopoly markets and other interdependent domains.

What are the primary aspects of a decision process in chess? [5] How will they illustrate issues excluded from mainstream models of choice? First, a utility function is absent; there is one goal – to win – and that is constrained by the rules of

the game. However, the problem of *incomplete knowledge* is central to this endeavor: the issue is not the end but the choice of means in a fluid environment where every action determines all subsequent tradeoffs. Such adjust to one's own decisions, but also with others' responses thereto. Each move vitally rewrites the game in its openings and constraints; chess is played on a shifting ground of ever-evolving options. All are also assessed in the light of a rival's expected response. Indeed, when experts contend, opponents' psychologies stay at the forefront: the course of one's own play is strongly attuned to contestants' standard techniques. Such is most – but not all – of a game whose substance is always strategic.

A second thing excluded in normal economic conceptions is the sequential limit on choice stemming from *irreversible time*. Most of the planning in chess is specifically aimed toward this problem: as noted above, each move opens up and erases subsequent options, such that these shifting tradeoffs in chess are really the primary objects of play. My definition of choice as *a normative process of multidimensional causal projection* is especially relevant here; the range of projection – the planning horizon (at least in its span over time) – is nicely analogous to the number of moves ahead a player can plan. Were our attention not scarce, all possible outcomes should be considered (in all of their awesome extensive variety). Instead, the challenge and draw of chess stems from how it stretches our reasoning power to its analytical limits. And there is no ratiocinative framework contrasting experts and tyros; only a slowly accreting experience serves to increase skill. Learning arises from *practice*, and not by invoking rational logics. The 'feel' of the game becomes art, defining an overview of its 'pattern.' Worse, every context is special, unique, and never repeated: just like the options we face in all choice. The 'chessboard' depicts every act as original, opening always anew without recourse. Such shall never be central to any decision in 'neighborhood stores.'

Perhaps the most difficult aspect of chess is that all of its planning is *social*, i.e., that decisions do not produce outcomes directly but only through *others' reactions*. Every set of projections embraces a wide open range of contingencies, such as: 'If I do this, and he does that, then I'll have the following options ... *but* ... if he responds thus, then I will be forced to a loss of my overall gambit.' In just such a way imagined decisions are scanned to assess their possible impact on present and distant tradeoffs. Immediate to all projections stand the expected reactions thereto, and how well opponents' moves are predicted (Clark, 1940, pp. 451, 457). Indeed, it is really the number of 'near-move contingencies' and both players' abilities that determine the range of projection (or 'move horizons') achieved in a game. Masters – opposing

their equals – shall plan a lot further ahead than when playing with duffers: first, they must do so to win; but second, dumb moves are ruled out so attention need only articulate fewer responses to each and so more can be seen in advance. All this suggests that planning horizons are relevant to our performance, and that our individual ranges of vision are intimately interactive (Jennings, 2009b, pp. 44-48).

So how would a 'chessboard' analogy alter economists' image of choice? My first concern – with incomplete knowledge – emerges as central to chess, in contrast to shopping in neighborhood stores with options all known and fully-projected. Second, repeatably open choice among goods in a market is now replaced by an uneasy anticipation of irreversible outcomes cemented in place, affecting all subsequent options. Third, the arena of action is social and not just of physical things; secure results are replaced by contingencies subject to others' control. I would argue a 'chessboard' metaphor is more realistic than 'neighborhood stores'; the former offers a vantage on how restrictive the latter appears. However, even the 'chessboard' affords but a pale reflection of real-world decisions; it drastically oversimplifies several dimensions of actual life.

Assessing the 'Chessboard' analogy

The obvious (already mentioned) drawback of chess as a generalized image of choice is that it defines a too-rigid array of constraints in its structure of play. In actual legal, ethical, cultural and institutional settings, system designs are more fluid, often tacit and always subject to change (e.g., cf. Boulding, 1968). In actual head-to-head choices – like chess symbolizes – the planning conundra are difficult due to the absence of well-defined rules. The range of projected decision is vaster, relative to any game.

Managers also will not often know what opponents' responses have been until long after each has committed to actions that – better informed – might not have been taken. Instead of denying our dissonant efforts – screening them through assumptions of 'perfect knowledge' or 'purely competitive' forms – our understanding of markets is better served by a concept of 'planning consistency.' Hayek claimed long ago that the goal of economy is *social coordination of individual plans* (Hayek, 1972, pp. 50-52). To the extent that social incentives encourage compatible human endeavors, so will our individual aspirations succeed with less effort? Waste and unresolved discord denote a failure of system design in the nexus of interdependent decisions.

So one limitation of chess as an image of choice is its *specificity*: the framework of action is structured too clearly in definite rules of play. Real-life decisions have fewer restrictions on how our games should develop and on what defines successful endeavor. If we impose a spectrum of realism on our two models of choice, it is clear that in most situations our actual options seem *more* complex than in chess, rather than less (as in neighborhood stores).

