Self-organisation or Selfcreation? From Social Physics to Realist Dynamics

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ABSTRACT

The currently fashionable theory of self-organisation has its origins in statistical physics. Many believe that the underlying physics model, which is based on inanimate systems, can be employed to explain and predict the emergence of social structures, even of history itself. Some are even convinced that it will be possible to construct a social physics to displace the social sciences. The purpose of this article is to test those claims by reviewing some of the physical studies that have been made of human society; and its conclusion is that those claims cannot be substantiated. The underlying problem is that self-organisation is a one-dimensional theoretical concept that focuses exclusively upon supply-side interactions, from which order and complexity are said (wrongly) to 'emerge'. But there is a better way. By systematic observation of living systems, both human and non-human, it has been possible to derive a general dynamic theory that embraces a more complex reality, involving a creative exchange between decision-making individuals and the changing needs of their society. I have called this interaction between the dynamic forces of demand and supply in living systems, the process of 'strategic exchange'. And it is this strategic exchange that determines all other structural relationships in society, including the interaction between its constituent members. It is important in the social sciences, therefore, to move on from social physics to embrace a realist dynamics.

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INTRODUCTION

Owing to the failure of orthodox social science disciplines to develop a realist general dynamic theory, raiders from the natural sciences have appeared regularly at our borders. In the mid 1970s, neo-Darwinian biologists threatened to absorb the social sciences into something Edward Wilson (1975) called ‘sociobiology’. This much-celebrated intellectual global empire, however, has failed to eventuate (Snooks 2003: chs 7 and 8). More recently – since the 1990s – the champions of statistical physics have claimed success where their biology competitors failed.

The purpose of this article is to test the strength of the claims for an all-conquering social physics. The results suggest that social physics, despite a build up of forces over the past few decades, has been no more successful in its objective of global mastery than sociobiology. Even their hybrid progeny – game theory and agent-based computational modelling (ABM) – resulting from opportunistic raids into new territory, have proved to be little more than shield-beating exercises. What the social sciences actually require is a transformation from within rather than a take-over from without. As social scientists are best placed to understand the nature of society, it is they, rather than intellectual warriors from the natural sciences, who should be developing our understanding of social dynamics. It is in this spirit that I propose the dynamic theory of ‘selfcreation’, which is a bulwark against the invading theory of self-organisation.

SELFCREATION – A REALIST THEORY OF LIFE

The essence of the theory of selfcreation is to be found in the *creative* exchange between purposeful agents and their society's unfolding dynamic strategy. It is this ‘strategic exchange’ that lies at the very heart of the self-sustaining dynamics of living systems. Social agents are self-motivated and self-driven, and they generate complexity and order in a *creative* response to a continuously changing strategic demand. It is this creative *exchange* between the demand and supply sides of a dynamic living system that generates changing genetic structures, technologies, ideas of all types, institutions, and organizations. By attempting to meet this constantly changing strategic demand, both the agents and their society are transformed in the long run. The creative process of exchange by which this takes place constitutes the 'life system' for the group of social agents in whom we are interested. Living systems, therefore, are 'autogenous' – or selfcreative – systems.

The dynamic theory behind the concept of selfcreation – the 'dynamic-strategy theory' – should be familiar enough by now. It has been published and formally commented upon in this journal on several occasions (Snooks 2002, 2005b; Nazaretyan 2005; Magee 2006) and in a series of books over the past decade (Snooks 1996, 1997, 1998a, 1998b, 1999, 2000, 2003). Accordingly, the dynamic-strategy theory requires no further elaboration here. The concept of 'selfcreation', as an autogenous dynamic process, has also been developed in my most recent book entitled *The Selfcreating Mind* (2006). As argued there, the 'selfcreating mind' is 'the mind that created itself' through the response of countless organisms to the ever-changing demands of their dynamic societies. They are driven to do so by the need to survive and prosper – a materialist force I call 'strategic desire' – but they are directed to do so by the requirements of a dynamic life system – a force I call 'strategic demand'. The concept of the 'selfcreating mind' – which displaces the mind hypothesised by psychoanalytic, Darwinian, and complexity theorists – provides a new perspective on the origin, nature, and purpose of the self-conscious mind; the reasons for its continuing breakdown in a significant minority of the population; and the surest road to recovery. It also provides answers to questions about the future of brain genetics, artificial intelligence, and the possibility of eliminating mental disorders. What I have not addressed in published form so far, however, is how the theory of selfcreation contrasts with that of self-organisation. This is the subject of the present article.

Selfcreation is an entirely new concept. In the selfcreation model, strategic exchange determines all other relationships in society, including the interaction between its constituent members. Strategic exchange is the core dynamic process, whereas agent interaction is a derived and, hence, secondary process. What this implies is that cooperation is central to the pursuit of survival and prosperity, while competition between agents is an attempt at the margin to improve individual strategic advantage. And cooperation is the outcome not of reiterative interactions between agents as claimed by game theorists but of a need to ensure the success of their joint strategic pursuit. The point here, of course, is that a society's strategic success is immeasurably more important to every individual than marginal changes in the individual pecking order. This key issue is completely lost on the theorists of self-organisation.

