

# Complexity theory and implications for policy development

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## **Abstract**

Complexity theory presents to us a view of the world as *essentially* systemic, interconnected: where the future emerges and cannot be predicted, and where diversity is essential for adaptation and change. This paper will explore what such a worldview implies for policy makers. Conclusions centre on the need for policies and regulatory frameworks to be interconnected and handle explicitly the sometimes conflicting objectives of economics, the environment and concerns for social justice; emphasis is given to the need for policies to be 'live', dynamic, able to respond to potential unintended outcomes. The issue of global governance and the role, in this, of social movements, is raised.

## **1. Introduction**

Our current dominant worldview – which underpins most mainstream schools of thought – in economics, policy-making, management, education and development – still centres on the mechanistic idea that the world is objective, measurable, predictable and controllable; and this is despite almost overwhelming evidence to the contrary. Has this always been the case? Early philosophers in both the East and West held a much more sophisticated view: of the world as changing and flowing, but yet with a degree of order and patterning that arose intrinsically, from within.

This image is captured in the following fragment, part of the few remaining writings of Heraclitus (Kirk et al, 1957:195).

*Upon those that step into the same rivers different and different waters flow...They scatter and ...gather...come together...and flow away...approach and depart*

The Hindu Upanishads and the Dao de Jing present a similar sense of temporary patterning emerging – without the need for extrinsic design or planning.

However, Plato (Hare and Russell, 1970:199) refused to believe that form or patterning could arise without external design and introduced the idea of a Creator who, guided by these perfect forms, created a world, which emulated and aspired to them. Uncertainty and fluctuations were seen as irritating limitations and something to be overcome; they were not seen to serve any useful purpose

This theme of perfection and order then paved the way for the seizing of Newton's mechanics, in the seventeenth century by French Enlightenment thinkers and becoming *the* dominant world view - where order, prediction and control are regarded as attainable and desirable and variation viewed both as a nuisance and largely irrelevant. How did this happen? Why was a theory of physics that applied to certain limited problems of interaction between discrete objects seized on as *the* dominant worldview? Many authors (for example Toulmin, 2001) have written on this topic at length. In summary, Newtonian thinking supports the notion of 'the grand design', and of the view that logic will lead to the 'right'

answer; indeed it implies there *is* a predictable ‘right’ way and ‘right’ answer. So it represents a way to control chaos, to be efficient, to overcome superstition, to make things happen in a predictable fashion – and this is very beguiling.

In contrast to this view of achievable perfection, stands the messy and inefficient and surprising process of evolution. It was Darwin (1859) who recognized that uncertainty is indeed *necessary* for change to happen. Whilst the realization that animals and plants evolve had been recognized for decades before Darwin’s expedition on the Beagle, indeed by his own grandfather (Darwin, 1794), Darwin’s contribution was to suggest that variation was a fundamental part of how this happened. The notion of messiness as having a useful role - *fundamental* to innovation, adaptability and change - is very significant and we are still resistant to this perspective as evidenced by the continued focus on prediction, design, control, measurement and an endless search for certainty.

The idea that variation is a pre-requisite for evolution and change to happen was a Big Idea that subsequently captured the imagination of philosophers, psychologists, sociologists and eventually even physical scientists. For example, the Pragmatist philosopher Charles Peirce (1955:318) was one of the first to recognise the wider implications of evolution as a worldview. In 1891, he wrote:

*‘Now the only possible way of accounting for the laws of nature and the uniformity in general is to suppose them results of evolution. This supposes them not to be absolute, not to be obeyed precisely. It makes an element of indeterminacy, spontaneity, or absolute chance in nature.’*

Equally, William James (1995:275), also part of the Pragmatist school, and regarded as the founder of psychology, explains in his lecture, ‘the Dilemmas of Determinism’, given in 1884:

*‘Of two alternative futures which we conceive, both may now be really possible; and the one become impossible only at the very moment when the other excludes it by becoming real itself.... To that view, actualities seem to float in a wider sea of possibilities out of which they are chosen; and, **somewhere**, indeterminism says, such possibilities exist, and form a part of truth.’*

So, the idea that the future is of essence unknowable started to return to philosophical considerations following Darwin’s Origin of Species.

