Systemic Risk Centre

SYSTEMIC RISK: WHAT RESEARCH TELLS US AND WHAT WE NEED TO FIND OUT

SRC

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

1965 - 2015 50 E·S·R·C 50 YEARS SHAPING SOCIETY

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Published by
Systemic Risk Centre
The London School of Economics
and Political Science
Houghton Street
London WC2A 2AE

Designed by DesignRaphael Ltd
Illustrations pgs 9/11/20/26/28 by Judith Allan

The support of the Economic and Social
Research Council (ESRC) in funding the
SRC is gratefully acknowledged
[grant number ES/K002309/1].

Key messages

The global financial crisis

The autumn of 2008 was not the first time that the world has faced systemic risk. The threat and, at times, its realisation have been present ever since the first financial system was created and they are an inevitable part of any market-based economy.

The challenge for policy-makers

Society faces a difficult dilemma when it comes to systemic risk. We want financial institutions to participate in economic activity and that means taking risk. We also want financial institutions to be safe. These two objectives are mutually exclusive.

Endogenous risk

The key insight from the emerging field of systemic risk is that the threat comes not from outside the financial system and the economic, social, political and legal setting in which it is embedded; rather, it comes from interactions within the system, possibly amplified by the structure of the system and the 'rules of the game' established by the policy authorities at national and international level.

Amplification mechanisms

Amplification mechanisms: Within the financial system, a small event can turn into a major crisis – a systemic event – while a much larger shock may whimper out into nothing. Behind those shocks that become systemic events is the presence of mechanisms that amplify and/or accelerate the impact through the rest of the financial system – 'positive feedback loops'.

Financial networks

The nature and extent of the interrelationships of markets and market participants influence the manner by which positive feedback loops grip the entire system. Network theory can be used to understand the strategic interaction of banks and the systemic implication of an individual bank's behaviour within a financial network: systemic risk is not necessarily driven by those that are the largest borrowers or most likely to default.

Policy responses

Laws, rules and regulations drawn up ostensibly to bolster financial stability and limit the build-up of risk can often become a channel for amplification mechanisms that have precisely the opposite effect. This occurs when multiple rules have inconsistent objectives and interact in unpredicted ways. Often these perverse consequences can remain hidden until it is too late, and this can occur in particular when policies are drafted hastily in response to a crisis.

Financial engineering

The financial system is often compared to an engineered structure. Before the crisis, this led to a degree of complacency among policy authorities and private market participants as advances in financial models and regulations seemed to have reduced the problem of overseeing the financial system to a well-understood engineering exercise. Just as buildings, machinery and other engineered structures can be made safe, so too can finance – or so it was thought.

Risk modelling

Before the crisis, a common view was that risk forecasting and risk management technologies had matured to such an extent that we could effectively prevent extreme outcomes in financial markets. In other words, we had reached a level of permanent low volatility in financial markets. The crisis demonstrated the folly of such thinking: just about every risk forecasting model failed miserably and the crisis caught almost everybody by surprise.

Pro-cyclicality

Prior to the crisis, perceived risk – the risk reported by most risk models – was biased downwards, giving a too optimistic view of the world; after the crisis, it became too high, making everyone too pessimistic and curtailing risk-taking at exactly the wrong time. This is one manifestation of the 'pro-cyclicality' of endogenous risk – where the behaviour of market participants and policy authorities amplifies the volatility of the financial system.

Model diversity

If banks are forced to have the same regulator-approved standard risk models, they will all analyse shocks in the same way, and react in the same way, amplifying price movements, all buying or all selling. In a worst-case scenario, this will cause extreme price movements. It will also undermine market integrity by encouraging predatory behaviour among other market participants not bound by the models.

Financial market regulation

Milton Friedman noted that 'The great mistake everyone makes is to confuse what is true for the individual with what is true for society as a whole.' This 'fallacy of composition' has serious consequences for systemic risk: attempting to ensure the safety of each part of the financial system independently can lead perversely to the system as a whole becoming more unstable. Trying to make every market participant behave prudently destabilises the financial system. Instead, policies should explicitly take account of the interactions between individuals and of endogenous risk.