Another reflection of this implication is that there is *instant feedback* in chess about one's opponents' responses. In a real choice, as noted before, reactions are often unknown or seen incompletely long after commitments are made. Thus incompatible efforts at times stray far from what they would be were all agents aware of each other's endeavors. There is no overlap between decisions and no informational lags in chess; so once again, the setting is more controlled and defined than in actual life. The 'neighborhood store' is so artificial compared to the 'chessboard' depiction of action that it does not treat time or sequence at all.

A strength of chess as an image of choice is its emphasis on *irreversible action*; tradeoffs evolve from prior relations which shape ongoing options. Although causal linkages are better known and more tightly bound in chess than in life – less subject to undue upheaval – their continuity offers some much-needed insight on orthodox static constructions. Nowhere in 'neighborhood stores' shall actions slide out of the past to their future effect on options still unencountered. Chess simplifies this sequential process enough for *us* to perceive it. Yes, we always inhabit the present, but choices are not so constrained. There is a need in economics for a theory of *planning*.

The *social* dimension of chess suggests a different domain of analysis than that depicted in shopping analogies. Economics has always maintained an ambivalent attitude toward choice, since if we admit to volitional action our models cannot be predictive (Hutchison, 1981, pp. 253; McKenzie, 1982, pp. 3). Forecasting is our chief output; we do not generally bite our providers' hands by attacking the product they purchase (from us)! But if the results of our actions are always subject to others' intrusion, knowledge is not so easily gained as our orthodox standards would have us believe. Instead, the interdependence of choices in time and across individuals should be seen as a fundamental constraint on all economic effects (Nove, 1969, pp. 850-52; Malmgren, 1961, p. 419). Separability ought to become the exception, not the rule (Krupp, 1963).

In sum, 'chess' depicts a process of choice more real than orthodox 'shopping.' Furthermore, if one imposes a spectrum upon the two images I have discussed, the actual features of choice seem to lie on the opposite side of the 'chessboard' analogy from the 'neighborhood store.' If so, then any implied improvement in realism offered by chess as an image does not go sufficiently far to warrant a claim that it is 'realistic.' More to the point, the shopping analogy is unacceptably unrealistic in three distinct regards.

First, our bounds of attention are absent in neighborhood stores, unlike chess. Though any such game is much too defined to reflect the complexity of real decisions, chess comes closer to capturing many uncertainties than does shopping. Second, decisions occur in a sequence of irreversible steps: such is the essence of chess and is not apparent in purchasing goods. The process of *planning* is simply omitted from mainstream models of choice. Third, all important decisions are social, with outcomes affected by others. Chess shows agencies shaping results; simple utility maximization abstracts from human intrusion. On each of these three criteria, 'chessboards' are more realistic than 'neighborhood stores.'

Toward a unified theory of choice

Ideally, of course, such analogies should be joined to combine their strengths. After all, the reason that choice in the 'neighborhood store' appears so robust despite its unrealism is that the image accords with a complex of models and constructs. Still, it is hard to imagine how one might theoretically formalize chess: indeed, I would venture a view that this feat is impossible in 'normal' terms. The point is simply to open discussion on issues omitted from orthodox schemes.

One direction of argument that is suggestive of further research is this: a recognition of interdependence – in time and space (both social and physical) – opens the door to a theory of *planning horizons* in human decision (Jennings, 2008b, 2012abc, 2015a, 2016abc, 2017ab). If all we do affects everything else on into the future forever, then we decide among incomplete images of suppositions still to unfold. Those we forego are eternally lost; those we pursue may not turn as expected.

'Planning horizons' signify our ranges of vision in choice. Such a concept distinguishes *foresight* from *myopic* action and thought. That distinction invites a consideration of social learning incentives, of how institutions shape our awareness (Boland, 1979; Senge, 1990). Planning horizons – for better or worse – shall influence prices and growth. A proper endorsement of interdependence –

suggested by chessboard analogies – opens a theory of planning perspectives into other unseen domains. Showing unexplored avenues and directions of undefined thought is central to any insightful discovery: this is indeed the power and impact of metaphoric conceptions, especially in realms of subjective value such as economics.

Essay 3: Interdependence and choice

Standard economic analysis structures its primary image of choice as a maximization of value over a set of fully known options. This suggests all choice is basically like that in 'neighborhood stores', with options familiar and wholly controlled. Furthermore, action is seen as self-contained, divorced from other decisions – in time and space, by self or others – so choices are independent. Where choices show interdependent ties, such are reported as 'externalities', special anomalies showing a 'failure' of markets calling for state intervention. The role of government is to prevent or resolve – 'internalize' – such externalities so that private decisions (in markets) account for their 'social' effects. Such is appropriate if our choices are generally held independent, through private property or other institutional-legal limits on action. Indeed, an orthodox interpretation of 'externality' problems as stemming from 'incomplete markets' suggests that interdependence arises from our inability to put a price on all things (Heller and Starrett, 1976; but also cf. Krupp, 1963). Such is one view of this matter.