In summary, the early philosophers noticed the world *was* uncertain but nevertheless had form; Darwin recognised that variation and uncertainty was in fact *central* to the emergence of new form; we can accord physicist Prigogine (1947) with the next step. He and his colleagues started to explore *how* uncertainty led to emergence and evolution – and how the future is *in principle* unknowable. This was the beginning of the new science of Complexity.

Prigogine (1947, 1996) is best remembered for explorations of non-equilibrium thermodynamics and rather problematical attempts to find general principles of entropy decrease in open systems. Later work centred on the use of the so-called ‘Master Equation’ that governs the dynamics of a probability distribution (Allen, 1988). Through this approach, he and his colleagues established the central role of variation, of fluctuations, in the emergence of self-organised structure in open systems. Prigogine (Nicolis and Prigogine,

1977; Prigogine and Allen (1977)) and also Haken (1978) explored *the way* in which fluctuations play their part.

## **2. Complexity**

Complexity theory (Boulton and Allen, 2007) has arisen, over more than half a century, out of the work of many scientists and social scientists who seek to investigate the implications of embracing the world as messy, interconnected, open to influences and change, able to learn – a world more like the river Heraclitus envisaged, and indeed more like the world we inhabit. Essentially, this work tells us that:

- ‘Things’ inter-relate, affect each other in a messy, complex, systemic fashion
- Variation and diversity are **necessary** for creativity, change, evolution, emergence
- The future builds on the past, but not with clear one-to-one correspondences and cause-effect relationships, but collectively; the future is created from a complex mix of influences including history, context, chance and choice
- There is more than one possible future; the future cannot be reliably predicted from the past
- During times of change, radically new features and characteristics can emerge which could not have been predicted or even imagined prior to their emergence
- Top-down design and control will certainly have an effect, but may not lead where intended
- Systems which are diverse, richly-connected and open to their environments can evolve form through the way connections are synergistic or antagonistic; such forms may be more harmoniously in tune with their surroundings than what was there before and hence prosper; or they may be less tuned to the context, and hence may disappear. The future, in this way, emerges through natural selection.

This complex, systemic, somewhat post-modern, worldview, which seems to resonate with our personal experience of life, creates a powerful new image for all kinds of organisational thinking – in policy and strategy development and implementation, in organisation change, in operational management. The complexity worldview is itself paradoxical and uncertain in that we are now less clear how to act, how to intervene. Does it mean there should be no design, no leadership, no control, might we not just sink into chaos and disorder? Is emergent structure always helpful? Indeed, are our current problems the result of too much control or not enough? It raises issues of ethics, of the politics of participation, of power and domination.

Complexity thinking emphasises that there are no simple answers – but imagining the world is predictable and controllable when it is not is not helpful either; our current economic, social and environmental crises are, perhaps, ample evidence of that.

## **3. Implications for economics and policy development**

### **3.1 Is complexity thinking relevant?**

We have demonstrated that the predictable, controllable worldview associated with Newtonian thinking and which had influence over the French Enlightenment was not always accepted wisdom; and that pre-Socratic thinking tended to emphasise the world in flux, with forms and patterns of relationships emerging rather than imposed. Complexity thinking, building on evolutionary thinking, created a new emphasis in the physical sciences that

moved us on from simple Newtonian approaches. Complexity thinking, at heart, reminds us that it is only in special cases that we can consider problems in isolation of their context and environment and assume the world is comprised of simple, linear relationships between unchanging elements; it reminds us that the world is essentially interconnected, messy, uncertain and changing. But does this have relevance for economics and for policy development? Applying complexity and evolutionary thinking is not a new thought. There is substantial interest in the fields of complexity and evolutionary economics, dating from Veblen (1898), Boulding (1950, 1981) and Arthur (1989); Beinhocker (2006) and Bronk (2009) provide good summaries.

