NEW APPROACHES TO ECONOMIC CHALLENGES

Insights into Complexity and Policy

29-30 September 2016
OECD Headquarters, Paris

Registration at:
naec@oecd.org

EUROPEAN COMMISSION

UNIVERSITY OF OXFORD

Institute for New Economic Thinking
AT THE OXFORD MARTIN SCHOOL

OECD

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Complexity and Economic Policy

by Alan Kirman

Over the last two centuries there has been a growing acceptance of social and political liberalism as the desirable basis for societal organisation. Economic theory has tried to accommodate itself to that position and has developed increasingly sophisticated models to justify the contention that individuals left to their own devices will self-organise into a socially desirable state. However, in so doing, it has led us to a view of the economic system that is at odds with what has been happening in many other disciplines.

Although in fields such as statistical physics, ecology and social psychology it is now widely accepted that systems of interacting individuals will not have the sort of behaviour that corresponds to that of one average or typical particle or individual, this has not had much effect on economics. Whilst those disciplines moved on to study the emergence of non-linear dynamics as a result of the complex interaction between individuals, economists relentlessly insisted on basing their analysis on that of rational optimising individuals behaving as if they were acting in isolation. Indeed, this is the basic paradigm on which modern economic theory and our standard economic models are based. It dates from Adam Smith's (1776) notion of the Invisible Hand which suggested that when individuals are left, insofar as possible, to their own devices, the economy will self-organise into a state which has satisfactory welfare properties.

Yet this paradigm is neither validated by empirical evidence nor does it have sound theoretical foundations. It has become an assumption. It has been the cornerstone of economic theory although the persistent arrival of major economic crises would seem to suggest that there are real problems with the analysis. Experience suggests that amnesia is prevalent among economists and that, while each crisis provokes demands for new approaches to economics, (witness the birth of George Soros' Institute for New Economic Thinking), in the end inertia prevails and economics returns to the path that it was already following.

There has been a remarkable tendency to use a period of relative calm to declare victory over the enemy. Recall the declaration of Robert Lucas, Nobel Prize winner and President of the American Economic Association in his Presidential Address in 2003 in which he said: "The central problem of depression-prevention has been solved."

Both economists and policy makers had been lulled into a sense of false security during this brief period of calm.

Then came 2008 and, as always in times of crisis, voices were raised, mainly by commentators and policy makers enquiring as to why economists had anticipated neither the onset nor the severity of the crisis.

When Her Majesty the Queen asked economists at the London School of Economics what had gone wrong, she received the following reply: "So in summary your majesty, the failure to foresee the timing, extent and severity of the crisis … was principally the failure of the collective imagination of many bright people to understand the risks to the systems as a whole."

As soon as one considers the economy as a complex adaptive system in which the aggregate behaviour emerges from the interaction between its components, no simple relation between the individual participant and the aggregate can be established. Because of all the interactions and the complicated feedbacks between the actions of the individuals and the behaviour of the system there will inevitably be "unforeseen consequences" of the actions taken by individuals, firms and governments. Not only the individuals themselves but the network that links them changes over time. The evolution of such systems is intrinsically difficult to predict, and for policymakers this means that assertions such as "this measure will cause that outcome" have to be replaced with "a number of outcomes are possible and our best estimates of the probabilities of those outcomes at the current point are…".

Consider the case of the possible impact of Brexit on the British economy and the global economy. Revised forecasts of the growth of these economies are now being issued, but when so much depends on the conditions under which the exit is achieved, is it reasonable to make such deterministic forecasts? Given the complexity and interlocking nature of the economies, the political factors that will influence the nature of the separation and the perception and anticipation of the participants (from individuals to governments) of the consequences, how much confidence can we put in point estimates of growth over the next few years?

While some might take the complex systems approach as an admission of our incapacity to control or even influence economic outcomes, this need not be the case. Hayek once argued that there are no economic "laws" just "patterns". The development of "big data" and the techniques for its analysis may provide us with the tools to recognise such patterns and to react to them. But these patterns arise from the interaction of individuals who are in many ways simpler than *homo economicus,* and it is the interaction between these relatively simple individuals who react to what is going on, rather than optimise in isolation that produces the major upheavals that characterise our systems.

Finally, in trying to stabilise such systems it is an error to focus on one variable either to control the system or to inform us about its evolution. Single variables such as the interest rate do not permit sufficient flexibility for policy actions and single performance measures such as the unemployment rate or GDP convey too little information about the state of the economy.