Self-organisation is a concept that has arisen from the use of statistical physics to explain the emergence of complexity and order in living systems. The history of this concept has taken two paths. First, some physicists have attempted to develop a physics of society – literally to explain the complexity of living systems in terms of the laws of physics. These are the hard-line intellectual warriors, who prefer to see people as particles. Second, there are others, mainly computer-oriented economists and political scientists, who are attempting to combine the structure of the physics model with the decision-making characteristics of living agents. While abandoning the laws of physics, they heroically assume that complexity is the outcome of supply-side interactions between agents subject to bounded rationality. It is argued here that self-organisation is a misnomer, because, as a theoretical construct, it does not embody a self-organising mechanism. Rather, it relies either on an exogenous driving force (physics model) or an exogenous rule-setter (agent-based model). Only the process of selfcreation transcends these limitations. Even more significantly, the concept of self-organisation is unable to account for the dynamics of life or human society. A physics of society, therefore, is totally out of the question. These issues will be explored further in the remainder of the article.

SELF-ORGANISATION – A THEORY OF INANIMATE INTERACTION

The currently popular theory of self-organisation has its origins, as already suggested, in statistical physics. As one populariser of this approach has said:

> Scientists are beginning to realize [assert?] that the theoretical framework that underpins contemporary physics can be adapted to describe social structures and behaviour, ranging from how traffic flows to how the economy fluctuates and how businesses are organized (Ball 2004: 13).

Less cautious authors are even convinced that the models of statistical physics can be employed to explain the origin of life (Kauffman 1993; 1995), the extinction of species (Bak 1997), and the transformations of human history (Buchanan 2000).

The basic idea behind the physics model of living systems is that their observed order and complexity is an outcome of interactions between large numbers of agents. These interactions are said to obey a few simple rules. It is an idea that arises from an analogy with the order that emerges spontaneously in inanimate systems owing to the laws of motion, gravity, and friction. In an open physical system, the interactions between its inanimate members are generated by the imposition of an external source of energy. Although it is not possible to calculate with any degree of precision the pattern of numerous colliding objects, the outcome is known to be ordered and complex.

The so-called sand-pile model, developed by Per Bak (1997), is a favourite analogy for those attempting to persuade us of the relevance of self-organisation theory to human society. The issue usually emphasised in discussions of the sand-pile model is the contrasting states of a sand-pile in equilibrium on a tabletop, and the same sand-pile augmented by a flow of sand grains from above. We are told that as additional grains of sand fall on the pile, it will build up until its slope reaches a critical level in relation to the force of gravity. From then on, the addition of further grains will cause either one large landslide or a series of smaller landslides, which cannot be determined in advance. Hence, our complex sand structure suddenly collapses and forms a featureless mass on the tabletop. This is known as a ‘phase transition’. By resuming the steady flow of sand from above, the process of construction and collapse will be repeated until sand covers the entire tabletop and begins flowing over the edge each time a landslide occurs.

From this point in the sand-pile's history, the quantity of sand on the tabletop stays (on average) the same, and the quantity flowing over the edge is equal to that being added from above. We are told that the sand-pile ‘system’ is now in a state of ‘self-organised criticality’ (SOC), created by a constant flow of energy from outside the system. The significant characteristic about a system in this critical state is that the addition of just a *single* grain of sand will cause the pile to generate either a single large avalanche or a series of smaller avalanches. While this constitutes a stationary state – as the system never departs far from it – it is not an equilibrium state because of the flow of energy (new grains of sand) from outside. It is a far-from-equilibrium state. Large claims have been made for the SOC concept first proposed by Bak and his colleagues (1989), but it also has its critics (Newman 1996; Sneppen and Newman 1996).

The sand-pile model has been analysed, using computer technology, from the micro as well as the macro level. But there is a problem. Grains of sand in real sand-piles do not behave in quite the way that computer sand-piles do. Grains of sand are not sufficiently 'sticky' to generate the above-mentioned series of well-defined smaller avalanches. It transpires that the 'best' sand-pile is one consisting of long-grained rice! Anyway, this 'ideal' computer sand-pile (or 'rice-pile') can be employed to view the interactions between individual grains by providing them with different colours.

This technique demonstrates an 'active' interaction between all grains in the pile. New grains falling from above do not just slide down the outside, they are driven deeply into the pile and after a time emerge again before being caught up in an avalanche. Some grains stay in the pile considerably longer than others. But, while no grain stays in the pile for the entire computer experiment, any grain can stay there for any length of time. In other words, all grains are involved in the process of interaction, build-up, and collapse.

Here in the sand-pile model are all the main features of the theory of self-organisation. The application of an external energy source to an open system consisting of a large number of particles, causes those particles to interact energetically so as to create complex structures that build-up to a critical point and then collapse in unpredictable ways. It is a cycle that recurs for as long as the exogenous driving force, and the resulting state of SOC, continue to exist. This process of self-organisation, therefore, is the outcome of a physical system obeying simple laws of physics, including those of motion, gravity, and friction.

Both macro and micro outcomes in this model are unpredictable owing to the large number of interacting objects. Newtonian precision is only possible when the interaction takes place between two or three objects. How then is it possible for order to exist in the real world? Unpredictable outcomes are said to obey a 'power law' – the law of large numbers – which governs the probability of fluctuations of a given size. This law tells us that while avalanches of any size can be generated at any time by small triggers in a sandpile experiencing self-organised criticality, the probability of large events is considerably less than that of small events. Fig. 1, which is a schematic double-log graph, shows that the approximate probability of large avalanches (on the right of the diagram) are less frequent than small avalanches (on the left). A power law is represented by a straight line on a double-log diagram. In this type of model, the exponent of the power law (the slope of the line) is close to – 1 (Newman 2005).

