



## **INSTITUTIONS AND PROGRESS**

**(Final Version)**

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## **Introduction**

“We can save men from hunger or misery or injustice, we can rescue men from slavery or imprisonment, and do good.....but any study of society shows that every solution creates a new situation which breeds its own new needs and problems”. (Berlin, 1991, p.14)

My starting point for this essay is a set of ideas that Dick Nelson has articulated more or less consistently during the past three decades. They centre on the notion of competition as a progressive element in the dynamics of capitalism and the instituted foundations of the competitive process. Neither competition nor institutions are straightforward concepts but I take them as the motif for the rest of this brief essay in which I reflect on the restless nature of capitalism. The subtext is that the ceaseless economic movement and transformation across time and space, that is capitalism’s defining feature, follows from the nature of knowledge accumulation in general and the institutions which shape the growth and application of scientific, technological and social knowledge in particular. Capitalism is restless because knowledge is restless. Special emphasis is given to the institutions defining markets and innovation systems for it is in their mutual dependence that we can identify the engine of capitalism, the generation of novelty in order, the emergence of order from novelty. There is a long established tradition in economics of judging economic arrangements against the standards of a world of perfect knowledge. The approach taken here is that we learn much more about capitalism if we start from the opposite direction and enquire how ignorance is overcome and judge the economic process against that more exacting standard.

In no sense is this paper a review of the work of Nelson. Rather it reflects upon one theme, albeit one that has become increasingly insistent in recent years, namely capitalism as an engine of progress. I want to suggest that the Nelson-Winter project is more radical in its treatment of the foundations of economic change than has been recognised and that these foundations lie at the interface of economics, sociology and the study of management. They are intrinsically concerned with the growth and application of practical knowledge.

## **Capitalism as an Engine of Progress**

Let me begin with an outline of the Nelsonian view of capitalism as embodied in two papers separated in time by almost a decade (Nelson, 1981; Nelson, 1990). The first of these papers

deals with an old problem, the appraisal of capitalism, but in a way radically different from the prevailing orthodoxy. Put bluntly, the argument is that the case for private enterprise does not (and perhaps never could) rest on the welfare principles of Pareto optimality. Rather it hinges upon its characteristics in relation to first, administrative parsimony (the planning debate), secondly, responsiveness to unforeseen change (the adaptiveness problem) and, thirdly, the rate and direction of innovation, that is to say the creation of new opportunities to utilize yet to be developed resources. It is here that we are introduced to the idea of private enterprise as an engine of progress. This I interpret to mean that what is unique about the private enterprise system is its unbounded capacity for self induced adaptation from within, of the highly decentralised and uncoordinated attempts to invent and innovate combined with the strong order imposing attributes of market processes. Interestingly, the evolutionary metaphor plays no explicit role in this paper although the idea of knowledge accumulation via search over imperfectly perceived opportunities to produce rival and conflicting conjectures is clearly articulated. More important is the quite explicit emphasis on the institutionally contingent nature of this capitalist engine. Private enterprise economies “are very variegated, and differ significantly from sector to sector; further they almost never are “pure” private enterprise, but involve various degrees of ascription, central co-ordination, and higher level monitoring” (1981, p. 110). From this perspective the key issue becomes that of institutional mix, and, Nelson asks, “How much supplementary machinery can be loaded on to a basic private enterprise design, before one ends up with a system that possesses a few of the advantages of private enterprise and many of the disadvantages?” (ibid, p. 110).

Reading the 1990 paper, the argument has developed into a more evolutionary and institutionally rich account, although the key idea remains that of capitalism as a system containing multiple sources of initiative with real competition between them. The links with evolutionary and Schumpeterian thinking are now transparent but, importantly, this latter perspective is claimed to be deficient in two respects. In regard to its lack of comprehension of the complex and subtle relations that have emerged between science and technology, and of its neglect of the rich and variegated institutional set up that conditions the generation and application of knowledge (the 1981 argument). But here the institutional context is made far more explicit. To paraphrase it, private firms remain at the core of the progress engine but their internal capabilities are augmented by their engagement with a wider matrix of knowledge generating and storing organisations that constitute the external organisation of the firm. Competition is important and so is collaboration. Profit incentives are important

and so are the non profit incentives guiding research in university and public laboratories. What we begin to see is the extended division of labour in the accumulation and application of knowledge, a picture of detailed cognitive specialisation, of the increasingly roundabout way of producing knowledge, a necessary picture of interaction and co-ordination in a mix of market and non-market contexts. Two years later (Nelson, 1992), the richness of the institutional frameworks becomes even more explicit. In an assessment of the diverse characteristics of fifteen national systems of innovation (subsequently Nelson 1993), attention is drawn, inter alia, to the striking continuity of background institutions, (education, law, polity), to the strong sectoral specificity and specialisation of innovation institutions, and to the fact that innovation systems are much broader than the arrangements for generating advances in science and technology. Many innovation scholars have found this framework compelling both conceptually and empirically and I suggest below that it leads us to interesting new hypotheses about the dynamics of capitalism.

In its most recent versions the discussion has switched back to the original question on the relative merits of different forms of economic organisation. The demise of the centrally planned model does not give carte blanche to the virtues of competitive markets within the penumbra of private property rights. Rather the case for markets is more “subtle, complex and variegated”. For many cases private profit incentives and free consumer choice deliver satisfactorily but there are a wide range of other cases where the basic framework must be supplemented by public or private regulation with major elements of provision based on non-market principles. Thus the balance of organisational arrangements is always changing, reform as it were is never ending and arises from within the system. (Nelson 2000) This is the scope of the engine of progress and to assess it we must turn first to some difficult issues.

