Complexity and the financial system
A complex global financial system
by Adrian Blundell-Wignall, Special Advisor
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Global finance is the perfect example of a complex system, consisting as it does of a highly interconnected system of sub-systems featuring tipping points, emergence, asymmetries, unintended consequences, a “parts-within-parts” structure (to quote Herbert Simon), and all the other defining characteristics of complexity. It is shaped by numerous internal and external trends and shocks that it also influences and generates in turn. And as the system (in most parts) also reacts to predictions about it, it can be called a “level two” chaotic system (as described, e.g. by Yuval Harari)

Numerous developments combined to contribute to the 2008 crisis and several of them led to structures and institutions that might pose problems again. Two important trends that would play a huge role in the crisis were the opening up of OECD economies to international trade and investment after 1945, and rapid advances in digital technology and networks. These trends brought a greater complexity of financial products and structures needed to navigate this new world, going well beyond the needs to meet the increased demand for cross-border banking to include new products that would facilitate hedging of exchange rate and credit default risks; financial engineering to match maturities required by savers and investors, and to take advantage of different tax and regulatory regimes; mergers and acquisitions not only of businesses, but of stock exchanges and related markets with global capabilities; and new platforms and technological developments to handle the trading of volatile new products.

The freeing up of financial markets followed the opening of goods markets, and in some respects was the necessary counterpart of it. However, the process went very far, and by the end of the 1990s policies encouraged the “financial supermarket” model, and by 2004 bank capital rules became materially more favourable to bank leverage as did rule changes for investment banks. The banking system became the epicentre of the global financial crisis, because of
the under-pricing of risk, essentially due to poor micro-prudential regulation, excessive leverage, and too-big-to-fail business models. The rise of the institutional investor, the expansion of leverage and derivatives, the general deepening of financial markets and technological advances led to innovations not only in products but also in how securities are traded, for example high-frequency trading. The increasing separation of owners from the governance of companies also added a new layer of complexity compounding some of these issues (passive funds, exchange-traded funds, or ETFs, lending agent’s custody, re-hypothecation, advisors and consultants are all in the mix).

The trends towards openness in OECD economies were not mirrored in emerging market economies (EMEs) generally, and in Asia in particular. Capital controls remained strong in some EMEs despite a strengthening and better regulated domestic financial system. Furthermore, capital control measures have often supported a managed exchange rate regime in relation to the US dollar. When countries intervene to fix their currencies versus the dollar, they acquire US dollars and typically recycle these into holdings of US Treasuries, very liquid and low-risk securities. There are two important effects of the increasingly large size of “dollar bloc” EME’s: first, they compress Treasury yields as the stock of their holdings grows, second, their foreign exchange intervention means that the US economy faces a misalignment of its exchange rates vis-à-vis these trading partners.

Low interest rates, together with the more compressed yields on Treasury securities, have encouraged investors to search for higher-risk and higher-yield products. In “risk-on” periods this contributes to increased inflows into EME high-yield credit which, in turn, contributes to more foreign exchange intervention and increased capital control measures. The potential danger is that in “risk-off” periods, the attempt to sell these illiquid assets will result in huge pressures on EME funding and a great deal of volatility in financial markets.
The euro affects financial stability too, often in unexpected ways... European countries trade not only with each other but with the rest of the world. However, the north of Europe is, through global value chains, more vertically integrated into strongly growing Asia due to the demands for high-quality technology, infrastructure, and other investment goods, while the south of Europe is competing with EMEs to a greater degree in lower-level manufacturing trade. Asymmetric real shocks to different euro area regions, such as divergent fiscal policy or changes in EME competitiveness, mean that a one-size-fits-all approach to monetary policy creates economic divergence. Resulting bad loans feed back into financial fragility issues, and interconnectedness adds to the complexity of the problem.

Population ageing adds to these concerns, notably due to the interactions among longer life spans, low yields on the government bonds that underpin pension funds, and lack of saving by the less wealthy who were hardest hit by the crisis and may also suffer from future changes in employment and career structures. To meet yield targets, institutions have taken on more risk in products that are often less transparent and where providers are trying to create “artificial liquidity” that does not exist in the underlying securities and assets.

However big and complex the financial system, though, it is not an end in itself. Its role should be to help fund the economic growth and jobs that will contribute to well-being. But despite all the interconnectedness, paradoxically, as the OECD Business and Finance Outlook 2016 argues, fragmentation is blocking business investment and productivity growth.

In financial markets, information technology and regulatory reforms have paved the way for fragmentation with respect to an increased number of stock trading venues and created so-called “dark trading” pools. Differences in regulatory requirements and disclosure among trading venues raise concerns about stock market transparency and equal treatment of investors. Also, corporations may be affected negatively if speed and complexity is rewarded over long-term investing.
Different legal regimes across countries and in the growing network of international investment treaties also fragment the business environment. National laws in different countries sanction foreign bribery with uneven and often insufficient severity, and many investment treaties have created rules that can fragment companies with respect to their investors and disrupt established rules on corporate governance and corporate finance.

Complexity is in the nature of the financial system, but if we want this system to play its role in funding inclusive, sustainable growth, we need to put these fragmented pieces back together in a more harmonious way.