Another is simply to recognize that every act is interdependent, on into time and across individuals. In other words, all of our choices spread their effects everywhere forever, in an unbounded, ongoing radiant process of echoing ramifications. If this is the case, a 'shopping' analogy as an image of choice ignores several important dimensions, such as imperfect knowledge, ongoing time and the social aspects of choice. A better image is chess. Choice on the 'chessboard' involves an uncertain projection of flexible tradeoffs, shifting in every move without recourse or respite throughout the course of a game. Each act determines subsequent options, subject to rivals' response. Such an example is closely analogous to international trade, oligopoly markets and management practice, each of which aptly illustrates some intractable aspects of choice.

Three implications of interdependence

To recognize interdependence suggests several things about choice. First and most significant is that if outcomes echo forever, it is *awareness* thereof that is bounded (Simon, 1978, 1979, 1982-97). Understanding the process of thought directing our action is therefore important (cf. Kelly, 1955, 1963, 1969; Earl, 1983ab; Loasby, 1976). Whether we act with 'conscience' – i.e., the extent to which we incorporate in our projections their radiant ongoing impact – determines the range of *unintended* 'social' effects we launch. If we act impulsively, our impacts endure but are not considered in the decisions that set them in motion. Myopic conceptions simply cost us control over ramifications, which shall occur regardless of whether they are addressed and dealt with or not. We have no choice about choosing, which we do on an ongoing basis; the only option we have is on how we anticipate our results. Since future options are opened or closed by all that we do today, our range of vision and imagination is central to whether and how plans succeed. The purpose of theory is simply to focus our thought on what is essential and how things unfold in response to decision (Hicks, 1976, p. 218; Heilbroner, 1980, p. 492; Martin, 1989, p. 369). The better attention is specialized on the important determining causes, then the wider the realm of correctly expected effects shall be in a choice. Models of thought are in no way irrelevant in their assumptions or application. They affect all that we do, along with its impact on everything else. If so, we ought to attend more closely to *how we think* about choice.

Second, if actions spread outcomes in every direction except to the past, then *externalities* are ubiquitous and not exceptional in our endeavors. Such implies each decision we take – as a rule – affects all others around us, either for better or worse, despite that those other people lack control over whatever we do. The purpose of institutions should be to internalize 'social' effects, such that 'external' gains and losses are turned into 'feedbacks' aimed at their source (Bertalanffy, 1968; Senge, 1990). I am unlikely to dump my costs upon others if I am accountable in advance for 'pollution' I cause, and if I discover some method to benefit all, then I should be able to capture at least enough gains to make it worthwhile. The name of the game in incentive design is aligning 'private' with 'social' effects (Culbert and McDonough, 1985, pp. 138-39). But how we implement this is not clear, as further discussed below.

Another ramification of interdependent transactions is that we cannot *aggregate* individual acts to calculate 'total' effects. For example, our textbook construction of 'market' demand curves from individual wants *by addition* is not legitimate if

our desires are interrelated. Only *indifference* allows summation of individual wants; if we care about others' well-being (either for better or worse), that total exceeds or falls short of its units' sum. Wants are only additive if independently formed (Boulding, 1966, pp. 28-29; Swaney, 1988, p. 321; Drakopoulos, 2012). Fads, bandwagons, snobs, movements – interdependent incentives as such – are thus incompatible with aggregation (Leibenstein, 1950). Some other rule of composition is needed when things interact (Krupp, 1963).

These three issues – limits of vision, the need to internalize 'externalities,' problems with aggregation – are relevant wherever units (transactions or agents) are not independent. How regularly are actions unconnected in motive or impact? I would say not very often. If so, then the 'problem of interdependence' suggests a serious shortcoming in conventional economics, since suppositions of 'agency independence' are rampant throughout this science.

Confronting interdependence

Instead of avoiding interdependence, a way should be found to embrace it. A systems approach is needed, such as in organizational theory (e.g., cf. Emery, 1969; Pugh, 1971; Lincoln, 1985). Yet there is a dearth of analytical rigor – despite many insights – in the organizational literature. How we attempt to address our effects on each other remains of vital importance. One way to look at the issue – as mentioned above – is in terms of *externalities*. Every action I take creates spreading effects upon other people, who either gain or lose from my efforts. If so, all my decisions show *concerns* or *conflicts* of value with others. To the extent that these spillovers are internalized, i.e., fed back to their source, then I am either encouraged toward or redirected away from an option. Such is a useful way to think about rights and to analyze interdependence.

For example, most people drink either wine or beer in the course of an evening, not both (cf. Jennings, 2009b, p. 42). Thus, we can think of these goods as *substitutes* in their consumption patterns. If so, producers of wine and beer are rivals in the same 'market.' The sales of each are *inversely* related; the greater the purchase of wine, the less beer is sought, and *vice versa* (given demand). This is a standard example, and it reflects why *collusion* is seen to jeopardize social levels of 'welfare.' If vintners succeed in affecting brewers' output – or the reverse – then either will gain when their rivals' sales decrease, so a linkage between them ought to raise price. As such ill serves the consumer, rivals are not to collude in the absence of 'entry' and

other competitive forces, under antitrust law along with the dictates of economic analysis.