### **Progress, Progression and Purpose**

In assessing any claims for the dynamic nature of capitalism some brief attention needs to be given to the meaning attributed to the word progress. No scholar today undertakes this task with other than trepidation, yet a century ago progress was all the rage. One did not have to be a Spencerian to accept either the fact of progress or even, pace Spencer, that governments could and should intervene to make capitalism more progressive, a style familiar in the writing of Hobson and Dewey to name only two. One hundred years on such confidence is

conspicuous by its absence and yet Nelson's claim is quite explicit, capitalism is an engine of progress.

Entangled in the debate are a number of difficult issues. First and foremost is the idea of progress as directional change, that there is a progression, an identifiable sequence of alterations in the characteristics of specific entities. That seems innocuous enough but which entities, which level of analysis, and which characteristics? Here lie the deeper problems. In the general literature there is an entire wardrobe of candidates to measure progress. They range from the idea of the increasing complexity of organisations and social structures, through the idea of greater command over the natural environment, to much more specific notions in relation to the efficiency with which energy (or resources more generally) are used in a society. Henry Adams had a nice phrase to capture this, that of "impossibilities made actual" (Adams, 1907/1999, p.411). The problem with all of these notions is that any trends are likely to be local and not universal. Since ongoing structural transformation is inseparable from the idea of evolutionary development it follows that advance in some directions is associated with deterioration in others. Progress overall is not a natural quantity but, necessarily, some constructed aggregate measure, over the composition of which there can be legitimate disagreement. If, for example, progress in knowledge is to be the focus of attention one must immediately face the problems of its provisional, contingent and fallible nature, the ever present threat of the falsification of any individual idea and its replacement by a 'superior' explanation. Progress in knowledge is necessarily non-uniform.

More serious still is the evaluation problem, is it possible to separate the idea of progress from the standards provided by an ultimate purpose, and the related notion, perfectability? Now one important consequence of the Darwinian theory was to banish the idea of perfection from the discussion of progress. Progress became "greater fitness for purpose" relative to some quite possibly transient selection environment, and progress became clearly linked to the possibility of adaptive inventions and the local properties of evolutionary processes. Small wonder that some biologists depict progress as "going nowhere rather slowly" (Ruse, 1988, p. 97).

Turning from biology to economics should then we avoid talk of capitalism as an engine of progress? I think not. The idea of material progress on average is rightly embedded in our understanding of modern economic history (Mokyr, 1990; Landes, 1998). Progress is

associated with the expansion of the range and scale of productive opportunity and measured, albeit very imperfectly, by the growth of GDP per head over time. It is widely recognised that the difficulties of concept and measurement are enormous (Kuznets, 1971; Nordhaus and Tobin, 1972). The measurement of non-market activity, the valuation of leisure, the treatment of some produced inputs, such as the provision of law and order, as outputs of the system are familiar examples. Yet one would have to be remarkably curmudgeonly to deny that an economy such as the USA has not made progress between 1900 and 2000. It is not an argument that would have much credence in the developing world. The argument is clearly buttressed when social indicators, or satellite accounts, are added to the picture, the extension of the expected life-span, the decline in infant mortality, the reduction in the duration of the working life all have released the gift of time in a fundamental way. Surely that is progress? While this clearly does not deal with Keynes' famous jibe to the effect that, while Queen Victoria was manifestly wealthier than Queen Elizabeth the First, this did not settle the question of whether or not she was a happier woman, it places the denial of progress very much in the camp of the sceptics. In saying this one is distancing oneself very clearly from the rightly discredited idea of progress as an intrinsic drive to perfection controlled by natural laws. Instead whatever directional changes we observe they are the "unintended consequences" of those variation, selection and development processes that characterise capitalism as a system.

Yet evolutionary minded scholars at least are acutely aware of the non-uniform nature of material progress, that it entails destruction of form as well as creation of form. If we mean progress we mean progress on average, progress that can have severe and unforeseeable distributional consequences. No one could ever claim that restless capitalism is comfortable capitalism, there are winners and losers and the former do not typically compensate the latter. Uneven progress so easily leads to social tensions and on occasion to wars and human misery that any judgements have to be made with extreme care. It is one of Richard Nelson's enduring themes that the progress of capitalism is uneven and it is uneven because the progress of practically useful knowledge is uneven. As with the writing of Simon Kuznets, the emphasis is on the differential growth and application of knowledge, indeed that the pattern of the growth of knowledge depends on the pattern of its utilisation. Contained in this view are two important insights into the progress theme. The first, is the relation between economic progress and the supporting infrastructure of social relations and the consequences when the two fall out of step. Creative destruction implies the decline of some activities as a

necessary element in the growth of others, and when activities decline and disappear they may leave behind a pattern of social life shaped by an institutional and organisational structure that has lost its economic *raison d'être*. Similarly, the growth of new activities may be well in advance of the creation of supporting social arrangements. In his essay, 'The Moon and the Ghetto' (1977), Nelson provides a detailed account of this mismatch problem in the context of the provision of day-care services for pre-school children, a problem that has arisen because economic stimuli have created more urban families with both parents economically active. But the issue is clearly more general and it relates to the second insight into uneven progress. Namely, that knowledge-based development is inherently unpredictable in its effects, whether good or bad, the unforeseen consequences are the invisible signatures of evolutionary change.

This line of thought opens up a different perspective, not progress as outcome but rather the progressive characteristics of the institutions and process of capitalism, that is to say, the nature of capitalism as an *engine of transformation*. What is progressive is the integrated set of processes at work. A progressive system is marked by its capacity to co-adjust the economic and social institutional arrangements, to solve problems as they are generated, to adjust for the 'bads' as well as for the 'goods'. Progressive systems are adaptive systems and adaptive systems are evolutionary in structure. Here, the force of Nelson's arguments is that the engine in question is a matter of institutional structures and that those are not given either. They too can be the outcome of variation, selection and development and it is in the working of these "higher" level processes that we find the key to understanding differences in economic growth across time and space (North, 1997).