In contrast, as is well-documented, neo-classical economics is based on the mathematics of the physics of equilibrium thermodynamics, which assumes that, for closed systems, and when history can be ignored, things move towards equilibrium. But why *should* things find balance or move towards equilibrium? Such thinking, as applied to human situations, was challenged very early on, by Thorstein Veblen, regarded as '*probably the most significant, original and profound social theorist in American history.*' (Hunt, 2002). In 1898 (Veblen, 1898) he wrote a paper titled '*Why is Economics not an Evolutionary Science*'. In this he points out that there is no basis for assuming the economy moves towards equilibrium; there is no evidence that this should or does happen. Veblen was influenced by evolutionary thinking and indeed felt that economics was lagging behind other disciplines – in anthropology and psychology – in not exploring the evolutionary perspective. He saw evolution as '*dispassionate cumulative causation*' and as a *rational* exposition, not dependent on assuming any maxims about the nature of man or about the destination or tendencies of the economy to reach equilibrium.

Many other economists since Veblen, including Frank Knight (1921), Shackle (1972) and more recently Stiglitz (2001) and Greenspan (2003, 2008) have questioned the validity of the various assumptions of neo-classical economics: assuming linear cause and effect relationships between supply and demand, assuming Man makes rational economic decisions, assuming the economy tends towards equilibrium. To assume the economy is complex is to say that the detailed and complex interactions of all that is there – individual choices, non-economic factors, political decisions, world views, the ecology - all play their part in what unfolds.

In the next sections I will consider what it means for policy development to work with this assumption of complexity rather than to ignore it.

### **3.2 Uncertainty and the inevitability of unintended consequences requires experimentation and learning**

I am writing this in 2009 when the globe is going through more economic and ecological uncertainty and chaos than perhaps ever before in our lifetimes; our society is a living example of how the most likely events are not always the ones that occur and how unintended consequences, even of seemingly logical and well-thought-through policies and strategies, seem unavoidable.

What seems so pernicious about the dominant worldview is that it is predicated on the idea that there **is** an optimal solution, a right answer, a best way. Alan Greenspan (2008) points out that this ideal is not achievable. In an article written last year, he said: '*...our economic*

*models, as complex as they have become, are still too simple to capture the full array of governing variables that drive economic reality.'*

And, earlier, Greenspan (2003) wrote:

*'Policy makers need to consider not only the most likely future path for the economy but also the distribution of possible outcomes about that path....Recent history has also reinforced the perception that the relationships underlying the economy's structure change over time in ways that are difficult to anticipate.'*

Greenspan is embracing a view of the world as complex, with more than one possible future path, with complex relationships that can change over time. This stands in contrast to the views expressed by economist Leon Walras (1874), in 'Elements of Pure Economics', as he developed general equilibrium theory. He said '*...this pure theory of economics is a science which resembles the physico-mathematical sciences in every respect*'. In other words, he is asserting that the economy can be described by mathematical relationships which predict the future exactly.

Greenspan (2003) also comments that neo-classical economics fails to take into account the fact that consumers do not make what economists regard as rational choices. So the basic building blocks of the complex economy are themselves complex; to mis-quote Bertrand Russell (Hawking, 1988), '*complexity all the way down*'. Economists are and were clearly aware of the limitations of assuming people made rational, consistent and predictable choices in full knowledge of all the facts about both today and tomorrow, but economists needed to make these assumptions in order for the mathematical methods, based on those from the physics of equilibrium thermodynamics, to be valid. Greenspan and others are emphasising that making such simplifying assumptions may give qualitatively misleading answers and that we cannot ignore the reality and complexity of how people make choices.

So, if we accept that the economy and the actors within it are complex, what does this mean for policy development? The intrinsic complexity of the social and economic world and the complexity of actors within it imply that the outcome of any intervention cannot be predicted; policy created for one reason can lead to unintended consequences and, furthermore may establish and lock-in unanticipated new regimes of practice (Arthur, 1989). Complexity thinking suggests this uncertainty is the norm rather than an aberration in difficult circumstances; we cannot know the future nor be sure of the outcomes of any actions.

A good example of this is the current banking crisis. How did this come about? One can perhaps trace its origins to the deregulation of the London Stock Exchange on October 27 1986, 'Big Bang Day'. As a fervent supporter of free market thinking, the then Prime Minister Margaret Thatcher's main concern seems to have been to abolish the closed shop. At the same time as this sweeping away of restrictive practices for the stock exchange, currency exchange regulations were scrapped which caused massive amounts of foreign exchange to flow through London; these two factors, together with the advent of powerful small computers, meant that volumes of business and numbers of stockbrokers mushroomed, with little regulation either formally or through established custom and practice. Following this, in 1997, Gordon Brown passed the Treasury's power to set interest rates to the Bank of England and its regulation of the banking sector to the Financial Services Authority. This move reduced, once again, levels of regulation and meant that financial stability was nowhere held as a goal. This deregulation has created a climate where financial institutions have, in some

cases, acted according to what was allowed as opposed to what was prudent, with the consequent creation and burst of the credit bubble.

