

APEC as a complex adaptive system: insights on the problem of multilateralism versus bilateralism from a new science

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Abstract

This paper attempts to apply some of the insights gained in the study of Complexity Theory to the evolution of the APEC trade system. First a review of the history and description of complexity theory will lead to a description of the characteristics and behaviour of complex adaptive systems. It will be shown that trade in the Asia Pacific region exhibits similar behaviour. The paper concludes with a discussion of some policy implications of Complexity Theory for APEC, especially as applied to the current debate about bilateral, plurilateral and multilateral modes of trade liberalisation.

Introduction

A perceived challenge to APEC is the proliferation of bilateral and subregional trade agreements in existence or currently being negotiated involving APEC members. Martyn (2001) has identified 43 such agreements. The existence of RTA's within APEC is not new. When APEC was initiated the Australian New Zealand CER was already in existence and work was well advanced on both AFTA and NAFTA's predecessor the US/Canada FTA. However in the current climate of equivocal attitudes to trade liberalisation these developments are viewed with concern.

The classical argument is that bilateral and subregional agreements can cause trade diversion rather than trade creation, and hence a decrease in global economic welfare. There is abundant literature about whether bilateral agreements help or hinder the development of a liberal trading system in APEC or in the world as a whole, see for example Goyal and Joshi (1999).

This paper seeks to use some of the methodology of Complexity Theory as an aid to understanding what is occurring and how best to arrive at policies which promote APEC's goals. As McKergow (1999) suggests that applying complexity theory to economics may not reveal answers but it can be used to formulate some good questions.

Most fields of human scholarship can be characterised as being attempts to discern order in the chaos in the world around us. When we discover some sort of order we label it as a law: thus The Law of

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Gravity, The Second Law of Thermodynamics or the Law of Supply and Demand. Less perceptive individuals imagine that because a phenomenon is named it is thus understood... at least by someone.

During the twentieth century the application of scientific and mathematical methods to biology and later social sciences including economics produced optimism that these subjects were amenable to understanding by essentially numerical methods. It was thought that if enough data and appropriate methods of computation were then available useful predictions about the future could be made. Over the past twenty years the emerging science of complexity theory has shown that these hopes are flawed.

Ecosystems and economies consist of vast networks of interconnected elements or agents. A well worn image of the interconnectedness of everything to everything else is the claim that a butterfly flapping its wings in can cause a cyclone on the other side of the world. Well that's great, but which butterfly? There are about 370 different species of butterfly in Australia, and probably billions of individuals, but only a few dozen cyclones each year. The point is that knowledge of the fact that the elements are interconnected does not allow us to make predictions about precisely how changing one element will impact on another.

The Asian Financial crisis that erupted in 1997 was a stark and painful reminder that economic systems do not exhibit smooth and predictable behaviour. Exchange rates, stock prices, investor and speculator behaviour, and the political and social consequences are clearly non-linear phenomena. McKergow (1998) uses a Complexity Theory framework to provide some commentary and suggestions about understanding the origins of the crisis, attempts to repair the damage and policies to prevent a recurrence.

The thesis of this paper is that Complexity Theory can be used to produce a better description of APEC's regional trading system and can provide insights on how the system can be managed to make it more closely resemble some desired state. This paper looks at some of the conclusions drawn from research in Complexity Theory and applies them to the problem facing APEC, and the multilateral trading system for that matter, in how to best further efforts to increase global living standards via the global trading system.

Complexity Theory

Chaos and Control

The long running television series *Get Smart* was based on the battle between KAOS and Control, two intelligence agencies vying for world domination. In this cosy world there were only two alternatives, and somebody had to win: either the good guys (Control) or the bad guys (KAOS). The ironic hinge that provided the humour in *Get Smart* was that the central character, Control agent Maxwell Smart,

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was not smart, but very chaotic. KAOS was inevitably defeated not by applying painstaking and systematic methods of control but by serendipitous events emerging from the chaos that Smart generated.