One asks of such an adaptive system, 'How creative is it?' 'What bounds does it place on the generation and trial of novel conjectures?' 'What properties does it have as an experimental system?' (Eliasson, 1996; Rosenberg, 1992; Foss and Foss, 1999). This perspective is essentially a perspective on the conditions for the growth of practical knowledge in relation to economic and social organisation. As such it is bound to have a close affinity with the conditions for the growth of knowledge more generally and the essentially open-ended, idiosyncratic way in which all knowledge is developed. There is much more to economic and social progress than formal science and technology and Nelson has always recognised this.

At this stage an example of an innovation that surely constitutes progress may be helpful. One of the most disabling conditions of advanced years is the loss of sight in otherwise active people, and in the economically advanced countries at least the population is ageing rapidly. Among the causes of deficient sight is the condition known as ‘cataract’ the clouding of the lens of the eye. Until recently the condition could scarcely be corrected until that is the development of a simple but deeply radical innovation (Metcalf and James 2000). The innovation that ‘solves’ this problem is the intra-ocular lens, a plastic lens that is inserted in the body of the eye to replace the defective natural lens. This innovation originated in London in 1949 and it required many years of trial and error development to make it safe for general use. It required many complementary innovations in relation to lens design, materials and operative technique before it could become widespread in its application, and it required collaborative development work across companies and clinicians. Ultimately the innovation resulted in the formation of a multinational industry that is closely integrated with clinical practice whether public or private. But the consequences run much wider. In the innovation process, the relation between medical demand and medical need has been redefined, patients are now admitted for the treatment when their sight is still sufficient for them to drive a vehicle, something unheard of twenty years ago. It is now the case that the medical procedures take place on a day-patient basis to the immense welfare enhancement of the patients. And a new division of labour is emerging in the delivery of the service as skilled nurses, specialised only in this branch of cataract surgery, replace the ophthalmic surgeon. It would be strange indeed to say that this does not represent progress in human welfare. Yet as an innovation it is symptomatic of capitalism more generally. Highly localised efforts at innovation are co-ordinated by market and non-market processes that are deeply embedded in formal and informal systems of regulation whether public or private.

### **Institutions and the Accumulation of Knowledge**

In this section, I explore the problem of knowledge and institutions as a basis for comprehending how different national patterns of knowledge accumulation are reflected in their different institutional structures. Since few scholars would deny that economic and social change is contingent on the continued growth of knowledge this is not a trivial issue. But, for example, precisely *who* is said to know *more* when we link the growth of knowledge to the growth of the economy?

The view I take here is foundationalist. Only individuals can know and what they know depends on perceptions, introspection, memory and inference, in short, experience allied with reason (Audi, 1998). These processes, by which we come to know as individuals, are greatly augmented by social processes that permit exchanges of information, representations of knowledge communicated between individuals such that they can lay claim to common understanding. This extended reliance upon the testimony of others is one of the key factors in understanding capitalism as a knowledge-based system. For it leads us directly to one of the most powerful of the ideas derived from Adam Smith, namely the division of labour in the production as well as in the use of knowledge. Not only within the pin factory but also through the role of those specialised philosophers and men of speculation, “whose trade is not to do any thing, but to observe everything; and who, upon that account, are often capable of combining together the powers of the most distant and dissimilar objects” (Cannan edition, p.11). Moreover, because the division of labour also applies to the philosophers, “Each individual becomes more expert in his own peculiar branch, more work is done upon the whole, and the quantity of science is considerably increased by it” (ibid, p.11). What Smith does not develop is how this growth of knowledge is co-ordinated. What is it that achieves for knowledge activities that which markets achieve for productive activities?

What Smith implicitly draws attention to is the individually idiosyncratic, specialized nature of personal knowledge and the corollary that not only the use of knowledge but the growth of knowledge is a social process that must be co-ordinated through appropriate patterns of social interaction. The growth of knowledge is a socially distributed process. If information flow is to convey personal knowledge with sufficient accuracy to achieve commonality of understanding, then there must be common standards of communication, language or other forms of symbolic representation, and agreed standards for the justification of that which can be said to be known. Otherwise private knowledge cannot develop into collective understanding. As Nelson puts it there must be ‘social technologies’ to make testimony possible (Nelson, 1999). In this regard institutions matter in two fundamental ways. First, they constitute the means to store and communicate information in general and the means to support particular patterns of interaction, “who talks to whom with what frequency and with what authority”, in a society. Thus, as the innovation systems and the related innovation networks literatures have made clear, systems are entailed by components and their patterns of interconnection (Carlsson, 1997). Different patterns of interconnection imply different distributed patterns of understanding and thus different paths for the growth of knowledge.

Secondly, institutions embody the rules, the standards of socially agreed belief, that are the means to accumulate justifiably true knowledge in relation to science, technology, as well as organisation and social discourse. It is the institution of understanding in common that makes economic and social life possible while simultaneously constituting a powerful engine for the differential growth of personal knowledge. Thus what interaction generates is a flow of information between individuals who, at best, treat that information as a representation of knowledge. Information flow may change the knowledge states of the recipients but there can be no expectation that the change of knowledge will be complete, that it will be identical for all recipients or that it will not be contested. Here lies the unpredictability of knowledge accumulation and its corollary, the unpredictability of capitalism.