But substitution and conflicts of value are only one form of interdependence, which also entails *complementarity*, i.e., 'concerts' of interest. The aggregation of firms into 'industries' solely includes the first, at the cost of unexplored insights into the latter relational form. Beer is not just linked to wine but to pretzels as well (as wine is to cheese). Note that collusion of pretzels and beer will likely *increase* sales and drop prices; mergers of *complements* should be encouraged (assuming more output is sought), as they are reciprocal to substitution (Richardson, 1959, pp. 233-34). These two alternative forms of interdependence – substitution and complementarity – lie at each end of a spectrum meeting where independence applies (or interdependent ties cancel out). One way to model this interaction is through a third image of choice.

Choice in a 'Transport Network'

I have already argued for 'chess' as a useful extension of 'shopping' examples, save that – in chess – *substitution* is still the applicable link among agents. If the goal is to win, the incentives are rivalrous (if the aim is to *learn*, they may be more complementary). What we need is an adequate way of framing interdependence, such as in networks or 'transport system' metaphors (Jennings, 2009b, pp. 40-42).

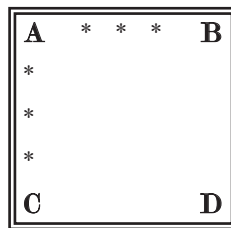


Figure 1 A simple transport network

Imagine the simplest transport network open to explanation: rail lines linking four towns in a square, as in Figure 1 above. Now consider routes AB and AC: are they rivals or complements? The answer is: it depends on the *context*. Passage between **A** and **D** uses either AB or AC as substitute routes. However, for shipments between **B** and **C**, these lines are complementary; they are travelled (or spurned) together, revealing a concert of interest. The mix of substitution and complementarity such as

in networks or goods suggests that a use of 'industry' as our only method of grouping firms is incomplete and inadequate. The notion turns our attention to only one form of interdependence, at the expense of another whose implications invert those in 'normal' domains.

With complementarity, integration is good (it augments output and welfare) just as collusion of rivals spreads harm. *Concerts* of value are realized with *cooperation* and placed out of reach if forestalled through rivalrous social incentives. Beer and pretzels should join to reach their full productive potential; apart, their output is less, since some of the gains from low prices are lost (to the other). The point is, real-world decisions show wider relations than 'market' models support; an 'industry' is, after all, defined as a group of *substitute* products. In other words, substitution is not our only interconnection; complementarity also reflects throughout all human relations.

Having opened a framework embracing both substitution and complementarity, I must admit a dilemma. Figure 1 is somewhat misleading, in all its simplistic construction: networks in actuality are too complex in most cases to be decomposed into concerts or conflicts of interest. The trouble applies to wine and beer as well, since – if I am throwing a party – these items are complementary and not substitutes for that decision. The linkage of goods or activities is both purpose and situation specific – *contextual* – in its identity. In almost all cases our interdependent relations are *nondecomposable*: any endeavor radiates gains and losses outward to others. Such shall impede any uniform generalization as to effects. Substitution and complementarity operate often together; any analysis only assuming that one or the other applies is selectively incomplete. As we cannot see what we shun and are barred from observing its ramifications, we should be open to many perspectives. Such is the aim of extending the 'neighborhood store' with the 'chessboard' and 'transport' analogies. All allow a more versatile outlook upon the limits of each.

Institutions and interdependence

If every act has unbounded effects, spreading to everyone else, the impact on output of proper internalization depends on whether our choices spill gains or losses upon other agents (who would support or oppose such pursuits were their influence fully accounted). Say that you – in the course of your business – find it 'efficient' to dump your refuse in landfills leaching onto my farm, destroying my crops and soil (assuming I trace the source of that damage to you, which may be the crux of our

problem). I must be able to sue for recovery of the losses you caused. (Appreciate that the determination of harmful effects shows the need for imagined projection of 'unexplored outcomes' in which pollution did not occur.)

Presuming my loss is correctly assessed and rightly assigned to its source, my claim against you is a 'feedback' adjusting your own incentives toward their full impact. My influence may be imperfect (due to intractable attribution dilemmas), but when externalities are internalized, 'private' rewards and constraints become better aligned with their 'public' effects. This applies best to 'external' losses; spillover *gains* show different incentives.

Suppose that you own a road improving my access to one of my fields. If we collude, I will pay for its use; such reduces my cost. Note that I have a private incentive to *realize* mutual gains, whereas I seek to *escape* all losses. 'Positive' externalities tend to *resolve themselves* in a market economy; if 'free rider' problems exist, that is the main exception. Often uncaptured benefits can be freely and privately internalized through clubs or other arrangements (Coase, 1960; Olson, 1971). Otherwise output is insufficient (assuming costs are privately borne), as profits understate 'worth' unless all who gain from this scene are included.