Simple Policy Lessons from Embracing "Complexity"

by Bill White

The dominant school of economic thought, prior to the crisis, essentially modelled the national economy (DSGE models) as a totally understandable and changeless machine. Moreover, the machine almost always operated at its optimal speed, churning out outputs in an almost totally predicable (linear) way, under the close control of its (policy) operators. While the sudden and unexpected onslaught of the current crisis, to say nothing of its unexpected depth and duration, might have been expected to have put paid to this false belief, in practice it has not. Nevertheless, the crisis has significantly increased interest in another viewpoint. Rather than being a machine, the economy should instead be viewed as a complex adaptive system, like a forest, with massive interdependencies among its parts and the potential for highly nonlinear outcomes. Such systems evolve in a path dependent way and there is no equilibrium to return to. There are in fact many such systems in both nature and society; traffic patterns, movements of crowds, the spread of crime and diseases, social networks, urban development and many more. Moreover, their properties have been well studied and a number of common features stand out. Economic policymakers could learn a great deal from these interdisciplinary studies. Four points are essential.

First, all complex systems fail regularly; that is, they fall into crisis. Moreover, the literature suggests that the distribution of outcomes is commonly determined by a Power Law. Big crises occur infrequently while smaller ones are more frequent. A look at economic history, which has become more fashionable after decades of neglect, indicates that the same patterns apply. For example, there were big crises in 1825, 1873 and 1929, as well as smaller ones more recently in the Nordic countries, Japan and South East Asia. The policy lesson to be drawn is that, if crises are indeed inevitable, then we must have ex ante mechanisms in place for managing them. Unfortunately, this was not the case when the global crisis erupted in 2007 and when the Eurozone crisis erupted in 2010.

Second, the trigger for a crisis is irrelevant. It could be anything, perhaps even of trivial importance in itself. It is the system that is unstable. For example, the current global crisis began in 2006 in the subprime sector of the US mortgage market. Governor Bernanke of the Federal Reserve originally estimated that the losses would not exceed 50 billion dollars and they would not extend beyond the subprime market. Today, eight years later and still counting, the crisis has cost many trillions and has gone global. It seems totally implausible that this was "contagion". Similarly, how could difficulties in tiny Greece in 2010 have had such far reaching and lasting implications for the whole Eurozone? The global crisis was in fact an accident waiting to happen, as indeed was the crisis within the Eurozone. The lesson to be drawn is that policy makers must focus more on interdependencies and systemic risks. If the timing and triggers for crises are impossible to predict, it remains feasible to identify signs of potential instability building up and to react to them. In particular, economic and financial systems tend to instability as credit and debt levels build up, either to high levels or very quickly. Both are dangerous developments and commonly precede steep economic downturns.

Third, complex systems can result in very large economic losses much more frequently than a Normal distribution would suggest. Moreover, large economic crisis often lead to social and political instability. The lesson to be drawn is that policymakers should focus more on avoiding really bad outcomes than on optimizing good ones. We simply do not have the knowledge to do policy optimisation, as Hayek emphasized in his Nobel Prize lecture entitled “The pretence of knowledge”. In contrast, policymakers have pulled out all the stops to resist little downturns over the course of the last few decades. In this way, they helped create the problem of debt overhang that we still face today. Indeed, the global ratio of (non-financial) debt to GDP was substantially higher in 2014 than it was in 2007.

Fourth, looking at economic and financial crises throughout history, they exhibit many similarities but also many differences. As Mark Twain suggested, history never repeats itself but it does seem to rhyme. In part this is due to adaptive human behaviour, both in markets and on the part of regulators, in response to previous crises. While excessive credit growth might be common to most crises, both the source of the credit (banks vs non-banks) and the character of the borrowers (governments, corporations and households) might well be different. Note too that such crises have occurred under a variety of regulatory and exchange rate regimes. Moreover, prized stability in one area today (say payment systems) does not rule out that area being the trigger for instability tomorrow. Changes in economic structure or behaviour can all too easily transform todays “truth” into tomorrow’s “false belief”. The lesson to be drawn is that policymakers need eternal vigilance and, indeed, institutional structures that are capable of responding to changed circumstances. Do not fight the last war.