A distribution obeying a power law is a modified random walk – a random walk punctuated with steps of any size, where the probability of occurrence decreases as the steps get bigger. In other words, it can be thought of as a gaussian probability curve with 'fat' tails. In a normal random walk, all steps are the same size. What, you might ask, does this actually mean? Even a physicist would have to admit that this discussion is merely descriptive. Nevertheless, a number of 'physical mechanisms' have been suggested by physicists to explain power laws. The chief among them are the so-called 'Yule process' ('the rich get richer') in which, for example, the largest cities acquire more inhabitants than smaller cities in proportion to existing population sizes; as well as the concept of self-organised criticality that has already been discussed. These explanations, however, are unsatisfactory because they are ad hoc, partial, and not part of a general dynamic theory. For example, in the case of city growth these mechanisms do not explain the underlying reasons for growth or why some cities initially grew faster than others. They only 'explain' the distribution of subsequent growth once the all-important general pattern has been laid down. Even then, the explanations are statistical rather than 'strategic' (or existential), as they are not part of a more general dynamic theory of complex systems.

More importantly, it is clear that the interaction between particles being described in this model is the result not of 'choice' but of the flow of outside energy. It has already been mentioned that 'self-organisation' is a misnomer, as interactions between particles are generated by exogenous forces. 'Forced-organisation' would be a better name. None of this matters, of course, provided everyone is clear about what the term 'self-organisation' actually means in this context, and provided the distinction between self-less 'self-organisation' on the one hand and self-full 'selfcreation' on the other is recognised. What does matter, however, is that self-organisation is a concept that applies persuasively only to inanimate systems, and only then as the outcome of an exogenous driving force.

What the sand-pile model cannot tell us is how complex inanimate systems change over time. What pathways do complex systems take? What is their history? Classical thermodynamics is unable to analyse these issues because its method is limited to comparative statics rather than dynamics. It is, in other words, interested in the equilibrium conditions that exist both before and after a 'phase transition' occurs. Traditionally, classical thermodynamics has focused on systems that change suddenly from one state to another, such as the transition from a liquid to a gas or a liquid to a frozen solid; or on increasing entropy in closed systems leading from order to disorder. It is interesting that neoclassical economics, which was strongly influenced by classical thermodynamics with its focus on equilibrium and comparative statics, also failed to develop a theory of dynamics (Snooks 1993, 1998b).

In contrast, complexity theory, which is an outcome of the more recent statistical physics, is concerned with non-equilibrium processes of change. It is, in other words, concerned to focus on the history of inanimate and, more recently, living systems. There has been a belated recognition by physicists that real-world processes of change rarely take the form of great leaps between equilibrium states. With this change of focus, the challenge became how to analyse the growth path of systems employing a supply-side model of forced physical interaction. The solution, pioneered by Ilya Prigogine (1981) and others from the 1950s and 1960s, was to view the growth process as the outcome of a succession of bifurcations or crisis points offering two very different paths forward. What links phase transitions with non-equilibrium bifurcations, of course, is the underlying model of 'forced interactions'.

Equilibrium is not an option for a system being driven by a persistent exogenous force. Once a crisis point has been reached –

see Fig. 2 – the dynamic system is forced to change its state abruptly and dramatically by 'choosing' one of the alternative paths available to it. In an inanimate system this 'choice', we are told, is determined by the smallest chance or random fluctuation. The outcome, therefore, is entirely arbitrary, being determined by the contingencies of history. Hence, two systems with identical starting points and the same driving force, can end up in very different places, such as X and Y in Fig. 2, at a given point in time. For as long as the exogenous driving force operates on this non-equilibrium system, it will continue to pass through time via a succession of bifurcations. The growth path, therefore, is the unpredictable outcome of forced crises, the local interaction of many system members, and historical contingency or chance. Also, owing to positive feedback, the path taken is highly sensitive to the system′s initial conditions.

The question of interest here is: How relevant is this model to the growth and fluctuations of human society? The short answer is: *Not at all relevant*, as human society does not change in this way at all. Hence, those economists interested in dynamics need to abandon statistical physics and adopt the method of 'dynamic stratology' outlined here. The critical point is that societal growth is not an outcome of exogenously forced crises, local interaction, arbitrary 'choices', or a pattern of bifurcated pathways. Rather, as I have shown in many publications (Snooks 1996, 1997, 1998a, 1998b, 1999, 2000, 2003, 2005a), it is the outcome of an endogenous driving force (called 'strategic desire') attempting to maximise the probability of survival and prosperity, the rational adoption by strategists of a sequence of dynamic strategies that fulfils this objective, and the forging of a dynamic pathway that reflects the wave-like pattern of the exploitation and exhaustion of this strategic sequence. The dynamic pathway of human society, therefore, is not a forced and unpredictable zig-zag pattern through an arbitrary world, but a predictable progression of wave-like surges that finally exhausts the system's strategic opportunities and collapses irretrievably. Such a collapse cannot just happen at any time or be caused by a small trigger; *rather it is the culmination of a robust process of strategic exploitation and exhaustion.*

What is true for human society is, as shown in *The Collapse of Darwinism* (Snooks 2003: ch. 9), also true of other species. Hence, the science historian John Gribbin (2005: 157) is wrong when he claims:

> What the fossil record seems to be telling us is that extinctions happen on all scales, all the time, and that (like earthquakes) an extinction of any size can happen at any time… An extinction of any size might be set off by a trigger of any size.