The 'monopoly problem' illustrates this. Here 'consumer's surplus' is lost if everyone pays the same price for a good. The firm will sell until $MR = MC$ for maximum profits, where $P = AR$ exceeds MR since *discounts* cannot be confined to the margin. However, if firms raise sales at the margin *without* cutting prices to current consumers, the claimed 'inefficiency' just disappears (Clemens, 1951-52; also cf. Jennings, 2005)! (There may – or may not – be 'inequities' stemming from individual pricing.) The *general rule* is that external gains (uncaptured) make output too low, where external costs (unless internalized) do not constrain production enough. Internalization – increased integration – cooperation – incentive alignment: all act to optimize output in the presence of external losses and benefits, so balancing private incentives with their social effects.

However, as said, a difference obtains between 'external' losses and uncaptured gains. Private incentives seek to *internalize* spillover benefits so – where possible – this problem may solve itself. Unprovoked harm is just the reverse, if unrestricted by law: here the incentives are to *avoid* and displace costs onto others. The name of the game, from a private perspective, is: *capture all gains* (one's own and each other's) and *dump all losses* one can (get away with). We should design institutions to feedback costs and not worry so much about gains, since private incentives incline to

externalize losses and *capture* rewards. Save for some cases, the latter tend to resolve themselves without help.

Toward a theory of 'Conscience'

Institutional avenues for the internalization of interdependencies have very limited scope in comparison to our 'external' effects. Such shall echo forever, ranging beyond any rational anticipation and knowledge of causal relations. The best one can do is to work at decisions, stretching one's understanding out to whatever reach is attainable in the embrace of fullest awareness. Furthermore, reason itself is enhanced through a lifelong effort to *learn* as much as one can about how both the world and its sundry inhabitants work and develop. Whether we like it or not, the locus of choice is *individual*. In such an interdependent domain, there is no way institutions alone can internalize most of the 'social' effects of ongoing 'private' decisions. We need other protections.

The *reach of imagination* – its choice of 'essentials' and how they are modelled, the fit of our representative frameworks to where they rightly apply, and the truth of our expectations and hopeful assessments of what our resulting outcomes should 'feel like' to wear – in all of these things and in many other regards shall effective achievement transpire (Rescher, 1979, pp. 15, 75, 102; Simon, 1981, p. 104; Pylyshyn, 1984, p. 251). Indeed, implied is an 'educational' *standard of social design*: to the extent that our institutional systems support or subvert our incentives to learn and to face our responsibility for the spreading effects of our actions (on other people as well as the world), to this very extent our rules and procedures raise or undermine welfare in their reward to reasoned choice. How might we better encourage the use of intelligence and proper 'conscience' throughout the course of human decisions (Jennings, 2009a, 2010, 2012c)? My answer relates – through the notion of interdependence – to 'transport' models of choice.

Figure 1 describes two forms of interdependent transaction: *substitution* and *complementarity*. In orthodox models of choice, substitution holds sway as the dominant type of economic connection: inputs and outputs are represented as substitutes almost without exception, throughout a framework concluding that competition in all things should be pursued. If the assumption – from Marshall again – that substitution is characteristic of all economic and human endeavor (implying inherent tradeoffs and scarcity are endemic throughout our relations) (Marshall, 1890; Frisch, 1950; Kaldor, 1972, 1975), then *competition* is properly

used as an organizational principle of design in social milieux. Where substitution prevails and institutions support competitive effort, they are conducive to increasing output, efficient production and rapid advance. However, recall the opposite tendency: in the presence of complementarity, *cooperation* is sought as a means to fulfill our productive potential. Here rivalry is self-defeating: we want *collusion* of beer and pretzels, since separation diminishes output, efficiency and productivity. The question is one of *fundamentality*: how important is complementarity vs. substitution in diverse social realms? That is the crux of the matter.

We are trained – as economists – to an emphasis on substitution. Economics is often defined as a science of 'scarcity' issues, and it is true that ambitions surpass our means. But that is not the whole story (Daoud, 2011; Hoeschle, 2011; Jennings, 2015d). Indeed, there is a very strong case to be made that complementarity is the most prevalent form of interdependence in a progressive information and service economy such as our own (Matthew, 2001, p. 2; Elsner, 2004, pp. 1032-33; as discussed in Jennings 2016a, pp. 10-11; also cf. Jennings, 2008a, 2015a). I shall attempt to bring a few parts of this argument into more focus.

Substitution and complementarity

Above I presented three models of choice, each of which should be considered. The 'neighborhood store' represents all choice as selection among known options, subject to resource constraints and desires that are consistent and complete. Three important dimensions of actual action are absent from this depiction: limited knowledge of options and wants; irreversible time and commitment; and the fact that most decisions are made in 'social' not physical space, so others' reactions structure outcomes.