It is ironic that the intellectual embrace of complexity by economic policymakers should lead to such simple policy lessons. Had they been put into practice before the current crisis, a lot of economic, social and political damage might have been avoided. As Keynes rightly said “The ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood”. Nor is the hour too late to embrace these ideas now. The recognition that the pursuit of ultra-easy monetary policies could well have undesirable and unexpected consequences, in our complex and adaptive economy, might lead to a greater focus on alternative policies to manage and resolve the crisis. Absent such polices, the current crisis could easily deepen in magnitude rather than dissipate smoothly over time. This is an outcome very much to be avoided, but it will take a paradigm shift for this to happen.

New Economic Thinking and the Potential to Transform Politics

by Eric Beinhocker

Economic ideas matter. For two centuries political debates have been framed by economic arguments – markets versus states; right versus left. But economic thinking is changing, and it is paramount that policy and politics change along with it.

Yet, today few politicians are even aware of these economic developments, although their implications for politics are potentially transformative.

First, new economics can offer us a better toolkit to analyse and develop policy. In 2006, economists at the Federal Reserve analysed what would happen if the then-growing US housing bubble burst. The answer that came back was 'not much'. The traditional economic model they used assumed that everyone would behave rationally, markets would function efficiently, and the system would smoothly self-correct.

We all know what happened. When the bubble burst it wiped out $10.8 trillion in wealth in the US alone. In Europe, the President of the ECB remarked, 'I found the available models of little help. In the face of the crisis, we felt abandoned by conventional tools'. Yet a crisis is exactly when a model should be at its most helpful.

So what would new economics have done differently? A team of researchers at Yale and several other universities have constructed a detailed bottom-up model of the housing market which shows the bubble in a new light. Unlike conventional top-down models, which show gentle self-correction, the team's 'agent-based model' showed the bubble bursting and markets crashing. The team modelled various policy responses to the housing bubble using real data. Conventional wisdom has been that sustained low interest rates following the 2000 dot-com crash were the primary cause of the housing bubble. But in the model raising the interest rates did not prevent a bubble forming, but tighter regulation of banks almost completely eradicated it.

This suggests better ways to frame economic policy in relation to the housing market. But, in coming years, similar work will undoubtedly highlight ways to improve policy in other areas. For example, the European Commission has funded a similar modelling effort to better understand and prevent financial crises, and these techniques are being applied to areas ranging from climate change, to health policy, to better understanding how economies grow.

Second, in addition to providing new models for understanding specific issues like the financial crisis, new economics offers a different way of thinking about policy more broadly.

Traditional economics views the economy in a fairly mechanistic way, ignoring what George Soros calls the 'reflexivity' of the economy: a two-way interplay between perceptions and actions which can send the economy off on a course very different from that predicted by traditional models.

New economics can take account of some of the complexity, unpredictability and reflexivity of the economy to take us beyond a mechanistic view of policy. Rather than finding a specific problem and following one policy to solve it (or not), we should create portfolios of small-scale experiments, building on those that work whilst rejecting those that don't. Policies and institutions should be made as adaptable as possible. California's building codes have succeeded in reducing energy consumption by setting standards which automatically ratchet up as technology improves. This allows regulations and state-of-the-art building practices to co-evolve. Policy-makers must begin to see themselves as 'system stewards' rather than social engineers. They should aim to provide the conditions which allow socially favourable outcomes can emerge from the interactions of the system's stakeholders.

Finally, new economic thinking could provide the foundations for an entirely new species of politics which does not correspond to a left-right framework. This isn't merely a centrist compromise. Rather it is a different frame work that agrees with the right on some things, with the left on others, and neither on still others.

New economic work shows that Hayek was ahead of his time in his insights into the power of markets to self-organise, efficiently process information, and innovate. But new economic work also shows that Keynes was ahead of his time in his concerns about inherent instabilities in markets, the possibility that markets can fail to self-correct, and the need for the state to intervene when markets malfunction. New economics offers the promise of a new synthesis that goes beyond the insights of figures such as Keynes and Hayek and re-frames historic left-right debates.

A new narrative of politics could develop out of such a shift. For example, Eric Liu and Nick Hanauer, in their book the *Gardens of Democracy* advocate a move from mechanistic 'machine-brain' narratives in politics towards a 'gardener' mind-set, with the state playing the role of a gardener, helping create the conditions in which the private sector and civil society can flourish.

New economics still has some distance to go to mature as a body of economic theory, and no doubt it will take time to further develop the policy and political implications of these ideas. This journey may not end our political debates, but it has the potential to make them far more productive for society.