It is tempting to view systems in the real world as either being controlled systems, based on simple rules, or chaotic systems where random or unfathomable interactions between the components defy any attempt to discern order. Complexity Theory concentrates on studying systems which are somewhere between these extremes - at what Wardrop (1994) refers to as at "the edge of chaos". These systems do exhibit order but they do not follow simple deterministic rules, they exhibit discontinuous rather than linear behaviour, and they tend to have positive feedback mechanisms which prevent them from moving to some type of equilibrium. However useful generalisations about the behaviour of complex systems can be made, and these generalisations can be used to improve analysis and policy making.

Analysis of a physical system, say the behaviour of a gas, reveals that at the molecular level gases consist of particles which interact according to Newton's laws of motion. These laws provide a simple and fairly accurate description of the behaviour of a single gas molecule: it bounces off other particles like a billiard ball bounces off other objects. The statistical summation of the motions of individual gas particles in a sample of gas determine the macro properties of temperature, pressure and volume of the gas.

This reductionist approach to understanding the universe has formed the basis of scientific method for the past few centuries. By analysing the components of systems and discovering underlying laws and principles which are universal, or at least nearly so, spectacular progress has been made in the development of an essentially mechanical view of the universe. This success has led to a series of industrial revolutions which have generated enormous increases in wealth and improvements to the human condition. There are still a few problems, like getting accurate weather forecasts longer than four days in advance, but it would be churlish to say that reductionist science has not served humankind extremely well.

The limits of reductionism occur however when we look at other macro properties of a gas. It is impossible to simply add up the descriptions of the behaviour of individual molecules to provide a coherent explanation of large scale behaviours such as turbulence. This is not to say that the macro properties cannot be described mathematically. There is a gap between the underlying simplicity of the interactions of the particles and the emergent properties of the gas.

Complexity Theory is a relatively new area of mathematics, dealing with systems and networks. It is related to Chaos Theory which has spawned significant popular literature. Complexity theory differs from the study of chaos in that it deals with systems which exhibit some order: emergent properties appear out of a chaotic background. The difference in approach is that complexity researchers are more interested in the emergent order than the underlying confusion. In one of the seminal works of

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Complexity Theory Holland (1995) sets out to demonstrate that high level order emerges from simple systems. Cohen and Stewart (1993) use the metaphor of chaos collapsing to order, but note that order does not just arise because of statistical averaging. Kauffman (1995) contends that order arises spontaneously from sufficiently rich mixtures of interacting agents. His pioneering work on self organisation in autocatalytic sets of organic molecules has been more widely applied across a number of disciplines.

Complexity Theory has been applied to many disciplines in the physical and biological sciences and more lately to economics. It has been found useful in understanding diverse phenomena such as the origin of life, evolution, meteorology, ecology, traffic congestion on roads, traffic congestion in computer networks, urban demographics, the frequency and scale of avalanches, stock prices and the onset of financial crisis.

Complex adaptive systems

First of all what are we really talking about? The first idea is to distinguish between complex systems and those that are merely intricate or composed of many parts. A mechanical clock is intricate, in that it has a number of parts arranged in a special way. However it does not exhibit complex behaviour.

By contrast, a pile of sand on a table to which further sand is being added grain by grain can exhibit dynamic complexity. As more and more grains of sand are added large and small avalanches will occur at irregular intervals. There is no way of knowing which grain of sand will cause the next large avalanche. If the grains of sand are of similar size, the system demonstrates that equivalent inputs can have widely differing outcomes.

The output from the clock however is predictable. It has a limited range of outputs: it can display the time of day, it can be going or it can be stopped. A clock has limited and predictable interactions with its environment.

At the heart of Complexity Theory is the proposition that many phenomena in the physical, biological and social sciences can be described in terms of complex adaptive systems.

Axelrod and Cohen (1999) define complex adaptive systems in the following way

Agents, of a variety of types, use their strategies, in patterned interaction with each other and with artifacts. Performance measures on the resulting events drive the selection of agents and/or strategies through processes of error prone copying and recombination, thus changing the frequencies of the types within the system.

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The identification of what constitutes an agent depends on the level of an analysis. The Australian economy may be an agent in the multilateral trading system but is equally a complex adaptive system in its own right. Within economies individual industry sectors can also be regarded as complex adaptive systems.

Complexity Theory has developed a number of analytical frameworks to assist in understanding and management of complex adaptive systems. Axelrod and Cohen (1999) have drawn on their definition of complex adaptive systems to design a framework around three major themes: variation, interaction and selection.