Recognising that there is no optimal solution, that what might be the outcome of any particular policy or intervention cannot be known in advance, pushes us to see policy as *experiment*, to recognise that there must be built into any policy implementation processes a way of reviewing outcomes collaboratively from a number of perspectives, of *learning*, of modification, of keeping policies live.

### **3.3 Policies need to inter-relate and grapple with conflicting intended outcomes**

We have so far considered the likelihood of unintended consequences in relation to one strand of policy but, to see the world as complex is to pay attention to the interconnectivities of policies and interventions.

There are many examples of the overlapping consequences of policies. If we consider economic growth purely as an economic issue, if we promote consumption as a way to grow the economy, we are likely to accelerate climate change. If we outsource manufacturing to countries where labour is cheaper, we are less resilient to increasing costs of transport. If we become reliant on oil and gas piped across the continent this has implications for security as well as for climate change. However policies - on energy, on defence, on financial regulation – are often treated as separate things and handled by different departments and the interaction between them is down-played or even ignored.

These examples hardly come as a surprise; the question is, perhaps, why **are** policies handled separately? One can argue that this is partly due to the prevailing mechanical, scientific worldview, which typically means it is normal to handle complexity by separating rather than connecting issues and by treating as second order the impact of inter-dependencies. Complexity thinking emphasises that it is rare to be able to ignore the systemic nature of the world in which we live. And, of course, to connect policy makers and policy making is to challenge existing governance structures and power bases.

Another impact of the focus on economics being ‘scientific’ was to assume that issues of values and ethics could be separated out and the economy be regarded as an objective machine that could be understood in rational scientific terms. However, to use mathematical methods and models borrowed from physics does not de facto make their use for economic purposes **scientific**, particularly when we have ample evidence that the economy does not in practice work in this way. It is also the case that to assume moral arguments can be separated from methods of economic modelling and analysis is in itself a moral stance as choices are always made as to what to include, what goals to seek, what to ignore.

Economics was of course born from the conjunction of both moral and scientific issues. As economist Alessandro Roncaglia (2009) explains:

*‘On the one hand we have the moral issue: which rules should human beings – especially the merchant and the sovereign – respect in the domain of economic activities? On the other hand we have the scientific issue: how does a society...keep the production process going....The link is reinforced by the idea (dominant in the Aristotelian tradition) that ‘good’ is what ‘conforms to nature’.*

Complexity thinking emphasises the impossibility of separating out economic from other considerations – in part as the basic element of the system, the person, acts in ways that are influenced by multiple concerns and agendas. Complexity theorists Allen and Varga (2007) have shown how our worldview, our values and our actions all inter-relate and self-reinforce. What we believe directs our attention; it is then often ‘easy’ to confirm our beliefs by unconsciously being selective about what we explore, how we then act and how we interpret the outcomes.

As well as interacting and overlapping, policy areas often have conflicting goals and timescales; governments and corporations want to satisfy their constituencies in the short-term and deliver wealth; issues of social justice and equality or the impact of economic policies on bio-diversity or climate change are often discounted against these immediate economic goals.

And this is as true for corporate strategies as it is for government-led policies. As David Korten (1995) says:

*‘The global corporation is programmed by its internal structures to respond to the incessant demands of financial markets to seek its own unlimited growth... Furthermore, the economy internal to a corporation is centrally planned and directed by top management, not to serve the whole of the society on which its existence depends, but rather to maximise the capture and flow of money to its top managers and shareholders. These characteristics – growth at the expense of the whole and centralised planning – represent serious violations of the principle of cooperative self-organisation in the service of life.*

So, to approach policy with due regard to the complexity and multi-faceted nature of the decisions and actions of individuals **and** to the complexity and inter-related impacts of policies as they are implemented, requires a re-thinking of the policy-making process. Such a re-thinking would cut across existing governance structures and have huge implications for existing well-established power relations. But not to do so limits the effectiveness of all policies.