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This is an edited version of a chapter from IPPR's forthcoming book, *New Era Economics [check title]*. For more see www.ippr.org/publications.

Urbanisation and Complex Systems

by Colin Harrison

The city is humanity's greatest invention. An artificial ecosystem that enables millions of people to live in close proximity and to collaborate in the creation of new forms of value. While cities were invented many millennia ago, their economic importance has increased dramatically since the Industrial Revolution until they now account for the major fraction of the global economy. All human life is there and so the study of cities crosses boundaries among economics, finance, engineering, ecology, sociology, anthropology, and, well, almost all forms of knowledge. Yet, while we have great knowledge in each of these domains individually, we have little scientific knowledge of how they come together in the overall system of systems that is a city. In brief: How does a city work?

Such knowledge would be helpful in the coming decades. In the last sixty to seventy years, globalisation has spread the Industrial Revolution ever more widely, creating in cities new opportunities that attract hundreds of millions of internal and international migrants. This process is lifting many of these migrants out of deep poverty, while causing cities from London to Nairobi to struggle in differing ways with the unending influx.

Further, cities are responsible for large fractions of greenhouse gas emissions, for the consumption of natural resources such as water and air, and the resulting discharges of pollution into the environment. If the battle against climate change is to be won, it will be won in cities. Cities are also the principal centres for innovation and economic development, both of which are needed to continue lifting migrants out of poverty.

While the roots of urban planning can be traced back more than three thousand years in terms of the master plans of cities, it was the tremendous growth of cities in the late 19th century that transformed that field into considering the many services and affordances that are required for urban dwellers. But urban planning emerged mainly from the humanities and works primarily through extensive case studies, although it has adopted many digital tools. The notion of the city as an object of scientific study is more recent and still in its infancy, triggered in part by developments in complexity theory such as network theory, scaling laws, and systems science, and the growing availability of urban data.

Urban scaling laws have been explored at least since the early 20th century, when cities were found seen to be an example of Zipf's law. In this case Zipf's Law states that "for most countries, the number of cities with population greater than S is proportional to 1/S". The understanding of scaling was greatly expanded in recent years by the works of West and Bettencourt and Batty. Their work showed that many properties of cities such as the number or lengths of roadways, the numbers of amenities such as restaurants, and so forth follow scaling laws over population ranges from ten thousand to tens of millions. Moreover these scaling laws have exponents in the ranges 0.85 to 1.15 that show large cities to be more productive, innovative, efficient in energy consumption, expensive, but also better paying than small cities. Likewise negative attributes such as crime, disease, and pollution also scale superlinearly, that is they don't rise in strict proportion to the increase in city size. For example, GDP is proportional to the Size (S) of a city raised to a power that is slightly greater than 1, thus $S^{1.15}$, while other attributes like energy consumption per capita scale sublinearly, at $S^{0.85}$. Network laws also describe well the evolution over long time scales of roadways and railways in cities.

While scaling laws and network laws have great descriptive power, opinions vary on whether they apply across different countries or have predictive power. That is, the scaling of attributes is a snapshot of frequency versus size at a given time. If a city grows and "moves up the scale", it may not achieve, in the short term, all of the positive benefits and negative impacts described. Nor do the laws provide explanations for the observed behaviours. Nonetheless, this is an important area for planners and developers seeing their cities growing or shrinking.

As urban data has become more pervasive, it is now possible to study cities as complex systems of interactions. We may view the city as a myriad of interactions among its inhabitants, its infrastructures and affordances, its natural environment, and its public, private, and civic organisations. Some of these interactions involve the exchange of goods or services for money, but many of them involve the exchange or transmission of information, enabling inhabitants and organisations to make choices. Public transportation is often studied in this way, revealing for example that small and medium sized cities evolve networks enabling commuting between small numbers of residential and business districts, while very large cities, such as London, have much richer networks that permit greater flexibility in where people live and work.

The operation of cities is also modelled using synthetic populations of software agents that represent the distribution of behaviours or preferences of much larger, real populations. Such agent-based models, with agents representing patterns of origin, destination, travel times, and modality preferences, are used to examine the overall impact of new services such as London's Crossrail.