All complex adaptive systems are based on a number of interacting agents. In evolutionary biology the agents will be species, and in international trade the agents are the participating economies. The agents exhibit **variety**, in that they can be distinguished by different properties or behaviours. The agents will therefore respond differently to applied stimuli.

The agents **interact** with each other. In ecology there are relationships which can be characterised as predation, competition, parasitism, and symbiosis. In international economics there are trade and investment relationships as well as more subtle interactions involving technology transfer, political and cultural emulation and migration. It has become a truism that we are in the information age. Interactions between economies are transmitted at unprecedented speed. Interactions need to be understood as two way processes. Trade alters the economies of both exporters and importers and often has flow on effects to unexpected sectors both inside and outside the principal economies. The interactions have inherent positive feedback loops. Increased trade increases economic growth which generates even more trade.

Understanding the nature and effects of these interactions is crucial to comprehending the system and then devising practical strategies to achieve desired outcomes. Without a thorough knowledge of the interactions in a system effective and efficient interventions are impossible. It is significant that at its first Ministerial Meeting in Canberra in 1989 APEC identified the collection of trade data as a key prerequisite for APEC's work.

Some agents or strategies undergo **selection** for replication or propagation. This is the core idea of adaptive systems. Selection must be against some criteria. It may or may not be a conscious act. Darwin's natural selection and Adam Smith's Invisible hand are examples of selection without conscious intervention. Individual firms, governments, non-government organisations and international organisations all try to select strategies to achieve their goals. The system thus adapts. The mixture of agents and their interactions change.

Complexity and economics

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Complexity theory confirms our intuitive grasp that complex systems can give unpredictable results. But can complexity theory tell us anything that is useful?

How does a complexity theory view of the economy differ from the neoclassical view? The neoclassical view of the economy is based on a concept of equilibrium being reached as the aggregate of the actions of rational choices by optimising agents. This view can be developed to include a dynamic systems approach which attempts to describe the state of economy as a set of difference or differential equations.

Arthur, Durlauf and Lane (1997) point out six features of the economy which are not adequately incorporated in neoclassical economics.

- The behaviour of the economy is determined by the interaction of many dispersed, possibly heterogeneous agents.
- The economy has no global controller, rather it is controlled by mechanisms of competition and cooperation between agents.
- The economy has a cross cutting hierarchical and often recursive organisation. Units at one level, including agents and interactions are building blocks for the next level.
- The economy is in a state of continual adaptation. The agents constantly update their behaviours and products.
- There is ongoing perpetual novelty created by new markets, technologies, behaviours and institutions. New niches appear and propagate further niches.
- These factors produce out-of-equilibrium dynamics where the economy is never in equilibrium or at some global optimum. New possibilities and improvements are always available.

These factors lead us to a view of the economy as an *adaptive nonlinear network* or a *complex adaptive system*. This paper contends that such a model of the economy better reflects the real world than the neoclassical model. Therefore attempts to understand the economy and formulate policy recommendations are more likely to be productive using a complexity paradigm.

Observation of the international trading system, which includes more politics than economics, suggests that a complex systems model may offer more insights than an economic model. A prominent Complexity researcher, Casti (1992) has elaborated on how the insights of Complexity Theory can be incorporated into economic models.

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Behaviours of the agents and interactions are selected, either actively or by invisible hands, against some criteria. Within APEC individual economies governments are attempting to devise economic policy to maximise economic welfare (or at least they say they are). APEC has been encouraging interactions which increase trade in the belief that trade will increase economic welfare of all participants. Competition ensures that patterns of trade and investment that do not serve the interests of participants are modified or replaced.

APEC economies currently trade and invest in each other (and with the rest of the world) in what might be called a semi-liberal regime. Even after a decade of liberalisation there are still considerable barriers, but a significant degree of economic integration exists and it is hard to argue that the region does not comprise an economic system. In Complexity Theory terms we can say that we are trying to change the state of the system to one characterised by liberalised trade and investment in the region

APEC in 1994 adopted the Bogor goal of free and open trade in the region. The goal was adopted without a clear definition of how it was to be achieved. Over the next two years, the methodology for achieving this goal was developed.