These ideas have some important implications for the economic approach to knowledge and information. If knowledge is of necessity an attribute of individuals then it is not obvious that it is a 'good' in the public domain. This is the 'ether problem' that knowledge is simply in the air and can be 'inhaled at will'. At its source is confusion between information and knowledge. Because knowledge is necessarily private, idiosyncratic, individual, what we should say is that only its representations, symbolic or otherwise, can be in the public domain. However, if we can say that information is in the public domain this does not imply that it is uniformly accessible, available to all without effort or cost. To turn information into knowledge requires prior knowledge (and beliefs), including the social knowledge of who to ask, where to look, and the investments of time and effort to acquire that knowledge. This is a necessary consequence of the specialisation of knowledge. Expertise in some domains is a trained aptitude for ignorance in other domains and this is why testimony is dependent on trust and the underpinning institutional structures that foster communication. Indeed if knowledge were 'in the ether' it is difficult to understand how any economy could be underdeveloped.

Obviously knowledge and information obey the principle of non-rivalry in use. While this has been emphasised in the recent economics of growth (and indeed in Arrow's statement of the economics of information, Arrow, 1962) an important part of the knowledge dynamic is missed namely non-rivalry in the use of knowledge to produce knowledge. The production of knowledge is autocatalytic and here lies another route to understanding the restless nature of modern capitalism. As scholars from Marshall (1898) to Kuznets (1971, 1977) have

recognised, economic activity changes knowledge directly and indirectly and every change in knowledge opens up the conditions for *changes in activity* and *thus further changes in knowledge*, ad infinitum, and in quite unpredictable ways. Economic systems are necessarily restless, the clock can never be turned back (Foster, 1993) and these are features uniquely associated with the capitalist system of organisation. For capitalism is at its core a system for the decentralised generation of new knowledge and the co-ordination of the consequences of that knowledge in ordered patterns of economic and social change. Popper (1985) is of help here, not least because of the clarity with which he also argues that the accumulation of knowledge is an unfolding process in which the realisation of possibilities makes possible the specification of new possibilities. Since all knowledge is provisional we adhere to what we know until something demonstrably better comes along, and this is as true of business conjectures as it is of conjectures about the social, natural and man-made worlds. It is the fact that knowledge generates knowledge that links together selection and development so as to mark economic evolution as an inherently unpredictable positive feedback process. Complex, adaptive, evolutionary processes may provide the most promising way to capture this dynamic.

In assessing the institutional framework for generating knowledge in an economy, emphasis is rightly given to formal processes of education and research. The development of these processes as investment activities is surely one of the principal factors in the cumulative growth of knowledge. But the accumulation of knowledge in capitalism is subtler than this; the engine of capitalism is greatly enhanced by but not simply dependent on having discovered and instituted formal processes for education and research. There is a danger in overemphasising the idea of a distinct 'knowledge sector'. The point is that knowledge does not accumulate out of context or of the passage of time. Much economic knowledge therefore results from the conduct of the market process as suppliers and customers interact and learn what to produce and from whom to buy. To this extent economically valuable knowledge is a product of market co-ordination and can be expected to accumulate differently in different co-ordination systems. A centrally planned system must be expected to generate quite different patterns of knowledge to those arising in a decentralised market economy. It is this fact which links evolutionary explanation with some Austrian approaches depicting economic evolution as a socially mediated discovery process (Rizzo 1994; Cowan, 1994).

## **Market Processes and the Problem of Equilibrium**

What kind of economic system underpins the idea of a capitalist engine of progress? The answer Nelson and Winter give is that it is evolutionary, and this claim needs some elaboration in so far as it results in a quite different take on some traditional economic questions. I shall not elaborate here on the notion that market processes are instituted selection processes that translate the micro diversity of individual activities into patterns of economic change. Nor will I elaborate upon the point that market institutions have to be constructed, that they involve operating costs, that they are regulated, formally and informally, and that their operation reflects a balance of public and private interests. (Nelson, 1997). This is well understood if not widely accepted outside of the evolutionary economics community. However, even a liberal interpretation of an evolutionary stance carries with it some deep consequences as to how economists should assemble a theory of an engine of progress.

The most important of these changes of perspective is difficult to handle for it involves the claim that the notion of economic equilibrium be abandoned, and equilibrium, of course, is the central organising precept of mainstream economics. Several fundamental issues need to be unravelled here. The first is that the dominant issue in economic organisation is not equilibrium but co-ordination, how diverse activities interact and to what effect. In this sense, equilibrium is an organising device to identify the mutual consistency of sets of simultaneous relationships. An equilibrium is defined in terms of the solution set of a particular 'model' a configuration of actions that is explained in terms of a set of consistency criteria. There is consequently no single notion of equilibrium since there are a multiplicity of economic consistency criteria. In the classical tradition, consistency is defined in terms of the equalisation of rates of return on economic investments, and the patterns of relative prices that support that uniform rate of return. In the Walrasian scheme, consistency is defined in terms of the attainment of a mutual consistency of plans to buy and sell prior to the act of exchange. In the Hicksian temporary equilibrium it is defined as the market-clearing sale of what has been produced and offered for sale. The point is this, if equilibrium is the solution to a problem, we need to know what the problem is.

Now the consequence of the Nelson and Winter perspective is this: if the problem is that of economic development and the role of innovation in the development of the economy, the

evolutionary problem, then equilibrium seems to be an internally inconsistent requirement for a solution. For the point about equilibrium is that there is no escape from it without the introduction of some external disturbing perturbation not explained within the model. To capture the evolutionary nature of capitalism we need a concept of open-ended development, of development from within the system that does not necessarily have an attracting set of limiting states. How else can we capture the historical record, the incessant emergence of qualitative and quantitative change, the utterly unpredictable long-term development of the system.