As the Internet of Things provides greater visibility into how inhabitants choose to exploit the opportunities offered by a given city, we may hope to discover abstract principles about how cities work. We may envision being able to construct agent-based models representing the complete spectrum of choices a city's inhabitants make at timescales from minutes to years and spatial scales from meters to kilometers. Equally, given the increasing availability of real-time information, we might hope one day to understand the effective use of a city's services in terms of a Nash Equilibrium, a game theory concept (often used to describe poker games), where no player can gain anything by changing their chosen strategy if other players don't change theirs – all the players' strategies are optimal. These are far in the future, but the EC's Global Systems Science programme is the beginning of that journey.

Complexity, Modesty and Economic Policy

by Lex Hoogduin

Societies and economies are complex systems, but the theories used to inform economic policies predominantly neglect complexity. They assume for example representative agents such as a typical consumers, and they also assume that the future is risky rather than uncertain. This assumption allows for the application of the probability calculus and a whole series of other techniques based on it.

In risk situations, all potential outcomes of a policy can be known. This is not the case in situations of uncertainty, but human beings, policy makers included, cannot escape having to take their decisions and having to act facing an uncertain future. The argument is one of logic. Human beings cannot know now what will be discovered in the future. Future discoveries may however impact and shape the consequences of their current decisions and actions. Therefore, they are unable to come up with an exhaustive list of potential outcomes of a policy decision or action.

Properly taking into account the complexity of the economy and the uncertainty of the future implies a paradigm shift in economics. That paradigm does not need to be developed from scratch. It builds on modern complexity science, neo-Austrian economics (in particular Hayek and von Mises), as well as the work of Keynes and Knight and certain strands of cognitive psychology (for example, Kahneman 2011). There is no room here to elaborate on the theory and the claim that it entails a paradigm shift. Rather, I will discuss the implications for economic policy that follow from this paradigm.

This starts with the recognition that the future cannot be predicted in detail. We should be modest about what can be achieved with economic policy. This is the "modesty principle". Economic policy cannot deliver specific targets for economic growth, income distribution, inflation, the increase of the average temperature in four decades from now, etc. Economic policy makers would be wise to stop pretending that they can deliver what they cannot. This insight implies that many current policies should be discontinued. To mention just one example: inflation targeting by central banks does not pass the modesty test.

This principle also implies refraining from detailed economic forecasts as a basis for policy making and execution. Policies should not be made on the assumption that we know the value of certain variables which we cannot know. An example here is the income multiplier in relation to changes in fiscal policy. The modesty principle also flashes red for risk-based regulation and supervision.

What economic policy can do is contribute to the formation and evolution of a fit economic order, and avoid doing harm to such an order, what I would call the "do no harm principle", and be as little as possible a source of uncertainty for private economic agents.

Order is a central concept in the alternative paradigm, replacing the (dis)equilibrium concept in mainstream economics. An order is the set of possible general outcomes (patterns, like growth, inflation, cyclicality, etc.) emerging from purposefully acting and interacting individuals on the basis of a set of rules in a wide sense (laws, ethics, conventions…), together called a regime. Economics can analyse the connection between changes in regime and changes in economic order. Economic policy can influence the economic order through changing the regime.

However, this knowledge is not certain. There is always the potential for surprises (positive and negative; opportunities and threats) and unintended consequences. Policy can therefore not be designed first and then just be executed as designed. Policy making and execution have to evolve in a process of constant monitoring and adaptation. This would also allow for evolutionary change. An economic order that is not allowed to evolve may lose its fitness and may suddenly collapse or enter a crisis (as described by Scheffer for critical transitions in society). This mechanism may have played a role in the Great Moderation leading up to the financial crisis of 2007/2008 and in the crisis of fully funded pension systems. It is also a warning against basing sustainability policies on precise temperature targets decades in the unknowable future.

Fitness of an order has five dimensions. The first is an order in which agents are acting as described in the previous paragraph – policymaking involves a process of constant monitoring and adaptation. In addition to that, fitness is determined by alertness of agents (the ability to detect mistakes and opportunities); their resilience (the ability to survive and recover from mistakes and negative surprises); adaptive capacity (the ability to adjust); and creative capacity (the ability to imagine and shape the future). Policies may be directed at facilitating economic agents to improve these capacities, although constrained by the “modesty” and “do no harm” principles. Note that the concept of stability does not appear in the definition of fitness. This marks a difference with current policies which put much emphasis on stability.

In its own actions the government should be transparent and predictable. The best way to do that seems to be to follow simple rules. For example in fiscal policy, balance the budget, perhaps with clearly-defined, limited room for automatic stabilisers to work.