Macroprudential policy

Since the crisis, the idea of designing 'macroprudential' policy to analyse interactions within the system and to reduce systemic risk has been a central focus of attention for regulators – the complement to 'microprudential' regulation, which seeks to improve the soundness of individual institutions. But the dichotomy of pro-cyclical microprudential and counter-cyclical macroprudential, together with the fuzziness of the macroprudential agenda and the interplay of political pressures, may undermine the reputation of central banks and threaten the effectiveness of monetary policy.

Financial transactions taxes

By curtailing 'noise trading', taxes on short-term speculative trading can in principle reduce the excess volatility of financial markets. But such taxes might actually be counterproductive: by impeding the ability of the price to incorporate new information, they allow mispricing relative to fundamentals to last longer and when corrections eventually occur, these will be sudden and large.

The legal dimension

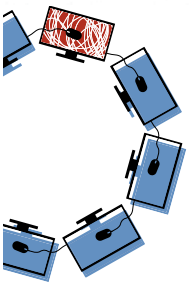
The legal system is one of the most important mechanisms for exposing hidden endogenous risk. Financial contracts are often very complicated, with untested legal terms. In crisis times, this risk manifests itself through various avenues. For example, while the financial system is global, the legal system is local; and court proceedings that address the same financial contract can result in conflicting decisions.

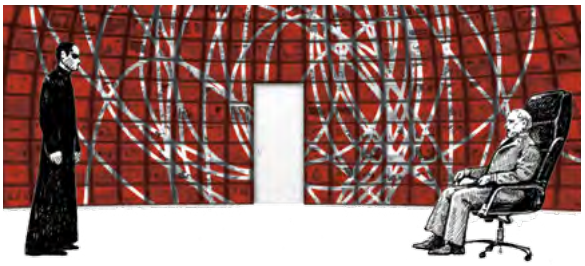
The political dimension

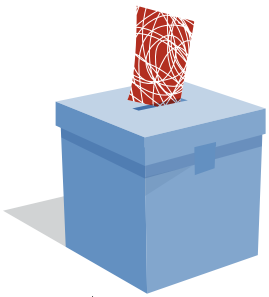
Systemic risk may arise from an unfortunate mix of special interest lobbying, regulatory capture, revolving doors, dysfunctional political institutions, and elite and mass public belief systems. Before a crisis, politicians are likely to celebrate the build-up of excesses and attempt to prevent any effective action by the regulators. After a crisis, they may want to demonstrate their toughness by clamping down excessively on the financial system. This leads to pro-cyclicality.

The research agenda

The SRC aims to develop a set of tools for policy-makers to adjust regulations to achieve the twin goals of ensuring the efficiency of the financial system and mitigating the incidence and severity of financial crises. While it is not possible to eliminate systemic risk or the incidence of crises entirely, the objective should be a more resilient financial system that is less prone to disastrous crises while still delivering benefits for the wider economy and society.







Contents

Introduction

‘Almost any interesting economic problem has the following characteristic: what is true for the individual is the opposite of what is true for everybody together.’

Milton Friedman, 1980

In the wake of the global financial crisis, the world's central banks and financial regulators are focused on 'systemic risk' – the danger that a serious disruption to the financial system will lead to widespread economic distress. The Systemic Risk Centre (SRC) has been established at the heart of the world's main financial centre to define this emerging field, to investigate the risks that may trigger the next financial crisis and to develop practical tools to help policy-makers and private institutions become better prepared.

Based at the London School of Economics and Political Science (LSE), the Centre is generously funded by the Economic and Social Research Council (ESRC) with an annual budget of £1 million.

Several public sector institutions are founding partners; and in the private sector, Markit, a leading supplier of financial information services, is our main data partner.

The unifying principle of the Centre's agenda is *endogenous risk* – the idea that financial risk is created by the interaction of market participants, including the policy authorities. What's more, risk can be amplified through *feedback loops* within and between the financial, economic, legal and political systems. We therefore take to heart the words of the LSE professor and Nobel laureate Friedrich Hayek, writing in 1956:

'Nobody can be a great economist who is only an economist – and I am even tempted to add that the economist who is only an economist is likely to become a nuisance if not a positive danger.'

This view is echoed in a recent article by Julia Black who reasons that we should go beyond economic frameworks and investigate social conceptions of financial markets (Black, 2013).

In our view, it is essential to take a multidisciplinary approach to the analysis of systemic risk. The SRC therefore brings together experts from computer science, law, political science and the natural and mathematical sciences, as well as from finance and economics.