A broader image of choice on the 'chessboard' demonstrates each of these aspects: outcomes cannot be valued or known in advance; all moves shift tradeoffs sufficiently to revise the whole game without recourse; and the reactions of others to one's own decisions shape their results. The 'chessboard' analogy is more realistic, although it defines a rivalrous scene in which only one player can 'win' and employs a more rigid delineation of rules than real life ever affords.

A full recognition of interdependence suggests it has *two* forms, not one, despite economists' selective use of 'industry' for aggregation of firms. *Substitution* and *complementarity* are reciprocal in their requirements (Richardson, 1959, pp. 233-34; also cf. Shapiro and Varian, 1999), shown by a 'transport' analogy: parallel

vs. end-to-end mergers have opposite impacts on prices and growth (Levin and Weinberg, 1979; Jennings, 1985, 2006a). The problem is that we cannot always untangle the difference in many cases, since it is *context* and *purpose* specific. The question becomes one of which is more fundamental in what situations: substitution or complementarity? The answer ought to determine how institutions should be designed to achieve our full productive potential: *competition* applies to realms where substitution prevails, while in the presence of complementarity, rivalry implodes – here we need *cooperation*. To the extent that we use the wrong model, output and human ambitions shall languish.

In a world of *physical* goods, where items are traded to greatest desire, rivalry operates well to identify who wants something the most. Take competitive bidding: I used to start my principles course with the auction of a rose and talk about 'things' vs. 'goods' as a question of *value* in its relation to *purpose*. I would commence the process by stating 'the economic problem': that we have one rose and a class full of people, and we want that good to end up in the hands of whomever likes it the best. That is the purpose of economics, to understand how to frame our rules and procedures so resources shift toward those who realize their highest value. It is widely believed that a process of bidding, where rivals are not to collude, directs our assets to maximum worth. Thus, shall *competition* allow us to be as well off as we can.

The previous theory applies most strictly under one set of conditions: a pure exchange economy in which all goods are physically bound. Two reservations are relevant, then: for one, the *production* process may introduce some complementarities, and the transaction of *immaterial* assets also wants attention. Each shall be outlined in brief.

First, it is an obvious truth that the *more* and *longer* we do something, the better at it we get: the unit costs of any activity ought to fall with both volume and time unless some fixed input cannot increase with output as growth occurs (Arrow, 1962; Alchian, 1959; Jennings, 2015b). If factors are all adjustable, then declining costs are the rule, especially in manufacturing (agricultural land may be an exception) (cf. Young, 1928; Kaldor, 1972, 1975; Schultz, 1993; Arthur, 1994; Buchanan and Yoon, 1994; Heal, 1999). Another source of 'locally' falling cost is if firms show 'excess capacity'; building beyond demand is common throughout the business community. Wherever *increasing returns* exist, a boost in output for any one firm may open new chances for rivals instead of freezing them out of the market. Note how waves of expansion occur, where all firms grow together instead of one just

displacing another. Such implies substitution is not their only interrelation, that they have concerts of value as well.

Another approach to the point is to see that all *specialization* – according to Smith – reduces cost of production (Smith, 1776; Warsh, 2006). Indeed, division of labor ought to be seen as a process of *cooperation*: if I make rubber tires and you fail to bring out the trucks I need, I starve, as I cannot eat rubber tires! In that regrettable case I do better to manufacture the vehicles – if less efficiently – all by myself. Increasing returns make trust and reliability – 'conscience' – of value (Jennings, 2010, 2012c). The latter give access to lower costs, so long as people can work together in carrying out their intentions.

Second, even without the production of physical goods (in the orthodox sense), a trading of *information* – nonphysical goods – shows complementarity also. When you and I converse, each of us gains something we did not know from the other as well as creating new knowledge that neither of us had possessed. This is a case where cooperation increases the information for all, and where rivalry – if imposed – discourages total learning. Competition in educational efforts subverts success, since it prevents sharing of what has been gained. There is no 'scarcity' of immaterial assets which should be 'hoarded'; instead, the information or love that I offer to you is not lost: indeed, it comes back to me amplified in a self-fulfilling communion (Boulding, 1962, pp. 133-34). There is no way competition of partners shall work in marriage or management either: these are realms where cooperation most clearly applies for the best. The only reason this statement might come across as controversial is that economists overstress substitution – and 'competition' – in human affairs.

Some institutional applications

The aim of this qualification is simply to open a door to alternative views. So many economic conundra arise from an improper application of frameworks supposing substitution to realms of complementarity, that it is hard to know where to start in discussing cases of this sort. The best illustration – as mentioned above – is in educational institutions (Jennings, 2008b, 2015a, pp. 596-97). Such are so clearly arenas in which our rewards are fully aligned that it is surprising how much competitive effort is still encouraged therein. Grading 'by the curve', for example, is one of these self-defeating incentives: such a practice sets students in opposition to learn 'more than others', at least in its most idealistic conception, under the view

that competition is strongly motivating of *effort*. That is not the result, except for a few (who likely are 'winners' already).