This alternative paradigm places highlights some methods and analytical techniques, including narrative techniques), network analysis), evolutionary logic), qualitative scenario thinking, non-linear dynamics (Scheffer), historical analysis (development of complex systems is path dependent) and (reverse) stress testing.

Economic policies developed along these lines help people to live their lives as they wish. They are good policies for good lives.

The Rising Complexity of the Global Economy

by Sony Kapoor

A complicated system (such as a car) can be disassembled and understood as the sum of its parts. In contrast, a complex system (such as traffic) exhibits emergent characteristics that arise out of the interaction between its constituent parts. Applying complexity theory to economic policy making requires this important recognition – that the economy is not a complicated system, but a complex one.

Historically, economic models and related policy making have treated the economy as a complicated system where simplified and stylised models, often applied to a closed economy, a specific sector or looking only at particular channels of interaction such as interest rates, seek to first simplify the real economy, then understand it and finally generalise in order to make policy.

This approach is increasingly out-dated and will produce results that simply fail to capture the rising complexity of the modern economy. Any policy decisions based on this notion of a complicated system that is the sum of its parts can be dangerously inaccurate and inappropriate. What are the forces driving this increasing complexity in the global economy? What, if anything, can be done about this?

A complex system can be roughly understood as network of nodes, where the nodes themselves are interconnected to various degrees through single or multiple channels. This means that whatever happens in one node is transmitted through the network and is likely to impact other nodes to various degrees. The behaviour of the system as a whole thus depends on the nodes, as well as the nature of the inter-linkages between them. The complexity of the system, in this instance the global economy, is influenced by a number of factors. These include first, the number of nodes; second, the number of inter-linkages; third, the nature of inter-linkages; and fourth, the speed at which a stimulus or shock propagates to other nodes. Let us now apply each of these factors to the global economy.

The global economy has seen a rapid increase in the number of nodes. One way of understanding this is to look at countries that are active participants in the global economy. The growth of China and other emerging markets, as well as their increasing integration into the world trading and more recently global financial systems, is a good proxy to track the rise in the number of nodes. The relative size and importance of these nodes has also risen with China, by some measures already the world’s largest economy.

Simultaneously, the number of inter-linkages between nodes has risen even more rapidly. The number of possible connections between nodes increases non-linearly with the increase in the number of nodes, so the global economy now has a greater number of financial, economic, trade, information, policy, institutional, technology, military, travel and human links between nodes than ever before. The increasing complexity of supply chains in trade and manufacturing, ever greater outsourcing of services, rising military collaborations, the global nature of new technological advances, increasing migration and travel, as well the rise and rise of the internet and telecommunications traffic across the world have all greatly increased the number of connections across the nodes.

It is not just that the number of interconnections between nodes has risen almost exponentially. The scope and nature of these inter-linkages has broadened significantly. The most notable broadening has come in the form of the rapid rise of complex manufacturing supply chains; financial links that result directly from the gradual dismantling of capital controls; and the rise of cross-border communication and spread of information through the internet. These ever-broadening connections between different nodes fundamentally change the behaviour of the system and how the global economy will react to any stimulus, change or shock in one or more of nodes in ways that becomes ever harder to model or predict.

Last but not the least, it is not just the number and intensity of links between the nodes that has risen, but also how quickly information, technology, knowledge, shocks, finance or pathogens move between the nodes. This results, in complexity theory parlance, in an ever more tightly coupled global economy. Such systems are more efficient, and the quest for efficiency has given rise to just-in-time supply chains and the rising speed of financial trading and other developments. But this efficiency comes at the cost of rising fragility. Evidence that financial, economic, pathogenic, security and other shocks are spreading more rapidly through the world is mounting.

To sum up, the Dynamic Stochastic General Equilibrium (DSGE) models and other traditional approaches to modelling the global economy are increasingly inadequate and inaccurate in capturing the rising complexity of the global economy. This complexity is being driven both by the rising number of nodes (countries) now integrated into the global economy, as well as the number and nature of the interconnections between these, which are intensifying at an even faster pace.

This calls for a new approach to policymaking that incorporates lessons from complexity theory by using a system-wide approach to modelling, changes institutional design to reduce the fragility of the system and deepens international and cross-sector policy making and policy coordination.