There are four key elements in the Centre's research programme that will contribute to a better understanding of systemic risk and inform future policy.

This report elaborates on these elements of the Centre's research programme, describes some of the initial findings and policy recommendations, and outlines the research agenda.

Endogenous risk

This is the risk that is created by and within the financial system itself rather than as a result of a devastating event from outside the system – what economists call an 'exogenous shock' and others might call an 'act of God'. Endogenous risk can build up over time and be released during an outburst or 'systemic risk event', such as the global financial crisis.

Amplification mechanisms

The outbreak of systemic crises is usually triggered by a small event, the impact of which is magnified by interlinkages and feedback loops within the financial system, potentially leading to its failure and widespread economic collapse. These amplification mechanisms create much of the destruction during the unravelling of a systemic event.

Furthermore, much like a tightening coil, these mechanisms often encourage the build-up of systemic risk in the first place. For example, a larger exposure may move prices in a certain direction, which attracts more money into the same trade, further increasing exposure until the coil is over-tightened and positions and prices are clearly unrealistic. At that point, just a small shock suffices for the event to unravel.

Crisis prevention and mitigation

By building up theoretical and empirical knowledge of the way that financial markets operate, the SRC can help policy-makers to identify the build-up of risk in time to respond. Ideally, this would help to prevent a crisis from materialising. At the very least, it would help to mitigate its worst consequences by cutting through the feedback loops and taming the amplification mechanisms.

Policy responses

Regulators need to focus on policy initiatives that will recognise and reduce systemic risk. They also need to avoid those that, even if well intentioned, will actually lead to the creation of new and larger risks.

Engineering and the financial system

The financial system is often compared to an engineered structure. Indeed, there has long been a whole field of research and practical applications known as 'financial engineering'. Before the crisis, this led to a degree of complacency among policy authorities and private market participants as advances in financial models and regulations seemed to have reduced the problem of overseeing the financial system to a well-understood engineering exercise. Just as buildings, machinery and other engineered structures can be made safe, so too can finance – or so it was thought.

What was forgotten is that finance is not really like engineering: it is much more complex. When engineers design a structure, they mostly have to contend with well-understood forces of nature and can tailor the margin of safety to the problem at hand. Engineers can generally rest safe knowing that an intelligent oil rig or rocket will not conspire with nature to undermine their handiwork. That is not the case in finance, where market participants – the 'forces of nature' in the financial system – are constantly seeking to find ways around rules and regulations.

But while engineering is an imperfect model for financial regulatory policy, its interface with humans does help to demonstrate 'endogenous risk' – the guiding SRC principle that risk is created by interactions of people within the system not by some outside force. The concept was first introduced by the SRC's co-director Jon Danielsson and Hyun Song Shin in 2003 and, to explain how it works, they generally use the analogy of London's pedestrian Millennium Bridge, the first new bridge to span the river Thames for a hundred years.

On 10 June 2000, the day the bridge was opened by Queen Elizabeth II, thousands of people used it to cross the river. This should not have been a problem, as the bridge was designed to cope easily with such large crowds. But within moments of being opened to the public, the bridge began to wobble violently, and it soon closed to the great embarrassment of the bridge's designers – Arup and Foster – and the authorities. In the process, it earned the nickname the 'wobbly bridge'.

Every bridge is designed to move with the elements and the Millennium Bridge was supposed to sway gently in response to the Thames breeze. But when a gust of wind hit the bridge, causing it to move sideways and wobble, people's natural reaction was to adjust their stance to regain balance. By doing so, the bridge was pushed back, making it sway even more, causing people to adjust their stance yet again – more and more at the same time – this time pushing the bridge in the opposite direction.

As an ever-increasing number of pedestrians started to adjust their stance more or less simultaneously, the bridge moved more and soon almost all the pedestrians joined in. This created a self-reinforcing feedback loop between the