What we cannot dispense with, however, is an idea of the pattern like order of economic activities. Thus, for example, there is nothing wrong in referring to a Hicksian market clearing solution as a 'temporary equilibrium' providing we also realise and build into our analysis its necessarily transient nature. But, from the viewpoint of the evolutionary economist, it is far better to refer to the consistency of actions as a temporary *order*, a pattern of economic outcomes, for co-ordination leads to order, not to equilibrium (Hayek, 1937; Loasby, 1999). Here we need to distinguish two senses in which the notion of order can be used. One relates to events in the market place, the traditional notion. The other is much wider and refers to the framing instituted conditions within which market order is established, the broad rules of the game if you will. In each case we mean by an *order* the formation of a pattern of activities or events that is assembled according to some underlying set of principles of interaction and interdependence. However, at the different levels, the velocities at which the respective orders change is very different, and tremendous change can and does occur at the market level within a relatively given set of rules of the wider game. This is not to say that the wider rules are stationary but only that their velocities of change are relatively slow. Thus, in the evolutionary picture, order implies regularity and regularity arises from the co-ordination of diverse behaviours (Coricelli and Dosi, 1988; Dosi and Orsenigo, 1988, Lane, 1993)).

Order, of course, occurs at many levels and we can distinguish between order within a market for a given class of products, order between these markets, and top level order of saving and investment flows in the capital market. The interlinking of these different levels of order formation shapes the process of transformation and maps onto corresponding levels of evolution. Indeed a notion of economic order is central to the problem of emergence

interpreted as the evolution of economic structure from within the system itself (Dooley and Corman, 2000).

At this point a detour may help, by considering the idea of order as the co-ordination of activities in a market context. The fundamental difficulty here has always been the relation between actions, plans and beliefs of the relevant agents. In the market process, non-Walrasian for well understood reasons, it is actions to buy and sell that are ordered at any point in time. Markets may clear in relation to actions, in a variety of meanings, but the underlying plans to buy and sell may have been falsified by these outcomes. The issue is what happens next, do actions converge to the given plans or does the discrepancy mean that plans are revised or even more fundamentally that the relevant beliefs are altered? A special case arises when the discrepancies between plan and outcome are noise events, transitory and individually offsetting and known to be so. In this case the mathematical expectation of outcomes is as planned, any errors are correctly expected errors and the plans can remain intact. But this is a very special sub-class of events in capitalism. More generally errors in an evolving economy are not offsetting and transitory they are systematic and unique and they are necessarily thus whenever agents champion mutually different plans in the same market context. Furthermore, if a business plan cannot be fulfilled the beliefs that underlie it need to be revised if the business is to survive. This may be only a matter of revising the price or production volume. More fundamentally it will involve a questioning of the scale of investment, or, more fundamentally still, a questioning of the products being sold, the markets to which they are directed and the methods by which they are produced. In short what is required is an innovative response. Quite clearly there is no formal way by which we can legitimately represent in their entirety such creative processes.

Now the issue is deeper than this for divergence of plans and thus their falsification is built into the system of capitalism in a fundamental way. The active search for profit, as distinct from the passive adjustment to market signals, is the active search for different models of business and associated implementation plans. Non transitory profits are not made by following the same model as rivals but by executing a different model. It is this search for micro diversity of beliefs, plans and actions that is, of course, the basis for market based evolution. To the extent that expectations can be rational they can only be so in extremely localised domains.

There is at this point a connection with the treatment of dynamic stability in economic models in general. The idea of a solution to a particular co-ordination problem can be approached from two directions (Samuelson, 1947; Weintraub, 1991). The first method requires the specification of a formal system of differential equations to describe the time dependent motion of the simultaneous variables and the solution, 'a rest point or path', is defined as the limit of the system variables as model time extends indefinitely into the future. Alternatively, in the second method, a solution can be pre-specified from knowledge of static relations and the stability properties of the solution analysed as a separate exercise. There is no question that the former method appears superior, taking the vector field at each point in time and not begging the question of the possible rest point(s). In this sense it is a more complete description of the dynamic problem. However, the second method is widely used, eg., in the analysis of the stability of general equilibrium, and for stable linear systems it is equivalent to the first method. This is the method where the agent beliefs, the relations of supply and demand, are invariant to the movement of the system through time. Being out of equilibrium does not alter the static relations that determine that equilibrium, and the distance from equilibrium governs the motion of the system.

For non-linear systems in general no such clear cut properties apply, and the chief complication is the existence of multiple basins of attraction, that may or may not contain a rest point, so that initial conditions matter and perturbations may carry the system from one basin to another. In general there is no basis for establishing which, if any, basin of attraction will dominate the system (Allen, 1988, 2000). More generally still, in the case of non-autonomous systems the dynamic relations are changing through time and this raises the possibility that any rest points may be accelerating faster than the variables under investigation can converge to them. However, the real difficulty with the second method is its dichotomous treatment of the relevant agents. A detailed specification of their behaviours when plans are fulfilled does not extend to a similar specification of their behaviours when plans and outcomes diverge. Out of equilibrium behaviour is in this sense arbitrary and, as it were, applies to different agents from those whose behaviour is described by the states of rest. The Walrasian fiction of the auctioneer is exactly a device of this kind. For these reasons the first method is much to be preferred as a basis for dynamic analysis.

We return now to the main theme, the incompatibility between equilibrium and evolution. Why is it that market systems are ordered but never in equilibrium? The clue here is to

recognise that different elements in the system are changing at different rates, indeed this feature defines any evolving system. Adjustment speeds are nested some variables adjust rapidly others more slowly. Thus markets can clear to give order at a point in time while the conditions determining that order are changing but more slowly, there is a sequence of partial but increasingly general patterns of order. Now from this perspective it seems clear that Marshall's famous periodisation scheme was a device for distinguishing analytically between different dynamic forces operating with different velocities even though everything is happening at once, all the time. Thus *ceteris paribus* is a dynamic device to distinguish variables with different velocities, among which the rate of growth of new knowledge is particularly significant. It is not a device to distinguish different notions of equilibrium. What is inadmissible is the claim that a knowledge-based economy can ever be in a state of rest, a state with no internally generated disturbing forces. Thus to use a concept of equilibrium, and to mean by it a state of rest, is to accept that the disturbing forces are outwith the system and thus that the origins of change are non-economic. No one has stated this better than Shackle (1968). In commenting on the nature of Marshall's periodisation scheme and the idea of equilibrium, he writes,

“Equilibrium is a state of adjustment to circumstances, but it is fiction, Marshall's own and declared fiction, for it is an adjustment that *would* be attained if the very endeavour to reach it did not reveal fresh possibilities, give fresh command of resources, and prepare the way for inevitable, natural, organic further change.” (p.36).