Instead, the opposite outcome occurs. First, appreciate that – to the extent there is only one 'winner' – rivalrous systems make everyone else 'second best', defining them as all 'losers' (Kohn, 1986; also cf. Rosenau, 2003). Furthermore, in such stressful environments students' misgivings are not revealed; everyone tries to act 'as if' they understood everything uttered. No one desires to 'play the fool' in front of fellows (much less the professor), as such shows someone's ignorance and may undermine one's standing in class (social *and* academic). Professors likewise shield all doubt behind their role as 'expert'. But a fear of confronting confusion or error amounts to a *fear of learning*, since such admissions stand as a vital first step to any renewed understanding. In sum, to reward students on a comparative basis instead of for real achievement is strongly counterproductive: it damages their motivation to learn in many important ways.

Second, private incentives here reduce social performance: each individual is 'better off' the *less* everyone knows. Is it any surprise that very good students are tagged as 'brown-nosers', 'wonks', 'nerds', or worse in our classrooms? They are the ones who make it difficult for the rest of the class, and they pay a high social price for success. There results a 'competitive' attitude of conspiracy in the classroom, where students see how little they can do and still be OK. Professors – under their own competitive pressures for 'research' – are often accomplices in this game, as too many homeworks and tests take time and brand you as someone who wastes too much energy teaching (over writing and publishing papers). Student evaluations suffer, if frequent assignments are given. Junior faculty often are told that tenure is granted for *research potential* (assessed by senior colleagues) and not for teaching (as seen by students). As a result, the learning process in such academic contexts slips to a minimal level at which it becomes a widely shared deception. These remarks are based on an image of what we are missing thereby, however, in need of clearer recounting. Otherwise one might wrongly conclude we are 'doing the best we can' in our schools, within some 'larger reflection'.

Unexplored options are always invisible, save to an open mind. Furthermore, any explicit encouragement of educational *cooperation* invites suspicion from students and colleagues: the first worry about, and the second enunciate, accusations of 'cheating'. We are so wed to our habits of *individual* learning that any attempt to raise the question of what we are missing thereby is seen as a threat to established approaches and one's academic career.

But when a small number of students succeeds at a venture in mutual learning, through which everyone's understanding gets amplified in a self-feeding process of growth, they uniformly express their enthusiasm at the result. Despite the hostile environment, there is a magic 'cooking' that often occurs when a group provides three ingredients: a *common purpose* and *known terms of discourse*, along with *mutual trust*. (The latter implies that no one holds back, causing others to do so as well.) Given this organizational license, surprisingly unexpected developments show on a personal level in the unfolding of individual outlooks into a shared perspective that is created by each together (Jennings, 2016c, p. 19).

Really it must be experienced to believe what can be achieved. Throughout my attempts to encourage 'collusive' endeavors, I was amazed at what otherwise seemingly average students accomplished. They worked as if unleashed from shackles of fear into realms where admission of error – rewarded – enticed them into a fully-absorbing odyssey of real learning, which became *fun* instead of a chore. I suggested to them – as they had to me – that there was a lesson in this about missing incentives in our education: namely, a system encouraging *competition* applied to a setting of complementarity is self-defeating.

This moral applies more broadly. The value of working together is found in many applications: sports, project management, business, marriage, and human relations in general; all suggest that teamwork is not an anomalous situation. But *cooperation* – like competition – is not automatic; it has to be *learned*. If we are socialized to competition at the expense of cooperation – distrusting 'collusion' wherever we find it as 'unproductive' and even 'unethical' – then we incur a loss in potentials that do not develop as fully as otherwise. I offer one more example.

Two illustrative auctions

The last two auctions I held in my principles course were jointly aimed to this point (Jennings, 2016c, pp. 30-32). After extolling the virtues of competition and market processes in their resource allocation capacities, and after introducing the more general issue of social incentive design and distinguishing 'private' from 'social' effects in the 'externality' sense, I would announce an auction ostensibly to run a test of our 'rationality'. I would tape two ten-dollar bills on the board, for sale to the two highest bidders, under the following rules. The top-most bidder would pay to me the amount of the top-most bid. Declaring that it seemed 'unfair' that the runner-up would get his or her bill for less than the 'winner' – and due to 'my own generosity' –

I then 'allowed' the next highest bid to be paid as a 'subsidy' to the top bidder. Then (to save time) I imposed a minimum jump of fifty cents, and duly opened the bidding.

Students leapt in with relish, seeing the chance to get a 'free lunch.' Only after the bids exceeded ten dollars, did people begin to drop out until only two bidders remained. I would then see what they did, and whether they got to the point on their own. Not once – in over ten tries – did the bidding ever stop short of twenty dollars (this was the only one of my five auctions that *never* incurred a loss)! Once I'd regained my investment, I would explain that time was passing while they were only enriching *me* and ask for another example from which we might draw any lesson or resolution. Eventually someone would mention the Arms Race, and the need for collusion. If the bidders were still too embroiled in the process to hear this suggestion – usually due to a predator-prey relationship – *I* would then enter the auction, releasing the victim and bid the aggressor for what was now to be *my* 'free lunch'... That always seized their attention!