This is a misreading of the fossil evidence arising from a commitment to the so-called 'universality' of complexity theory. In reality, the scale of extinctions at any point in time is a function of the various levels at which the strategic pursuit occurs – at the population, species, closely-related-groups of species, and dynasty levels (Snooks 2003, 2005a). While extinctions at any of these levels may be happening at any time, they are the complex outcomes of the exploitation and exhaustion of dynamic-strategy sequences *at these levels* – the outcome of strategic laws – not the outcome of power laws at the global level for life as a whole. Collapse and extinction emerge from cumulative strategic processes in which the key relationship is that of 'strategic exchange' between purposeful agents and a changing strategic demand as the strategic sequence unfolds (in a materialist and not teleological way). All other relationships and 'interactions' are shaped by this *creative* exchange (Snooks 1997, 2003).

THE RELEVANCE OF A THEORY IN WHICH 'PARTICLES BECOME PEOPLE'

Complexity theory has a number of useful applications in the physical world. Self-organised criticality has been employed by some to explain the size-distribution of earthquakes, volcanic activity, forest fires, solar flares, and 'starquakes' (Bak 1997). This may well be reasonable in the case of these inanimate systems. Yet, increasingly, there have been attempts to apply this form of statistical physics to living systems; to the origin of life (Kauffman 1993, 1995), the extinction of species (Bak 1997), and, initially, to various extreme situations in human society (Axelrod 1984; Axelrod and Bennett 1993). More recently, there has been a push, called agent-based modelling (ABM), to formalise this concept in the social sciences in general and economics in particular (Epstein and Axtell 1996; Epstein 1999, Tesfatsion and Judd 2006). To justify this inflation of complexity theory, the science writer Philip Ball (2004: 135, my emphasis) says: 'To develop a physics of society, we must take a bold step that some might regard as a leap of faith and others as a preposterous idealization … [in which] *particles will become people*'. It certainly is both bold and preposterous, but more significantly it is totally unable to encapsulate the dynamics of life.

The central deficiency of complexity theory is that it does not constitute an endogenous general dynamic theory of life and human society. It does not, in other words, embrace a self-starting, self-sustaining system driven by self-motivated agents capable of participating in a creative exchange with their constantly changing parameters. It postulates either a system of interacting particles driven by an exogenous force or, more recently, a system of 'heterogenous autonomous actors with bounded information and computing capacity' (Epstein 1999: 56). In both cases the structure of the theory is essentially the same. Hence, complexity theory is unable to explain or predict the group dynamics of living systems. Without these abilities, a physics of society is impossible. The best case that can be made for the theory of self-organisation is that its conclusions are not entirely inconsistent with the outcomes – rather than the processes – of living agents *caught up in extreme or arbitrary situations over which they have no control*. These situations include traffic jams, flight from burning buildings, and the like. Also the focus in these attempts to model living systems is usually on the way life forms travel over physical terrain. A brief review of some of the claims of social physicists will demonstrate this point.

Many of the studies in question focus on the physical pathways of life forms (bacteria), including our own (cities). Why? Because physical laws are clearly involved in the way life forms traverse the physical terrain of this planet. The flaw in this approach, however, is that our movement over the Earth's surface is the outcome of a more profound dynamic process, driven by laws of its own. This geographical expansion of human society can take the form of urban development that is the outcome of either the commerce strategy of the pre-modern era, or the technological strategy of our own era; or of the occupation of new productive lands, trading bases, or fortified towns as the outcome of the family-multiplication, commerce, or conquest strategies respectively. While physical constraints must be overcome in any type of geographical expansion, the underlying dynamic processes are strategic not physical.

Complexity theory, therefore, is completely unable to explain the fundamental dynamic processes of life. Accordingly it has focussed instead on the trivial outcomes of those processes, such as the fractal patterns of growing bacteria, the way crowds of people react to crisis in constrained conditions, and the reaction of car drivers in traffic jams. Even if it could be demonstrated that the laws of physics can explain these dynamically marginal and non-strategic happenings, this would still be a very long way from building the fanciful citadel of 'social physics'. The problem for would-be social physicists is that even in highly physically constrained situations, self-motivated 'people' can and do respond in ways that 'particles' cannot and will never do. This is why the statistical results of human interactions never conform entirely to what is expected of particles obeying power laws. Instead, the so-called mechanical interactions on the part of individuals caught in extreme situations are a form of 'strategic interaction' – of following those individuals who, or rules that, give promise of success (called 'strategic imitation') – which is shaped by the more fundamental 'strategic exchange'.

Some complexity theorists, however, are not satisfied with examining the physics of crowd behaviour. They appear to believe that an all-embracing physics of society really is possible. Accordingly they are determined to apply their theory to less trivial – in a dynamic sense – aspects of human society. These issues include the history of civilization, 'economic' fluctuations, income distribution, the size and growth of firms, the role of government, cooperation, the world-wide-web, voting, crime and punishment, and marriage. Of these I will consider only the more ambitious.

A physics of history?

A number of attempts have been made to develop a physics of history. In *Ubiquity*, for example, the physicist and science writer Mark Buchanan (2000) claims that history operates in a self-organised critical way, via a recurrent process of growing com plexity and collapse owing to interaction between agents. Essentially this process is the outcome of conflicts and wars, which in turn are the result of international tensions that keep the major nations in a state of constant diplomatic crisis (that is, a SOC). In such circumstances, conflicts and wars are inevitable, and they are governed by a power law. That is to say, conflicts of any size can be sparked at any time by the smallest disturbance – such as the assassination of Archduke Franz Ferdinand in Sarajevo in 1914.