The point is this, every position of temporary economic order creates within itself the conditions to change that order, and this is especially true of knowledge accumulated in the pursuit of innovation. As Schumpeter was especially keen to emphasise, and for very good reason, the development of capitalism arises from within, because capitalism is a system 'designed' to generate change. Every position is open to challenge, there are powerful incentives to mount those challenges and the characteristic feature of the market mechanism is to facilitate those challenges. This restless perspective is reinforced when we recognise that all economic processes take place in real time, subjective time, and that the mere passage of time means experiencing events and thus gaining new information and new thoughts. On both these counts it is particularly problematic if we try to posit some equilibrium economic state that is invariant to the motion towards it, for this is tantamount to holding knowledge (and the real time of human experience) constant while we get to equilibrium. In

equilibrium, clock time passes but nothing changes, cause and effect evaporate. This makes no sense other than in a formal way to avoid the problem. In short, if economies are out of equilibrium they stay out of equilibrium. But they always exhibit order and that order reflects, and might be measured in terms of processes of interaction and the patterns of coordination that ensue. Notice that this point runs much deeper than that of path dependence of outcomes in the presence of increasing returns to scale processes. It is the point made forcefully by Kaldor (1934) and it arises even when all production and marketing processes are of the constant returns to scale kind, in the conventional sense. One cannot have economic activity without a simultaneous change of knowledge (Metcalf *et al*, 2000).

One of the further difficulties here relates to the way time is treated in economic dynamics. There are, of course, at least three possible ways to define time. As solar clock time, as the idiosyncratic time of individual experience and as the logical time defined for analytic purposes in relation to a particular model of some world. The first defines time's arrow. The second defines the solitary moment of any individual's existence such that the past is a matter of memory and the future a matter of anticipation (Shackle, 1961). The third notion, logical, model time is quite different. We may run it backwards or forwards, all its points coexist simultaneously in the mind of the analyst and the analyst knows the future. In fact this notion of time has exactly the same status as any other model variable subject only to the fact that it is never the dependent variable in the system under consideration. This is clearly not the time of human experience.

The outcome of this line of thinking is that the market order stimulates its own 'destruction' in a number of ways. Market signals and their recent history, provide the benchmarks against which innovations can be imagined, and the plans created to marshal and apply the necessary resources. The observation of the activities of others, the experiences of the market process are essential ways in which new knowledge is generated and embodied in new business conjectures. The openness of the market order makes it possible for innovative challenges to be mounted to established plans and beliefs and for the pattern of resource allocation to be modified by the ensuing competition. The pattern of profits that arises from this process provides the means to finance further investments in innovation and in the physical and organisational capacity to bring them into effect. Thus the market system contains within it the incentives and the adjustment processes to enable continued economic evolution. Through all of these channels the growth of knowledge and the development of beliefs mean

that equilibrium as a state of rest is never attained. Capitalism evolves because capitalism is restless. Witt (1991) so accurately expresses the point, when he claims that cognitive creativity is at odds with any notion of equilibrium. The forces making for order are simultaneously the sources making for the imminent and immanent disruption of that order.

This approach to the engine of capitalism entails a parallel claim that there need be no attracting state(s) to which the economy is converging over some temporarily indeterminate 'long-run'. Instead an economy is a self-organising process that is continually being redefined by its novelty generating properties while being given pattern by the co-ordinating properties of markets and other institutions. If equilibrium is abandoned so necessarily is disequilibrium. Instead we have order and process, patterns and potentials, and the differential dynamic forces that redefine those patterns of activity, institutions and knowledge. Nor does this mean that all changes in pattern are haphazard, rather they are the results of evolutionary processes in which the changing relative importance of different activities is related to the distribution of the relevant behaviours around their associated population means. What I have elsewhere called Fisher's Principle provides the attractor free dynamics necessary to understand pattern formation and change and, incidentally, the rationale for local efficiency to increase an ensemble of average characteristics over time (Metcalf, 1998). In this sense there is an evolutionary rationale for local progress. Notice that an attractor free dynamics is not a constraint free dynamics and that those constraints must be expected to arise within the system and to vary endogenously over time. Evolutionary systems are always marked by a considerable degree of inertia, indeed quasi-stable relations are the *sine qua non* of creative change.

Within the developing body of research on the evolutionary economics, sociology and management of innovation a subtle shift is taking place away from the idea of institutions toward that of patterns of institutedness, the nature of the rules, practices and procedures that maintain and modify institutionalised relationships. It is these rules or habits that give to distributed innovation processes their stability. They not only provide the frameworks for generating and combining knowledge they also permit parsimony in the need for knowledge. Novelty is crucial but so is stability if the novel is ever to be evaluated constructively. Not everything, perhaps relatively little, can be permanently questioned and challenged at the same time. In the confidence to take many things for granted we find the scope for creative activity.