Can we create a pure free trade world. Many of the objections to bilateral agreements seem to assume that such a state exists and that there is a unique path to it. Complexity Theory suggests that such an optimal system is illusory. Kauffman (1995) uses a metaphor of a 'fitness landscape' where a system may have many local peaks where fitness or some other parameter is high, but no obvious global optimum. It is unwise to develop policy on the basis of aiming for an unachievable goal. It is equally unwise to act as if there is only one path to any desired goal. The best that we can do may be to move towards such an ideal state.

Policy implications for APEC

As an aid to developing policy directions when seeking to manage a complex system McKergow (1999) lists five characteristics of the "complex world" as opposed to the "ordered world"

<i>Ordered world</i>	<i>Complex world</i>
Cause and effect can be determined precisely	Cause and effect are intertwined and cannot be determined in advance
Certain parties have control	All parties have influence
There is only one way ahead	There are many possibilities for progress
Large effects require enormous coordinated efforts	Large effects come from small starts and positive feedback
The future can be planned	The future emerges from the combined actions of the players

Table adapted from McKergow 1999

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APEC's stated goal is to improve the living standards of its member economies via free and open trade and investment. It is possible to imagine this goal as representing an ideal state where all twenty one APEC economies were free to trade and invest in each other in some sort of dynamic equilibrium. Comparative advantage would shape the mix of enterprises, industries and their trade and investment patterns throughout the region. As we have seen above, Complexity Theory suggests that this state probably does not exist, certainly not as an equilibrium. Assuming for a moment that it did, what policies would change the current semi-liberal system to a fully liberalised system.

One of Kauffman's key concepts is that of the *adjacent possible*. He argues that moving from one state to another in a complex system involves investigation of nearby possibilities and choosing promising candidates, rather than imagining we can move in one step to the ideal state. Events in Kuala Lumpur in 1998 and Seattle in 1999 demonstrate that the ideal is sometimes unattainable. Political and negotiating energies might have been better spent evaluating the adjacent possibles and moving in a favourable direction.

Bergsten (2000) has argued that APEC has failed at three previous attempts at trade liberalisation. Firstly liberalisation by Individual Action Plans (IAPs) seems to have stalled. The sectoral approach worked in the case of the Information Technology Agreement but crashed spectacularly when it was attempted in nine other sectors in the Early Voluntary Sectoral Liberalisation (EVSL) program. The third try to accelerate liberalisation was the decision at the Auckland Leaders Summit to refer part of APEC's Agenda to the World Trade Organisation ministerial meeting at Seattle.

Many APEC economies are now actively seeking a fourth mode, liberalisation via bilateral and subregional agreements.

It is perhaps worth commenting on these modes from the viewpoint of Complexity Theory. The IAP mode of liberalisation seems to be an attempt to change the system by changing the agents. Although progress may be possible via this method its chances of success are limited by lack of positive feedback to allow the gains to be propagated. It could be argued that IAP's may form part of an overall strategy, but will probably not succeed alone. More emphasis needs to be put on using the gains of IAP's, such as they are, to enhance feedback. Strategies which use positive examples in one economy may be useful in assisting the reform process elsewhere. Work within APEC on development of an Outreach Strategy could be useful here. It is unlikely however that relying on IAP's alone was ever a viable option to approach the Bogor Goals.

The IAP program drew heavily on the naive belief that the economies would act as rational optimisers. Neoclassical theory implies that liberalisation would benefit the economies, therefore they would more or less spontaneously do it. In the real world governments are complex systems that act in political ways, not as economic optimisers.

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The experience with EVSL provides an example of trying to apply a simple strategy to a complex system. Although the EVSL initiative contained some non-trade elements the agenda seemed to be driven by emphasis on achieving liberalisation to a deadline. Modifying the interaction received more attention than attempts to modify the agents. The experience also points out the danger of applying a method that works in one context with into a different context, or rather nine different contexts. The strategy that succeeded in developing the Information Technology Agreement was not transferable to other sectors. It is now clear that the APEC system was not ready for such large steps in 1998. While it is possible that a sectoral approach may play some role as new niches appear, it is unlikely to succeed if APEC relies on it as the sole or dominant mode of liberalisation.