In terms of the dynamic-strategy theory – the basic theory underlying the concept of selfcreation – this argument makes little sense. In reality, wars are either part of the conquest strategy or they are the outcome of attempts to defend or gain control of a nation's dynamic strategy. In both cases, wars have deeply felt strategic causes and are not the outcome of trivial or accidental events. But, of course, trivial events may be employed as an excuse to begin a major conflict, such as the First World War, that has deeper strategic causes (Snooks 1997: 503–508). What a more profound analysis makes clear is that as major wars are extremely expensive in terms of financial resources, infrastructure, and human lives, they are only undertaken by strategically rational nations if the likely outcome is expected to be highly profitable. Certainly, they are not likely to occur at ‘any time’ as a result of trivial causes that could be resolved more economically – such as by diplomacy, counter assassination, or limited military strikes. Like all other dynamic strategies, wars obey strategic laws not power laws (particularly when only a handful of nations, rather than the required large numbers, are involved).

Despite the limitations of these physical models, even some political scientists have been tempted to explain major historical episodes in their terms. Robert Axelrod (1993) and his colleagues have employed the theory of statistical mechanics to develop what they call ‘landscape theory’ to explain the formation of alliances between nations. The landscape model centres on the idea that there exist forces of ‘attraction’ and ‘repulsion’ between interacting nations, and its objective is to discover the most stable way that resulting national alliances can be arranged. To discover this equilibrium state, Axelrod et al focus on the ‘energy’ generated by these forces of attraction and repulsion. Close rivals generate high energy levels if forced into the same camp, but lower energy if grouped with nations that are complementary rather than competitive. Hence, the lowest-energy configuration is supposed to provide the most stable pattern of alliances. A three-dimensional energy landscape can be computer generated to show an energy terrain consisting of peaks and valleys, in order to see how best to maximise alliance stability.

While the landscape model makes reasonably accurate retrospective 'predictions' about the alliances during the Second World War, similar results could have been obtained merely by possessing a moderately good understanding of the political ambitions and economic strategies of the nations of Europe during the interwar period. The energy landscape diagram is merely technical window dressing. And of course it tells us nothing about *why* the Second World War broke out. That requires a more sophisticated understanding of historical and, particularly, 'strategic' processes.

More importantly, what this exercise highlights is the poverty of the supply-side approach that plagues not only social physics but all orthodox academic disciplines. When a theory has no demand-side, how is it possible to determine where a system is headed – its 'directionality'? While the life sciences elect to explain outcomes as being extruded from fixed supply-side characteristics, such as the genetic structure or the psychology of agents, the physical sciences employ the idea of 'attractors'. Attractors, or equilibrium states, are usually discussed in physical terms. They are the 'valleys' and 'depressions' in energy landscapes towards which complex systems are attracted, just as water or other physical objects traverse physical terrain. The attempt to apply this type of physical thinking to living systems, particularly human society, is doomed to failure.

An entirely new type of social theory is required to explain the direction taken by history. We need to abandon simplistic supply-side theory – the sound of one hand clapping – and adopt a more sophisticated and comprehensive type of theory that includes a demand side. Over the past decade I have developed such a theory, in which 'directionality' in human society and history is determined by the generation of 'strategic demand'. In the above example of alliance formation, political patterns and any resulting conflicts can be seen as the outcome of national strategic pursuits, which in turn are shaped by changing strategic demand (Snooks 1996, 1997). When dealing with the dynamics of human society, we must look to strategic laws not the laws of physics (Snooks 1998a).

A physics of the economy – or of the 'casino'?

Currently there are two broad approaches taken by physicists to the modern economy. The first of these is known as 'observational econophysics', and one of its pioneers is Bertrand Roehner (2002), a physicist at the University of Paris. This is an important approach to reality, concerned to discover the real-world patterns in a wide cross-section of comparative data on economic events in order to *inductively* develop theoretical explanations. We can expect major advances in our understanding of human society from this systematic empirical methodology. The second approach involves an attempt to apply existing theories from statistical physics to the human economy. This is a deeply flawed approach that requires further discussion.

There is a fundamental confusion in the minds of many physicists about the identity and nature of the modern economy. They are determined to treat the stock exchange as if it were the core of the market economy. In this way, statistical physicists feel comfortable in turning their backs on real economic data (such as GDP, output, labour, capital, and the prices of *real* commodities and services), and in focusing their attention on the prices of stocks and shares. They are in effect turning away from the economy to embrace the 'casino'. They do so because not only do they fail to understand what the economy really is, but because they think they see the laws of physics reflected in the behaviour of the stock exchange if not in the real economy.

Philip Ball (2004: 240), for example, focuses on Standard and Poor's 500 stock-market index, which, we are told, is 'a common measure of the state of the US economy'. By doing so he concludes that 'market prices' are not randomly generated. Instead of being confined to a limited range, this price data is subject to some large fluctuations – a random walk with some 'big leaps'. He also claims that 'the economy [he means the stock exchange] does not appear to be guided very much by rationality', rather it is 'chaotic and irrational', 'intrinsically unstable', and, hence, not amenable to the correcting influence of public policy. Instead, the 'economy' is said to obey a power law, by which economic crises both large and small can arise at any time in this state of self-organised criticality as the outcome of even small triggers. In this light, the Great Depression of the 1930s is seen as an outcome of the Wall Street crash, triggered by some small, overlooked, disturbance.

But there is a caveat, as even stock-exchange prices do not behave as a statistical physicist would wish. Hence, we are told that:

> The idea of a self-organised critical *economy* is an appealing one [only to a physicist!]. But sadly, like the sand-pile model, it seems to be right in spirit but wrong in detail. The very essence of SOC is scale-free behaviour described by a power law. But although *economic* data, such as the rise and fall of the S&P 500 index, can appear to behave in this way within certain limits, these features do not persist in the big picture … The larger the time step, the more the probability distribution of fluctuations approaches the gaussian form … So any model which assumes or predicts a single mathematical form for statistics of price changes on all timescales cannot be right … So … SOC alone is not the key to how the *economy* works (Ball 2004: 301–302; my emphasis).