Two further aspects need to be cleared up before concluding. The evolutionary approach naturally rejects perfect foresight as the basis for economic reasoning and it also rejects the opposite extremes of radical subjectivism. The first rules out innovation by definition, the second makes it impossible. Of course, the future can only be imagined but this does not mean that over a wide range of economic activity that our imagination is not reliable. It is elementary that the economy must exhibit a great deal of continuity for future oriented economic action to be possible. Although knowledge is idiosyncratic, understanding is social and shared and if it were not a division of labour would not be possible. More precisely innovation is only possible in a stable but malleable world. Judgements must be trusted and imagination deemed to be reliable. Marshall's epigram, 'Natura non facit saltum' captures this perfectly, change is premised on continuity but continuity is not equilibrium.

There is a further casualty of the evolutionary view, namely the resort to arguments expressed in terms of representative agents, or more precisely uniform firms and households. Leaving aside the difficulty of how innovation is to be introduced without destroying the assumed uniformity of behaviour, the fundamental point is that behaviours that are representative in a statistical sense are emergent not intrinsic properties. Emergent properties are not attributes of individual agents but rather behavioural consequences that arise from the interactions between agents, and such interactions cannot be properties of the individual agents (Langlois, 1983; Blume and Durlaf, 2000). What is considered to be representative behaviour, therefore, must be a product of the analysis not an assumption underpinning it. Consequently, representative behaviour in a population of agents can evolve even when the underlying individual behaviours are constant. In a world of uniform agents this would, of course, be impossible. It then follows, in the presence of diverse micro behaviours, that what is representative in any given context depends upon the manner in which the individual behaviours are co-ordinated by markets and other institutions. Notice that this gives an evolutionary, adaptive theory an inevitable non-reductionist flavour, it is necessarily a rather sophisticated form of methodological individualism.

There is no more difficult concept to try and deal with in representative agent terms than that of the entrepreneur. Since entrepreneurs are agents of change they cannot exist in equilibrium, the rewards they earn depend on the economy being far from equilibrium, and the very notion of enterprise is tied to the introduction into the economy of novel behaviours.

Clearly an evolutionary, adaptive account of the economy must give entrepreneurship and enterprise a special place in its analysis. Indeed the notion of entrepreneurial behaviour is what we believe an unavoidable component of any complexity-based approach to the economy.

### **Markets and Innovation Systems: An Instituted Nexus**

The force of Nelson's account of the engine of progress should now be clear. It is that the evolutionary nature of capitalism rests on the mutual interdependence of selection in market systems and development within innovation systems. Market systems are competitive not by virtue of their structure but by virtue of the fact that every economic position within them is open to challenge, while the unpredictable generation of novelty becomes the means to mount those challenges. In this way, the self-organisation of knowledge becomes an essential part of the evolutionary story. It is the combination of institutions for selection and development that gives to capitalism its undoubted potential to change itself from within, to be, as it were, in a permanent, self-induced state of transformation.

Idiosyncratic firms and their capacity for differential development are central to this frame of thinking. The capabilities model of the firm has, since Penrose (1959) first articulated it, provided a coherent way of identifying what matters for an evolutionary theory of the firm. (Nelson, 1991). But an excessive concern with the internal accumulation of capabilities must clearly be avoided. Within innovation systems it is the external organisation of the firm that must also be articulated and managed, and it is this which gives the firm a unique role, namely to act as the one organisation that combines together multiple kinds of information from multiple sources in pursuit of innovation. It is not only knowledge of science and technology that is relevant here but equally knowledge of markets (product and factor) and knowledge of organisation. The network relationships that provide conduits for the relevant information do not occur naturally; they too have to be organised, the firm in effect has to construct its own external organisation. Thus a principal attribute of the engine of progress is that firms in their pursuit of competitive advantage actively construct, within the broader rules of the game, their own innovation system from the organisations that are open to interaction. To compete it is necessary to collaborate, and the sets of relations this entails, whether with suppliers, customers, universities or other agencies, are assembled and broken up as the innovation agenda develops. Patterns of innovation and the instituted arrangements that generate them can thus be said to co-evolve.

This hypothesis has I think some important consequences for the systems of innovation literature. The issue is not the domain of their definition, national, sectoral or whatever, but rather the dynamics of their birth, growth, stabilisation and decline. What is national is not the system per se but rather the set of capabilities located in national organisations and the frameworks of law and polity that condition their accessibility. Science and technology all operate with their own networks and communities of practice, part national, part sectoral, but they do not of themselves constitute an innovation system. Rather the innovation system has to be assembled, constructed by firms from the available capabilities often nationally located but not necessarily so. What a given nation offers is the richness of its knowledge capabilities and an institutional context that facilitate the recombination of capabilities into idiosyncratic innovation systems.

Evolutionists are familiar with the selectionist view that innovation is the driving force behind competition. The claim here is that the converse is equally true. From a developmentalist perspective competition drives innovation. The engine of progress runs in both directions.

### **Progress as Growth**

I conclude with some observations on a Nelsonian engine of progress perspective on the sources of economic growth. One important reason for spelling this out is that the orthodox approach to the growth of knowledge and the growth of the economy, is at the opposite end of the spectrum from the evolutionary adaptive framework discussed here. Why this is so is worth careful statement. Many scholars would agree that knowledge accumulation is the proximate source of economic growth, that the engine of progress is also an engine of discovery, but beyond this the differences in view become profound.

The first source of difference is with the question of ideas growing at a steady rate either in terms of themselves or in terms of their practical applicability. If our growth models are to be steady growth models then knowledge too must obey this requirement. That knowledge feeds on knowledge is a perfectly sensible idea but that it does so at a uniform geometric rate seems particularly hard to swallow. That research effort may grow in aggregate at such a rate does not entail the steady growth of the output of that enquiry, an observation that is surely

consistent with the uneven growth of science and technology over time let alone its uneven rate of application. That innovation scholars distinguish radical innovations from incremental innovations, or macro innovations from micro innovations reflects this obvious fact.