The third strategy, reference of the APEC liberalisation agenda to the WTO, represented an attempt to appeal to some sort of global arbiter or controller. It was quickly revealed that the WTO is not in control of the trade rules within APEC. The strategy was a shortcut that failed. This is not to say that the WTO is not the appropriate forum, rather the experience shows that multilateral trade liberalisation is a difficult process.

APEC's current dilemma is dealing with perceived threats to its relevance from subregional groupings while continuing the pursuit of its multilateral free trade goals. Some of the lessons from complexity theory can be applied here. The argument about bilateralism versus multilateralism revolves around the idea that bilaterals necessarily involve a loss of economic welfare because they are trade diverting rather than trade creating. Much has been written about this problem, the alternatives are characterised as "building blocks" or "stumbling blocks". There seems to be a strong argument that the building blocks argument *can* be right.

Theoretical work such as that of Goyal and Joshi, (1999) suggest that bilateral agreements can lead to increased economic welfare. It depends on whether barriers are raised against third parties.

Gonzalez-Vigil (2000) argues that Preferential Trade Agreements (PTAs) have a place in the quest for a liberal multilateral system because they allow participants to make gains in economic development. Although APEC represents over a half of the world's GDP it is still a regional agreement. So it has a regional as well as a multilateral agenda. It is managing to progress both strategies at once, there is no reason why it is impossible for subregional groups to do likewise. If, as Gonzalez-Vigil argues, subregional groupings have inherent value and can contribute to long term goals then why not pursue them.

One of the characteristics of complex adaptive systems is that they can undergo phase transitions. Kauffman (1995) describes a thought experiment. A room has ten thousand buttons scattered on the floor. The experimenter randomly chooses two buttons and joins them with a thread. They are then replaced on the floor and the process is repeated. Gradually the pairs of linked buttons will form small

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clusters as previously chosen buttons are picked up. From time to time the experimenter checks to determine the largest group of linked buttons. In the early part of the experiment only pairs and small clusters are present. When the ratio of threads to buttons approaches 0.5 giant clusters suddenly appear. The system has undergone a phase transition.

The rash of subregional negotiations currently being negotiated certainly have the possibility of generating a phase transition in the multilateral trade system. Firstly there are enough RTA's being negotiated to cover a substantial proportion of world trade. Perhaps more importantly positive feedback may be occurring as governments, not wishing to be left behind are pursuing bilateral agreements in response to observing other agreements.

In complexity theory terms APEC's Ecotech Agenda can be seen as an attempt to influence the agents and its TILF Agenda can be seen as an attempt to influence the interactions between the agents. Complexity Theory suggests that it may be counterproductive to develop policies and programs for one in isolation from the other. Ecotech assists APEC economies to recognise and exploit opportunities for improving welfare from trade liberalisation. Clearly attention to both agendas is needed. APEC has in fact been developing these strategies in parallel but critics and some commentators have not given adequate recognition to this.

Economic reform of APEC economies is a major task for APEC Finance Ministers. We can say that they are interested in changing the agents in the APEC complex adaptive system. Trade Ministers are obviously more interested in interactions between the agents. The Complexity Theory view is that both Finance Ministers' Meetings and Trade Ministers' Meetings are important and related. At different times and in different contexts progress will be more feasible in one forum than another, but neither can be ignored, and neither will have sustainable success without progress in the other.

In complex systems no one agent has control, but all have influence. Since APEC leaders agreed to the Bogor goal we have learnt that changing a complex system is harder than was imagined. As Uren (2001) points out nations bring a variety of concerns, not all economic to the negotiating table.

Conclusions

APEC has inherent variability in its member economies. The Bogor goals of APEC explicitly recognise this. This can be exploited as a strength by facilitating communication between members in their pursuit of economic reform.

In Complexity Theory terms there is a trade off in choosing strategies to optimise the interactions against strategies to change the nature of the agents. APEC has always pursued its agenda using a number of simultaneous strategies tailored to the varying circumstances of its members. Although this

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has not always lead to the tidiest or most coherent outcome, but it may be that APEC has hit upon the most promising method of achieving its aims.

It is instructive to ask the current problem one of perception or of substance for APEC. APEC has had considerable success in pursuing its two strategies of TILF and Ecotech. APEC's sceptics like tend to point to perceived failures in one agenda. It is up to APEC's champions to point to successes across the board.

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