So, complexity theory applied to the 'economy' is right in spirit but wrong in some of its details, mainly in the longer term. Right? *Wrong!* Complexity theory is wrong in spirit as well as in *all* the details. In the first place, the stock exchange is not the real economy. While it plays an important role in raising capital for business ventures, it is largely a house of speculation – what I prefer to call the 'casino'. Instead of looking to the real economy for answers, physicists focus instead on the 'casino'. Data from the real economy – such as GDP, labour, capital, and the prices of real goods and services – reflect the incentives and outcomes of the strategic pursuit, whereas data from the 'casino' – such as the prices of stocks and shares – largely reflect the gambling spirit of society. As John Maynard Keynes once shrewdly said (in effect): all is well while speculation is the bubble on the ocean, but when it becomes the ocean, society is in deep trouble.

Despite facilitating the raising of capital, the stock exchange is highly dependent upon the real economy, and it can be understood in the *longer term* only by what is happening there – in particular what stage has been reached in the unfolding of the dominant dynamic strategy. For example, in the era of the Great Depression, investors accustomed to high profits shifted their attention from the real economy to the 'casino' as the US dynamic strategy exhausted itself by the mid 1920s. It was this that led to grossly excessive speculation on, and the collapse of, Wall Street – not the other way around (Snooks 1997: 384–390). In the *shorter term*, stock-market prices are driven merely by the daydreams and nightmares of speculators and gamblers.

Why are physicists attracted to the 'casino' rather than the real economy? Because, in the short term, at least, the stock exchange vaguely resembles their physical models of interaction, with buyers and sellers responding not to strategic demand but to the flashing lights (like the tail lights of cars caught in a growing traffic jam) on a great electronic board, or on millions of small electronic boards carrying the same seductive data. The desperate knee-jerk reaction of speculators makes the stock exchange operate like the physicists′ interaction model in the *short run*. But in the *long run* the stock exchange is dominated by the real economy, attracting or disgorging investors who are habituated to reaping high material returns. In the long run even the stock exchange must be explained using strategic laws rather than power laws. Hence, there will never be a physics of society, and physicists will never frame economic policy.

In the second place, real economies do not obey power laws, because human agents manage the prevailing feedback mechanisms, thereby restraining growth, and preventing small triggers from exercising chaotic effects. The strategic organism is much under-rated by social physicists. Societies eventually collapse not because of run-away growth on the cusp of chaos but because the strategic sequence they are pursuing is finally exhausted and cannot be replaced. And this exhaustion is the outcome of a long-run, cumulative process of development – a process that obeys strategic laws not power laws.

A physics of economic dynamics?

Some economists unhappy with the comparative-static approach of their discipline are attempting to employ the physics approach to systems to develop a theory of economic dynamics. The pioneers of this movement appear to have been influenced by statistical physics initially in the form of game theory and later through complexity theory (Axelrod 1984, 1987; Epstein 1999). This agent-based computational economics (ACE) group is concerned with the complex outcomes that arise from the interaction between agents that possess computing abilities and operate with bounded information. As such they are concerned with the interactions between 'people' rather than 'particles'. Yet they accept and adopt the causal mechanism of the physics' model – the local interaction between agents – to explain the 'emergence' of complexity. Their model, therefore, is a physics-influenced, supply-side approach to complex systems. It is, in their words, a theory about 'artificial societies'. They see the 'emergence' of order and complexity as being in the tradition of Adam Smith's 'invisible hand' and Friedrich von Hayek's 'spontaneous order'. But neither they nor their heroes are/were aware of the universal dynamic force that shapes interactions between agents. As I have suggested earlier, that unseen but universally powerful force is 'strategic demand', which is responsible for managing the key process of 'strategic exchange'.

The influence of this supply-side physics can be seen reflected in the central question posed by ACE advocates: 'How could the decentralized local interactions of heterogeneous autonomous agents generate the given [macroscopic] regularity?' (Epstein 1999: 41). In order to answer this highly physics-biased question, ACE-advocates develop simple sets of rules of local interaction intended to mimic the real-world patterns which they are interested in. This is done by employing computerised simulation techniques. In other words, they attempt to develop computerised 'artificial societies' – for example, the sweetly seductive but achingly hollow computer game called 'Sugarscape' (Epstein and Axtell 1996) – that are based on the insights of complexity in physical systems to explain real-world patterns in human society.

This is a very risky approach. If the supply-side physics model is not applicable to living systems, then the entire ACE programme is fatally flawed. It will create a model *not* of the universe we actually inhabit but of some parallel universe in which the physics model is valid for living systems. In other words, this programme will entirely distort our understanding of reality. The question that should have been asked is: What is the real-world mechanism that is actually responsible for the macro-societal patterns we observe, and how can it be encompassed in a general dynamic theory of life and human society? Such a question is far more difficult to answer, but at least it does not commit us to a prejudicial and deforming answer.

Does the theory of self-organisation survive the translation from physics to the life sciences? When analysing physical systems, it may be reasonable to suppose that local interactions are the outcome of the laws of physics and that these interactions are responsible for the emergence of complexity. But how can we relate this to living systems, and how are we to interpret the implications for reality? Essentially the rules of interaction in ‘artificial’ living systems are those devised and manipulated by a human simulator in order to mimic patterns observed in reality. Yet what does this imply about the emergence of complexity in reality? It implies that the whole process is generated by an artificial outsider – a ‘Divine Simulator’! Once you abandon the laws of physics, ‘God’ is required to make any ‘self’-organisational system work. This involves a massive contradiction – an omniscient outsider to create the rules for ‘self’-organisation – from which there is no escape for ACE advocates.