Part of the problem here is in conceiving of an aggregate stock of ideas. Are ideas to be added, multiplied together, or aggregated in combinatorial fashion, in which case the stock grows faster than exponentially? Whatever the process of aggregation we still need the weights (prices) with which an idea in carbon chemistry, say, is to be combined with an idea in the production of insurance services. It is not obvious what these weights are, and they certainly are not to be found in market prices.

It seems clear that the source of these difficulties is twofold, relating to the macroeconomic level of aggregation and the notion of a steady rate of knowledge accumulation. Neither of these is compatible with the idea of growth as transformation since they exclude from consideration the most pervasive of all the stylised facts of economic growth, structural change. As Kuznets (1971) emphasised, high rates of productivity growth are inseparable from high rates of change in the production structure. The fact that macro aggregates vary slowly over time does not imply that the underlying micro components also change slowly. Growth does not occur without persistent changes in the relative importance of products, methods of production, firms, industries, regions and whole economies, and these changes in structure are a consequence of the growth process. The empirical observation of steady aggregate growth is invariably based on microeconomic turmoil. Such turmoil is not an inconvenience that hides all that is essential about the economic process: like the shadows on the wall of Plato's cave, *it is the process of growth*. Economic, technological and business historians have long understood this elemental point, as have the group of scholars that sail under Schumpeter's banner, and those who are more explicitly evolutionary in their approach. Growth 'theorists' of the 1930s, including Young (1929), Kuznets (1930) and Burns (1934) also understood this fact. Indeed their theories of growth placed special emphasis on the uneven accumulation of knowledge in the economy.

To take these ideas on board requires that the macroeconomic approach to growth needs to be reinterpreted in radical fashion in the light of the restless nature of capitalism. This is the conclusion drawn by a number of scholars who are working with detailed longitudinal data sets on the USA manufacturing economy. They have produced compelling evidence on the wide range of productivity differences even between firms in the same narrow industry, on

the persistence of these differences over time, and on the corresponding importance of the changing relative importance of different firms and industries to the process of overall productivity growth (Foster *et al.*, 1998; Bailey *et al.*, 1992; Baldwin, 1995; Bartlesman and Doms, 2000). It is clear from this work that micro-diversity, in this case in relation to productivity and productivity growth, cannot be reduced to random fluctuations around a common productivity level and that there are a multiplicity of reasons for these differences between firms (Nelson, 1991, Harberger, 1998). This supports the view of some management scholars on the idiosyncratic properties of the firm, each one, as it were, writes its own signature in the economic record (Metcalf, 1996). To accommodate these findings requires a very different approach to the study of growth, to that embodied in the evolutionary perspective.

Let me conclude with two observations on what our representations of the engine of progress will be like. The first casualty of the change in perspective is a top-down approach to understanding growth. We can always measure macroeconomically but to do so necessarily averages away the details that matter for comprehending the growth process. This is not at all simply a statistical matter of eliminating unnecessary detail to get to the essentials. Rather it is the micro-diversity of behaviours and the interaction processes in specific market and innovation system contexts that define the transformation process from which growth is a consequence. To add together the consequences of transformation is not the problem, to obscure the process generating them is. Evolutionary growth theory has to be assembled from below, it is necessarily bottom-up, and the growth rates at different levels are emergent phenomena. However, 'bottom up' does not simply mean the absence of feedback from emergent effects evident at higher levels of aggregation and it would be a mistake to think otherwise. The second consequence is that the modelling of growth will be far less of the 'lemma, theorem, proof' variety (Krueger *et al.*, 1991; Comin, 2000). Instead of the tools choosing the problems the problems can choose the tools among which the most likely candidates lie, in my view, in the analysis of evolving adaptive systems. Such an approach is likely to depend more heavily on the historical record than is currently fashionable among economists, and a command of history is surely essential to the progress perspective.

## **Concluding Reflection**

In the insistence on the differences between formal and appreciative theory it is too easy to lose sight of the profoundly radical nature of the ideas promulgated by Nelson and Winter (1984) and extended by Nelson in his treatment of capitalism's engine of progress. The emphasis on the instituted origins of justifiable belief and the connection with plan and conduct take us to the heart of economics as a discipline.

No less an authority than Professor Hahn (1987) has suggested that consideration of the foundations of economic belief mean that 'we cannot satisfactorily pursue a history free economics' (p.325) and that an economic equilibrium must be an equilibrium of beliefs and that, consequentially 'it is history or path dependent' (p.327). With these sentiments we can only agree but not with the conclusion that Hahn draws. His concern to preserve a notion of equilibrium, in a world where knowledge, information and beliefs are paramount, leads him inexorably to a view incompatible with the engine of progress motif, namely that, in equilibrium, 'history has come to a stop'. That is to say, there are no longer internally generated reasons for beliefs to change. This is precisely to place equilibrium out of the time and out of human experience, as if the constituent actors are inanimate objects. Whatever this relates to, it surely cannot be capitalism. How strange to say that history matters in an essential way and yet to organise the theoretical system around a central analytic device that is inherently ahistorical. Like all Utopias, equilibrium is a fiction, at best a satire, a state of perfection within which "all is still and immutable and eternal". (Berlin, 1991, p.22)

This is why order is more general and more fundamental than equilibrium. The notion of order hinges on economic formulations of interaction and co-ordination, yet it is inherently open to the idea of internally generated change. The forces making for disturbance, and for resisting disturbance, the forces distributing different rates of change across the system and the forces that create interdependence of rates of change come immediately to the fore. In Nelson's evolutionary, adaptive picture these creative forces are premised on new knowledge and beliefs, together with the way in which the institutions of the market process translate those new beliefs into the emergent market order. The bottom line is simply this. In the analysis of creative systems we cannot use a notion of equilibrium *qua* state of rest but we can and must use a notion of order premised on interaction and co-ordination. On this plea for the importance of regularity in the presence of diversity and change I conclude.

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