Big Data and Economic Complexity: Opportunity and Myth

by Luciano Pietronero

The immense accumulation of data is a new phenomenon which induces many considerations, it represents a great potential and leads also to mythical expectations. Here we show a specific example of BIG DATA applications, the case of Economic Complexity. This is a new perspective to fundamental economics with a bottom up approach which starts with a novel use of older data and then develops into its own streamline. It confirms some expectations but also disproves others.

For some practitioners BIG DATA is a problem of computer memory and access speed. Once the data are enough they contain all the possible information one may need and they will speak by themselves. This is actually not the case in general but it can basically work in some specific cases.

An example of this type is the Picketty analysis of economic inequality. In this case the problem is to compute a single ratio, the inequality. The work consists in the accumulation, cleaning and checking of the data. Once these are given the calculation is indeed straightforward. The result is nevertheless remarkable and it is a good example because in economics it is important to change attitude and start from data.

In general things are more complex and we are going to show this with the specific example of Economic Complexity (1-3). The standard analysis of the competitiveness of countries considers a number of elements like education, transportation, production, export, pollution etc and with a suitable weighting of these elements, it leads to a global mark for the country. In a way this is also a BIG DATA problem but of traditional nature. In the end this analysis needs the fixing of more than 100 parameters for all of these elements, each of which is characterized by a lot of data. Clearly this is a subjective task which cannot properly consider all the possible interactions between these elements. In addition the analysis is made for each country individually and only at the end different countries are compared.

Economic Complexity corresponds to a change of perspective and goes beyond the individual analysis. All countries are considered as nodes of an integrated network and the links are given by the products they produce. In practice one considers the bipartite network of countries and products. The first problem with this is that one needs coherent and homogeneous data which usually are not or only in part available. So the new vision immediately shows the limitations of the available data. It is a qualitative problem, not dependent on how big the data are. One then starts working with what is available but would really like to have something else.

In principle one has more information than just the products but the problem is that these data are not independent and considering them all just leads to confusion or to an interpretation which is intrinsically subjective. Assigning parameters and weights to the various data. But we wanted to go beyond this stage and make an analysis which is scientific, namely one that provides a unique result, not dependent on the subjective interpretation. This leads to a selection among the data and actually to a reduction of them. Only a selected subset is really useful (1-3), adding more data leads to confusion.

This shows that a BIG DATA problem often starts with small data. One has to select a method of analysis and choose the questions and problems to consider. The data do not provide these things by themselves. In this case one needs an algorithm similar in spirit to the Google Page Rank. In economics, however, the Google algorithm is not appropriate and we had to look for a different one. This is a conceptual part of the work which, however, needs the appropriate data to be tested.

Then one begins to get nice result and the approach gains popularity and attention. The ambition grows and the limits of the original data set become apparent. This opens the search for much more data but in a specific direction which is identified by the method of analysis and the new algorithm. Now the problem can evolve into a real BIG DATA level by adding more and more information on the countries and the products but in the new perspective.

A natural evolution is then to go to the analysis of companies and here a new situation appears. Companies are specialized in terms of products so a matrix of companies and products would lead to a very limited information and not particularly useful. One has to study which are the data suitable for companies and which is the new criterion and the new algorithm to extract useful information from these data. This is the present frontier.

Take home message 1: as soon as you have a new idea and a new algorithm you immediately realize that the data available (collected for different purposes) are not optimal and you want more data of new type. There is no infinite dataset one may collect a priori which is good for all problems.

The step we have indicated corresponds to a shift from the individual country analysis with 100 parameters to a network algorithmic analysis with zero parameters. So one may think that the key to BIG DATA analysis is the study of Complex Networks. Indeed there is a vast literature mostly on the statistical characterization of their properties, but is this really what we need?

The example of Google would rather point in a different direction. No matter what are the specific characteristic and structure of the network this algorithm is successful in defining the correct hierarchy of WEB sites. On the other hand, in the absence of such an algorithm, the classification of the specific properties of the network would not lead to much useful information.

The situation is actually similar for our algorithm for countries and products. With the standard Complex Network studies one can show that in the past decade the economic cluster around China has become larger than that around Japan. Hardly a surprise and not particularly interesting result. On the other hand with the appropriate algorithm one can get a wealth of results like ranking of countries and products, identification of the hidden potential and forecasting of GDP growth etc. (1-3)

Take home message 2: BIG DATA SCIENCE in the sense we have indicated can indeed produce a revolution in our knowledge in many fields. But for each area there should be a clear understanding of what is the relevant information and how to extract it from the data. This cannot be a single recipe but it should be studied and tailored to each problem.