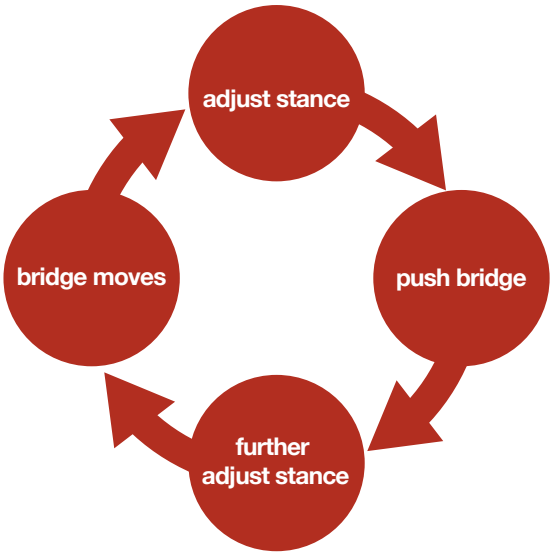


Figure 1:
The self-reinforcing feedback loop of the Millennium Bridge

synchronised adjustments of the pedestrians' stance and the bridge's wobble, as Figure 1 shows.

The financial system is replete with analogous processes in which an innocuous shock akin to the first gust of wind has the potential to trigger a systemic crisis. Financial markets are examples of environments where individuals not only react to events around them but also by their actions directly affect market outcomes. The pedestrians on the Millennium Bridge were like traders reacting to price changes and the movement of the bridge was like price moves in markets.

The Millennium Bridge example also illustrates the concepts of perceived risk and actual risk (explained in more detail on pages 13-14). After the June 2000 incident, experiments by the engineers revealed that the critical number of pedestrians on the bridge that unleashed the wobble was 156. Below that number, no noticeable wobble occurred, while above it, there was a wobble. It seems that beyond 156, the idiosyncrasies of individual behaviour no longer cancelled each other out and very rapidly interactions became mutually reinforcing.

In that sense, an actual but latent build-up of risk occurred as more people populated the bridge. It is even possible that up to that critical number, the steps of those pedestrians cancelled each other out and made the perceived risk of the bridge ever lower. The lowest point on the perceived risk scale corresponded to what was nearly the maximum actual risk since all that was needed was for a small number of net additional pedestrians to go onto the bridge for risk to materialise in the wobble.

In engineering, this kind of calculation can be determined by repeated experimentation in an environment that is largely constant. But finance is more complex given the larger number of interactions and forces, and the fact that the 'financial Millennium Bridge' is likely to change over time, making similar repeated experiments to determine the critical build-up largely impossible. ■

Systemic risk and the global financial crisis

The world economy was on the brink of collapse in the autumn of 2008 following the failure of the investment bank Lehman Brothers. Confidence, the lifeblood of the financial system, was evaporating at an alarming rate; financial institutions refused to do business with each other; people took their money out of banks; and it looked like the economy might be heading for a second Great Depression. Then, just as suddenly as the crisis materialised, it seemed like it was over: while the economic, social and political repercussions continue to this day, the immediate threat of disaster was gone.

"Once upon a time the world economy was on the brink of collapse..."

What happened in 2008 was a near-miss systemic crisis, generally defined as a state in which interlinkages and feedback loops within the financial system lead it to stop performing its essential roles. This event was followed by an economic recession and a sovereign debt crisis in the eurozone, which in turn worsened the global financial crisis. A full collapse of the entire financial system was only averted thanks to the swift actions of the policy authorities – the central banks and finance ministries of the leading economies – which stepped in to bridge some of the defects in the system.

But this was not the first time that the world has faced systemic risk. The threat and, at times, its realisation have been present ever since the first financial system was created and they are an inevitable part of any market-based economy (Danielsson, 2013a).

So what led to the most recent build-up of systemic risk and the resulting global financial crisis, an outcome that seemed to catch almost everybody by surprise? One explanation is that the relative absence of crises over the past few decades lulled policy-makers, financial institutions and researchers into complacency.

Central bankers mostly focused on fighting inflation while regulators tended to neglect the system as a whole, instead aiming to ensure that each individual financial institution was well regulated – through so-called prudential regulations.

The latest crisis has demonstrated the folly of such thinking, which assumes that as long as each component of the system is safe, the whole system must be safe as well. This assumption carries the danger of policy authorities falling victim to the 'fallacy of composition' prefigured by the economist and Nobel laureate Milton Friedman in 1980:

'The great mistake everyone makes is to confuse what is true for the individual with what is true for society as a whole. This is the most fascinating thing about economics. In a way, economics is the most trivial subject in the world, and yet it is so hard for people to understand.

'Why? I believe a major reason is because almost any interesting economic problem has the following characteristic: what is true for the individual is the opposite of what is true for everybody together.'