### **3.4 Self organisation and the need for regulation**

The notion of the ‘invisible hand of the market’ introduced by Adam Smith, (1776) is widely quoted - but interpreted in diverse and sometimes contradictory ways. The central idea is that there is potential for balance to emerge in a market merely through the inter-related behaviours of the actors within it. The economist Hayek (1958) describes the invisible hand as showing ‘*how...complex and orderly and, in a very definite sense, purposive structures might grow up which owed little or nothing to design, which were not invented by a contriving mind but arose from the separate actions of many men who did not know what they were doing*’.

The invisible hand as defined by Hayek resonates with the notion of self organisation derived from complexity thinking. Self organisation describes the situation where new emergent structures and properties may arise without being imposed from above or from without; it is a distributed response of a system (i.e. it cannot be expressed as a function of one part or element but only as a function of parts in concert). Prigogine (1978) calls it ‘*long-range order through which the system acts as a whole*’.

In addition to the concept of emergent order, Adam Smith believed that the emergent process followed ‘natural law’; hence any emergent order creates balance which is ‘good’. This is because, as Alessandro Roncaglia (2009) explains, ‘*good is what conforms to nature*’. The underlying thesis of un-regulated free market economics associated with the neo-liberal thinking of the 1980s (Harvey, 2005) builds on this idea of natural balance, although, perhaps, more modern thinking has now replaced ‘good’ with ‘the best that can be done’.

At first glance, complexity thinking would seem to support a free market perspective, as there is emphasis on the emergent, self-organising nature of structures and patterns rather than in their imposition from above or outside. However, the argument is more subtle than that. Over time, in some circumstances, the self-organising process can lead to the dominance of a few players and lose diversity and the resilience diversity engenders. Holling’s (Homer-Dixon, 2006) work on the life cycle of forests illustrates one example of this. Holling shows that as forests mature, diversity reduces and they become finely-tuned and efficient, but less adaptable and resilient as a consequence. So when something new and unexpected happens, they are less able to respond and survive.

There are other examples of self-organisation which are not necessarily positive. Allen (1976) showed, in work on predator-prey relationships, that if a predator becomes too adept and flexible in its strategies it can become dominant enough to destroy the population of its prey and ultimately lead to its own destruction. And William Golding’s novel ‘Lord of the Flies’ gives an example of where self-organisation can lead, in extremis. Interestingly, Golding invented the term Gaia theory in conversation with James Lovelock (1979), to represent Lovelock’s idea of the world in its entirety as a self-organising complex system. And notions of runaway climate change, where certain relationships self-reinforce and become, potentially, unstoppable is another example of the way certain feedback loops can break self-regulating processes and dominate outcomes.

Complexity economist Brian Arthur, equally, showed that the economy can show the same tendency - due to the effect of increasing returns - that is, due to the fact that it is sometimes the case that flooding the market with more goods of a particular type can lead to greater consumption; equilibrium theories assume there are decreasing returns and the demand stabilises. Arthur said (1994):

*‘where products or technologies experience increasing returns to market share, markets can become unstable, so that in the long-run one product or technology can come to dominate and drive out the others.’*

Furthermore, one can argue that power itself leads to increasing returns in the sense that people or organisations or nations with power often – and perhaps usually - seek more power, rather than spontaneously act to share or reduce it.

This idea that self-regulating markets can lead to monopolies and create unequal distribution of power is not a surprise to economists and is the reason why at least some uphold the need for regulation. Joseph Stiglitz (2001) in his introduction to Polanyi’s classical text, *The Great Transformation*, written in 1944, reminds us of Polanyi’s views on this topic. He says:

*‘Among [Polanyi’s] central theses are the ideas that self-regulating markets never work; their deficiencies, not only in their internal workings but also in their consequences (e.g. for the poor) are so great that government becomes necessary.’*

So we are grappling with the fact that, if self-regulation can lead to greater power in the hands of the powerful, then we need to find ways to represent the poor or disadvantaged and ensure that the issues of climate change as well as social justice are considered as well as short-term economic goals, not to mention issues of resilience and long-term sustainability.