References

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Complexity and Better Financial Regulation

by Harald Stieber

The financial crisis of 2007/08 was not caused by complexity alone. It was caused by rapidly increasing financial leverage until a breaking point was reached. While the mostly short-term debt used for leveraging up consists of “run-prone contracts“, the precise location of that breaking point had to be discovered in real time and space rather than in a controlled simulation environment. Also, the complex dynamic patterns that emerged as the crisis unfolded showed that little had been known about how an increasingly complex financial system would transmit stress. The sequence of markets being impacted and the speed of risk propagation across different markets and market infrastructures was not known beforehand and had to be discovered “on the fly”. Our ignorance with respect to these static and dynamic properties of the system reflects deep-rooted issues linked to data governance, modelling capabilities, and policy design (in that order).

From a policy perspective, the crisis revealed that several parts of the financial ecosystem remained outside the regulatory perimeter. As a result, the public good of financial stability was not provided any longer to a sufficient degree in all circumstances. However, the regulatory agenda that followed, under a principles-based approach coordinated at the level of the newly created G20, while closing many important regulatory gaps, also created increasing regulatory complexity.

Regulatory complexity can also increase risks to financial stability. Higher compliance cost can induce avoidance behaviour, which makes financial regulation less effective as regulated entities and agents will engage in regulatory arbitrage as well as in seeking to escape the regulatory perimeter altogether via financial innovation. Until recently, at least the largest financial institutions were considered to “like” regulatory complexity.

However, the perception of complexity in the financial industry is changing. Complexity cannot be gamed any longer as compliance cost and risk of fines have increased. One of the clearest statements in that direction came in the form of a letter from financial trading associations that we at the European Commission received (together with all main regulators) on June 11 2015. In their letter, the associations called for coordinated action in the area of financial (data) standards that would reduce complexity to a level that could again be managed by the sector.

The European Commission’s Better Regulation agenda has at its heart the principle that existing rules need to be evaluated in a continuous manner to assess their effectiveness[1]as well as their efficiency[2]. Under this agenda, the Commission launched a public consultation in 2015 calling on stakeholders to provide evidence on 15 issues with a strong focus on the cumulative impact of financial regulation in place. The purpose was to identify possible overlaps, inconsistencies, duplications, or gaps in the financial regulatory framework which had increased considerably in complexity. The area of (data) reporting emerged as a major area where responses pointed to important possible future gains in regulatory effectiveness and efficiency.

Regulatory reporting has seen massive changes as the lack of relevant data at the level of supervisory authorities had been identified as a major source of risk during the crisis. Especially, legislation in the area of financial markets such as the European Market Infrastructure Regulation (EMIR), but also MiFID/R, employed a different approach to regulatory reporting compared to existing reporting obligations for regulated financial institutions (e.g. COREP, FINREP). EMIR puts the focus on the individual financial transaction (of financial derivatives traded over-the-counter rather than on a regulated exchange), with reporting at the most granular level of the individual financial contract. Reporting under EMIR started to be rolled out in several phases from February 2014 and is still ongoing, starting from the most standardized contracts and continuing to the least standardized ones. This approach is extended to a broader class of instruments under MiFID/R.

This granular approach to regulatory reporting holds tremendous promise from a complexity science perspective. It could, at some point, allow the mapping of the financial ecosystem from bottom-up, as well as further the development of a Global Systems Science policymaking process. However, to arrive at more evidence-based, data-driven policies, data governance, and more precisely financial data standards, will have to be adapted to the increasingly granular data-reporting environment.

Data governance requires robust financial data standards that keep up with technological change. We see a few precise implications at this stage what standards need to do in that respect. Financial contract data is Big Data. Financial data standards produce small data from Big Data. They add structure and scalability in both directions.

In a follow-up project to the call for evidence, we are therefore looking at different ways how financial data standards and regulatory technology can help achieve Better Regulation objectives. These possible ways comprise the definition of core data methodologies, the development of data point models, exploring the use of algorithmic standards, as well as possible uses of distributed ledger and decentralized consensus technologies. We cannot say at this stage if the vision of a “run-free financial system” is within our reach in the medium-term. But the resilience properties of the internet are one possible guide how technology could help regulatory reporting achieve its objectives in a much more powerful way in the future that will at the same time acknowledge the complexity of our subject matter.