But there *is* a way out for those willing to abandon the supply-side physics model entirely. As suggested above, the theory of self-organisation theory is wrongly focused. We need to look at the creative exchanges between agents on the one hand and the ever-changing parameters of their society on the other, not just at the interaction between agents. While agents do compete with each other over resources and material outcomes, this is secondary to the ‘strategic exchange’ between these agents and the unfolding dynamic strategy of their society. The vast majority of individuals actually struggle to conform to the pattern of strategic behaviour exhibited by successful strategic pioneers. This is what I call ‘strategic imitation’ – one of the most powerful forces in human society. Hence, the ‘strategic pursuit’ is a joint and cooperative activity. Individuals are not bouncing off each other in arbitrary and irrational ways, but are rationally attempting to join together in *creative* ways to maximise their joint material outcomes. While they compete with each other, it is merely to achieve marginally better positions within this process. It is essential to realise that the joint strategic pursuit is of far greater importance than any individual competitive interaction. Further discussion of the idea of cooperation will clearly demonstrate this conclusion.

Cooperation or chaos?

Cooperation is a vital but problematical concept in social physics. Cooperation is vital because the idea of order on the edge of chaos – self-organised criticality – is a frightening one for physicists who have little understanding of the self-sustaining nature of human society. Cooperation is seen as a way of avoiding the descent into chaos. One commentator writes: 'If we know that cooperation is possible, even in a world that lacks altruism, we have no reason to despair' (Ball 2004: 563). And cooperation is problematical for social physicists because complexity theory cannot explain it persuasively. Self-organisation theory is all about physical interaction – or primitive competition – not about working together on a joint life pursuit. Indeed, no supply-side theory – whether it be neo-Darwinist or game theoretic – can deal successfully with cooperation as it appears in the real world (Snooks 2003).

It is for the above reasons that some physical and social scientists, convinced of the importance of self-organisation theory, are concerned about the implications of the Snooks-Panov algorithm. This algorithm is a mathematical formulation showing that the process of biological/technological transformation over the past 4,000 myrs has occurred exponentially (Snooks 1996: 79–82, 92–95, 402–405; Snooks 2005a: 229–231; Panov 2005). These scholars are concerned, unnecessarily, that the checks and balances required to prevent the order of human society from descending into chaos are not sufficiently robust (Nazaretyan 2005a-c; Panov 2005). Their unwarranted concern is primarily the result of the limitations of a supply-side complexity theory. As my demand-side dynamic-strategy theory shows, robust checks and balances do in fact exist, with the result that the exponential growth of life and human society has occurred over the past 4,000 myrs, and will continue to occur, at a *constant*, not an increasing, compound rate of growth (Snooks 2005b, 2005c). Human society is not about to launch itself into the chasm of chaos, because strategic agents are past masters at managing feedback.

How do social physicists attempt to resolve this dilemma – of cooperation or chaos – which is of their own making. The role of governments in compelling cooperation and punishing transgressors is usually considered but finally rejected by all except those with authoritarian tendencies. So, in hope rather than conviction, it is suggested that game theory – another supply-side approach – might provide the answer all concerned social physicists are looking for. This would be a happy outcome indeed, because game theory was the joint product of the statistical physicist John Von Neumann and the economist Oskar Morgenstern, which resulted in the celebrated *Theory of Games and Economic Behavior* in 1944.

The often-expressed hope of social physicists is that 'cooperation can evolve'. It is believed that through repeated interactions, players in the game of life will learn from past errors and develop 'mutual trust'. One problem with this line of argument is that the results of organised games are not encouraging. In the late 1970s, Robert Axelrod (1984) organised a series of internet tournaments to discover how interactive games could be most effectively played. He found that there is no 'best' way to play these games, as it all depends on who the participants are and what tactics ('strategies' in this context is a misnomer) they are convinced in advance will win – which merely demonstrates that the physical interaction model makes little sense. What did emerge clearly from these games is that even when convinced cooperators made initial gains, they were always ultimately vulnerable to rogue defectors. Even a small band of defectors could totally destroy a cooperative culture. Some have concluded that only a strong and harsh central government could prevent this, which is hardly a solution for liberal democracies. And, of course, this brings us back to the very reason that game theory was resorted to by social physicists in the first place!

It is also clear from any realist stance that game theory is not well founded. First, games like 'prisoners' dilemma' and 'tit-for-tat' (in its various forms) are highly artificial and unrealistic. They are merely the result of arbitrary rules that can be changed to obtain the outcomes one desires. In reality, the rules of engagement are set by strategic demand in any life system. Second, the implications of this approach for our understanding of reality are metaphysical. It suggests that life resembles a supply-side computer world in which the rules of interaction are determined and arbitrarily changed by an all-powerful being from outside the system. Game theory, as in ACE 'artificial' societies, requires 'God' to make it work – to generate order and prevent chaos. The only solution to this problem is a robust general dynamic theory that is capable of generating all the necessary rules of engagement endogenously.