And what does complexity thinking suggest? Conventional views of complexity thinking (Ostroff, 2006) do indeed argue for the decentralisation of authority and for leading *‘with a trust based on creating shared values and visions through the ongoing processes of dialogue and reflexive learning which promote the capacities for self-organisation and self-renewal’*.

I would not disagree with such sentiments but emphasise that self-organisation is only likely to lead to a positive outcome if values are indeed shared and do promote the sharing of power and, in economic systems, the sharing of wealth. In the absence of such shared values, I would argue that a complexity view would concur that some regulation is necessary – at least to break up cartels, limit the size and concomitant influence of firms and national political interests and to promote diversity and seek to equalise power.

How that regulation is developed, kept current, and applied is a critical issue; this is not an argument for un-subtle, top-down control. Complexity theory, I would argue, implies that there needs to be some balance between judicious, regularly-reviewed, intelligent, participatively-developed regulation; and participative, emergent, self-organising market processes. And of course it is the case that in practice a market is never actually devoid of regulation, sometimes resulting from accepted laws and practices, such as firms having limited liability, or governments subsidising or taxing certain products. What emerges will be as a result of the complex interplay between controls, freedoms, embedded practice, experiments and chance.

How should such regulation be achieved? And how can we ensure regulation is kept alive and responsive to changing circumstances? Who, in effect, regulates regulatory bodies? And how can we approach governance on a global scale, given corporations, financial systems, climate change, even water sources have a global reach? One can argue that this is one of the roles of political bodies; but national governments, like company share-holders, often seek short-term solutions which are often not in the best interests even of themselves. These are very difficult questions to answer.

The issue of global governance is perhaps one of the remaining imponderable structural dilemmas and also one of the most urgent given our evident lack of progress in facing up to climate change, sustainability and issues of equality and justice; how do we establish processes of global governance that can transcend local and/or short-term and/or uni-dimensional interests? A partial solution is suggested by Rosenau (2006), in his book *‘The Study of World Politics’*. He notes that new forms of governance are emerging. He in particular points to the collective, emerging impact of international non-governmental organisations and also social movements, such as the International Nestle Boycott Committee or the Transition Town movement (Hopkin, 2008) or, less positively, terrorist syndicates. He sees them providing a role in bottom-up influencing and providing a sort of governance of complex global issues and in strengthening the voices less heard.

#### **4. Conclusion**

It is safe to say that our world is increasingly complex and fast-changing and uncertain; this does not imply we should not, collectively, try to achieve the outcomes we feel are

appropriate, but that we should regard actions and policies and strategies as experiments and be prepared to learn, modify our approaches, listen to feedback and, quite often, just be prepared to pay more attention to what is actually happening, what is plain to see. The need for multiple perspectives and multiple stakeholders to have a voice in policy development has never been more urgent.

And, although the future cannot be controlled or designed, we *can* make choices as to where we place attention, what we intend, how we act. In that way we can intentionally seek to facilitate the emergence of a positive future, to provide ‘good’ ingredients in the mix and to actively oppose current practices and power structures if they seem to stand in the way of sustainability and social justice.

In summary, complexity theory suggests that:

- The economy is systemic and does not in practice consist of distinct, independent strands. So policy-makers must collaborate and consider issues of contradiction and inconsistencies in the eyes of policy-followers, who are usually impacted by multiple policies.
- The economy is sited within society, within a political framework and, clearly, impacts sustainability and social justice as well as economic outcomes. Policy makers must make explicit the *intended* outcomes of policy and make explicit what is the *intended* balance between economic goals and issues of justice, sustainability, security – and define timescales.
- Complexity thinking emphasises that policies will not in general go to plan, they will have unintended consequences and must handle an often-times fast-changing and complex context. Policy-making hence needs mechanisms to make policies alive, able to adapt and be refined in the light of experience.
- Self-regulation and free markets are likely to lead to a concentration of power in the hands of the few and to a diminution of diversity; some regulation – at least anti-monopoly law - is required to counter this tendency.
- Economic, environmental and social justice issues do not conform to national boundaries, but economic policy and regulation often do. How can we tackle trans-national regulation more effectively – particularly in relation to the behaviour of large global companies?

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