In our last meeting, I would repeat the same auction for just the *outer* two-thirds of a twenty dollar bill (tearing up money would always shock them!), and then I would put an optional question on their final exam about these two auctions' incentives. (HINT: The larger half of a torn bill is redeemable at its face value, giving me full veto power against any predatory behavior.) The point is, if we impose competitive values in complementary contexts, we just squander resources in the pursuit of frustrated ends. Would anyone argue that these phenomena are irrelevant to our reality, in an age where so many of our institutions seem ineffective?

Conclusion

A problem appears in our economic conception of interdependence. If private decisions spread 'social' effects in all directions forever, we need to understand how institutions and 'conscience' shape behavior. Furthermore, aggregation – so widely used throughout traditional theory – is not a reliable tool in the presence of generalized interdependence. The notion of 'industry' is inadequate as a method of grouping firms; in its stead, a 'transport' or 'network' analogy opens to *both* forms of vital linkage: substitution and complementarity. Each is seen to endorse the opposite organizational form: all the virtues of *competition* apply to substitute trades, whereas complements call for *cooperation*. There is 'the rub,' however: rivalrous struggle undermines effort in complementary settings, such as in

educational institutions and other related environs, just like collusion does among substitutes. Substitution assumptions are rampant in orthodox economics, due to an overly simplistic image of choice as akin to that in 'neighborhood stores.' Even a 'chessboard' analogy is not open to complementarity. Models unfit to their realms of use shall lead us astray in our choices. Such appears so in this case; some of our institutions embody aims that work counterproductively.

Interdependence is subject to formalization in numerous ways. We might denote the difference of substitution from complementarity in terms of welfare, output or growth effects in narrow or broad domains. Here I have argued in general that any decision affects other people diversely, either for better or worse. Such 'externalities' – if internalized through integration or cooperation – improve the alignment of 'private' incentives and plans with their 'social' effects. Such can only be done incompletely by institutional goals; individual *conscience* is seen as important in this regard. To the extent that our economic conventions suggest that *disintegration* of firms and agents is how we assure efficiency in their performance, without acknowledging how essential are substitution assumptions to that conclusion, our institutions shall foster rivalry even where it fails. So we suffer unneeded discouragement and frustration of effort. Our only escape is to entertain new and alternative views of the process.

Competition has shown demonstrable economic efficiencies in a context where rivalry allocates scarce resources among contending ambitions, all of which cannot be served. However, economists' preoccupation with *physical goods* and *exchange economies* – at the expense of *informational and nonmaterial assets* along with *production and learning phenomena* – is responsible for a failure to emphasize both forms of interdependence. Such is the legacy of a 'neighborhood store' as our primary image of choice, as two other metaphors show: the 'chessboard' implies that thought, time and society act to influence choice; while 'transport' analogies also incorporate both types of human relation. The issue reverts to *fundamentality*: is 'substitution' the most general form of agency interdependence, as so much economics supposes? How important is 'complementarity,' in its reverse implications? [6] So far, I have only opened a question, noting that informational realms show where incentives might well be adjusted to emphasize cooperation. The argument to be extended demands a *horizontal* theory of 'conscience.'

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] Joan Robinson (1941, p. 241) put it so eloquently: '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'.

[3] As S. Y. Wu (1979, pp. 69-71) explained, as one example:

When we move away from ... static certainty... the shortcomings of monopoly may not be compared unfavorably with those of pure competition. ... Under these circumstances, the static certainty-oriented normative criterion – price equals marginal cost – ceases to be valid... A new welfare criterion is needed ... the neoclassical welfare criteria are no longer adequate to guide policies in an economy with uncertainty.

[4] Cf. Polanyi (1958, pp. 141-42); Georgescu-Roegen (1967, p. 104) remarked on this subject thus:

From time indefinite, the natural sciences have cherished a positivist epistemology... Objectivity ... requires then that a proper scientific description should not include man in any capacity whatsoever. ... True, the ideal of a man-less science is gradually losing ground even in physics... However, for a science of man to exclude altogether man from the picture is a patent incongruity. Nevertheless, standard economics takes special pride in operating with a man-less picture.

[5] Cf. Znosko-Borovsky, 1959 and De Groot, 1965; Waldrop (1992, pp. 150-51) quotes Brian Arthur's response to 'What is the real problem with economics?' as: 'Chess!'

[6] Kaldor (1975, p. 348) answered this question in his critique of general equilibrium theory: 'This approach ignores the essential complementarity between different factors of production ... or different types of activities ... which is far more important for an understanding of the laws of change and development than the substitution aspect...'

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