This brings us to the third and most fundamental problem. Social physicists have failed to recognise the existence, let alone the role, of 'strategic exchange', which is the central feature of a demand-dominated general dynamic theory. Social physics is, as I have mentioned before, like one hand clapping, as it focuses solely on the supply-side interaction between agents. In doing so, it fails to appreciate the existence of a dominant demand side that shapes the social order as well as the rules of engagement. It is, as we have seen, the demand side that provides the 'directionality' lacking in self-organisation theory. Strategic demand, which changes as the dominant dynamic strategy unfolds, calls forth a joint response from all active agents in any society. This is the process of strategic exchange. And in this process, trust is invested by individuals in the successful strategic pursuit – reflected in an increasing material prosperity – and not in each other. Cooperation is the outcome. When the success of the strategic pursuit wanes, both trust and cooperation decline and, under conditions of extreme crisis, evaporate completely. Competition, or interaction, between agents is a phenomenon that is secondary to 'strategic cooperation'.

Order, therefore, is the outcome of a successfully unfolding dominant dynamic strategy. The anxiety expressed by social physicists about sustaining order on the edge of chaos is the outcome of a fundamentally flawed theory – *a science fiction*. There can be no social physics, only 'social stratology' – a new study of the dynamics of the strategic pursuit.

CONCLUSIONS

Despite all the obvious difficulties in applying statistical physics even to the margins of human society, there are those who believe it has a role to play in the social sciences. Numbered among them are even some social scientists. We have seen how advocates of ACE have distorted our view of dynamic processes by adopting the structural characteristics, if not the laws, of the physics model. Even a few historical economists, such as Paul David (1993), have been misled by physical models in their adoption of the hypothesis of 'path dependence' (Arthur 1989). This is the idea that institutional features of the past exercise a strong and relatively inflexible influence over the present. And, more recently, some scholars interested in 'big history' (or universal history) have embraced the theory of self-organisation, largely because it tells a simple, apparently universal, story about the complexity of the real world. In both cases this simple story of complexity is also a misleading story. The social and behavioural sciences will only tell a convincing story about social complexity when they turn from simplistic physical theories to embrace more complex realist societal theories.

But to some, statistical physics continues to offer a degree of hope and universality in an apparently chaotic and fragmented world. We are, for example, encouraged to respond

> With a certain wonder at the universality that organizes many aspects of society in the same way as it directs the properties of atoms. We need not turn this into a 'religion of science' …We can simply celebrate the fact that there are indeed 'laws of large numbers' and that they let us divine order and regularity in an otherwise terrifying diversity (Ball 2004: 310).

Of course, a 'terrifying diversity' is the fate facing those who possess no realist general dynamic theory to explain the world in which we live – a terrifying diversity that causes many to clutch at the straws of an entirely deficient complexity theory.

As we have seen, neither physics nor ABM has much to tell us about the choices made by living agents. And choice is central to the process of 'strategic exchange' that drives all living systems. Complexity in human culture is not simply extruded from the supply side of human society through 'local interaction' but rather is the outcome of a creative response to the strategic demand generated by an unfolding dynamic strategy. Similarly, complexity is not the isolated outcome of individual psychology as many behaviouralists would claim. That too is an unhelpful supply-side approach, as shown in *The Selfcreating Mind* (2006). To understand the real 'global state' of human society, we need to adopt a realist general dynamic theory from within the social sciences, not a statistical theory from the physical sciences.

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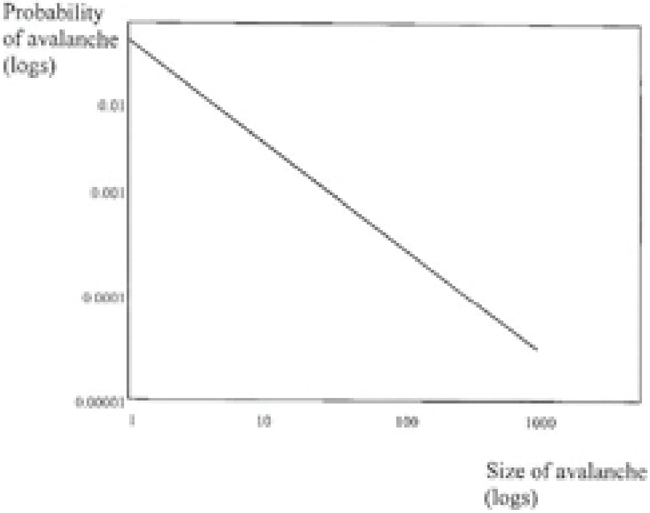

Fig. 1. The sand-pile model – the power-law probability distribution of avalanches

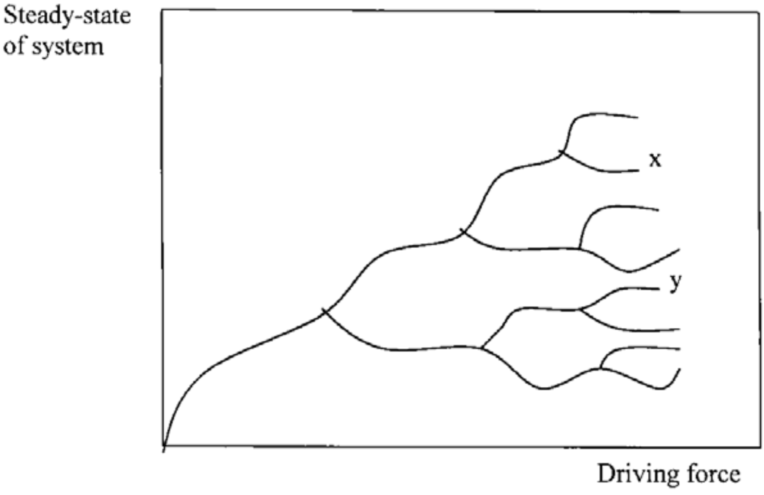

Fig. 2. Non-equilibrium growth pathways