**Useful links**

The original article on OECD Insights, including links and supplementary material, can be found here: http://wp.me/p2v6oD-2JC

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Complexity and better financial regulation

by Harald Stieber, Economic Analysis and Evaluation Unit, DG FISMA, European Commission

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 co-ordinated 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 11 June 2015. In their letter, the associations called for co-ordinated 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 effectiveness¹ as well as their efficiency². 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

¹. Effectiveness: Does the impact observed on the ground correspond to the outcome aimed for by the EU co-legislators?
². Efficiency: Is the desired regulatory outcome achieved at lowest possible compliance cost?
rolled out in several phases from February 2014 and is still ongoing, starting from the most standardised contracts and continuing to the least standardised 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 policy-making 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 decentralised 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.

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Agent-based models to help economics do a better job

by Richard Bookstaber, University of California

Economics has not done a very good job of dealing with crises. I think this is because there are four characteristics of human experience that manifest themselves in crises and that cannot be addressed well by the methods of traditional economics.

The first of these is computational irreducibility. You may be able to reduce the behaviour of a simple system to a mathematical description that provides a shortcut to predicting its future behaviour; the way a map shows that following a road gets you to a town without having to physically travel the road first. Unfortunately, for many systems, as Stephen Wolfram argues, you only know what is going to happen by faithfully reproducing the path the system takes to its end point, through simulation and observation, with no chance of getting to the final state before the system itself. It’s a bit like the map Borges describes in On Rigor in Science, where “the Map of the Empire had the size of the Empire itself and coincided with it point by point”. Not being able to reduce the economy to a computation means you can’t predict it using analytical methods, but economics requires that you can.

The second characteristic property is emergence. Emergent phenomena occur when the overall effect of individuals’ actions is qualitatively different from what each of the individuals are doing. You cannot anticipate the outcome for the whole system on the basis of the actions of its individual members because the large system will show properties its individual members do not have. For example, some people pushing others in a crowd may lead to nothing or it may lead to a stampede with people getting crushed, despite nobody wanting this or acting intentionally to produce it. Likewise no one decides to precipitate a financial crisis, and indeed at the level of the individual firms, decisions generally are made to take prudent action to avoid the costly effects of a crisis. But what is locally stable can become globally unstable.
The name for the third characteristic, non-ergodicity, comes from the German physicist Ludwig Boltzmann who defined as “ergodic” a concept in statistical mechanics whereby a single trajectory, continued long enough at constant energy, would be representative of an isolated system as a whole, from the Greek *ergon* energy, and *odos* path. The mechanical processes that drive of our physical world are ergodic, as are many biological processes. We can predict how a ball will move when struck without knowing how it got into its present position – past doesn’t matter. But the past matters in social processes and you cannot simply extrapolate it to know the future. The dynamics of a financial crisis are not reflected in the pre-crisis period for instance because financial markets are constantly innovating, so the future may look nothing like the past.

Radical uncertainty completes our quartet. It describes surprises – outcomes or events that are unanticipated, that cannot be put into a probability distribution because they are outside our list of things that might occur. Electric power, the atomic bomb, or the internet are examples from the past, and of course by definition we don’t know what the future will be. As Keynes put it, “There is no scientific basis to form any calculable probability whatever. We simply do not know.” Economists also talk about “Knightian uncertainty”, after Frank Knight, who distinguished between risk, for example gambling in a casino where we don’t know the outcome but can calculate the odds; and what he called “true uncertainty” where we can’t know everything that would be needed to calculate the odds. This in fact is the human condition. We don’t know where we are going, and we don’t know who we will be when we get there. The reality of humanity means that a mechanistic approach to economics will fail.

So is there any hope of understanding what’s happening in our irreducible, emergent, non-ergodic, radically uncertain economy? Yes, if we use methods that are more robust, that are not embedded in the standard rational expectations, optimisation mode of economics. To deal with crises, we need methods that deal with computational irreducibility; recognise emergence; allow for the fact that not even the present is reflected in the past, never mind the future; and that can deal with radical uncertainty. Agent-based modelling could be a step in the right direction.
Agent-based models (ABM) use a dynamic system of interacting, autonomous agents to allow macroscopic behaviour to emerge from microscopic rules. The models specify rules that dictate how agents will act based on various inputs. Each agent individually assesses its situation and makes decisions on the basis of its rules. Starlings swirling in the sky (a “murmuration”) is a good illustration. The birds appear to operate as a system, yet the flight is based on the decisions of the individual birds. Building a macro, top-down model will miss the reality of the situation, because at the macro level the movements of the flock are complex, non-linear, yet are not based on any system-wide programme. But you can model the murmuration based on simple rules as to how a bird reacts to the distance, speed and direction of the other birds, and heads for the perceived centre of the flock in its immediate neighbourhood.

Likewise, the agent-based approach recognises that individuals interact and in interacting change the environment, leading to the next course of interaction. It operates without the fiction of a representative consumer or investor who is as unerringly right as a mathematical model can dream. It allows for construction of a narrative – unique to the particular circumstances in the real world – in which the system may jump the tracks and careen down the mountainside. This narrative gives us a shot at pulling the system back safely.

In short, agent-based economics arrives ready to face the real world, the world that is amplified and distorted during times of crisis. This is a new paradigm rooted in pragmatism and in the complexities of being human.

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