With financial market regulation, the fallacy of composition has serious consequences: attempting to ensure the safety of each part of the financial system independently can lead perversely to the system as a whole becoming more unstable. Trying to make every market participant behave prudently destabilises the financial system.

One mechanism that allows this to happen is shown in Figure 2, which illustrates how a regulatory requirement for all banks to be run prudently can create systemic risk if it prompts the sale of risky securities in response to an external shock.

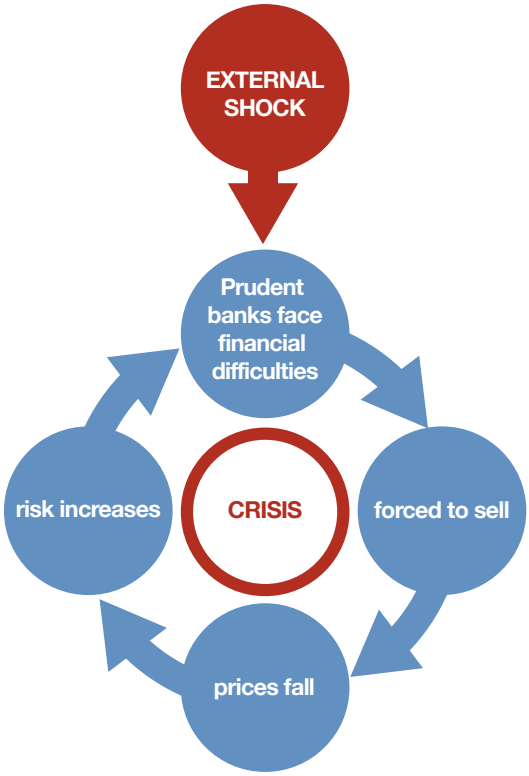


Figure 2:
When individual prudence leads to a systemic crisis

If all banks respond in this way, a downwards spiral of asset prices is created, forcing banks into more sales and further depressing prices, resulting in a crisis.

Attempts to reduce the risks related to any one institution and to dampen the natural volatility of the markets over the short term lead to a 'Great Moderation' – a seemingly permanent state of stability. But this false sense of security is itself the cause of a hidden build-up of systemic imbalances. The outcome is a manifestation, perhaps in a novel manner, of Hyman Minsky's famous dictum 'stability is destabilising'.

This is the key insight of the emerging field of systemic risk: the threat comes not from outside the financial system and the economic, social, political and legal setting in which it is embedded; rather, it comes from interactions within the system, possibly amplified by the structure of the system and the 'rules of the game' established by the policy authorities at national and international level.

This way of thinking – in terms of endogenous amplifying effects in both the build-up and unfolding of a systemic event – is applicable to real world situations, past, present and future, and forms the basis of systemic risk modelling. ■

Systemic risk and endogenous risk

The Financial Stability Board, the international body created in 2009 to oversee the global financial system, defines systemic risk as follows:

'The disruption to the flow of financial services that is (i) caused by an impairment of all or parts of the financial system; and (ii) has the potential to have serious negative consequences for the real economy.'

There is broad acceptance of this as a descriptive definition but a more fundamental understanding of systemic risk requires a deeper sense of what constitutes a 'system'. After all, how can one think about systemic risk without having a clear sense of what a system is in the first place?

Analysis by the SRC's co-director Jean-Pierre Zigrand (2014) defines a system as a functioning mechanism governing a set of elements (i) that makes reference to something or to a central concept in a coherent fashion ('deductibility'), (ii) that implies meaningful relationships between its elements ('irreducibility') and (iii) to the extent that it evolves, that it keeps its identity.

Examples include a 'banking system' (with a central bank at the centre of a network of interrelated banks) as opposed to a collection of banks; a 'payment system' as opposed to a set of bilateral payment and settlement arrangements; a 'solar system' as opposed to a cluster of celestial bodies; and a 'nervous system' as opposed to a collection of unrelated nervous cells.

The term systemic risk comprises the risk *to* the proper functioning of the system as well as the risk created *by* the system itself. The risk that is created or amplified within the system is endogenous risk. In the extreme, the risk may be a risk to the very central concept that guarantees the logical coherence of the system in pursuit of the best use of scarce resources with multiple ends.

Instances during which the central concept is itself incapacitated in the four systems outlined above could involve the following. The inability or unwillingness of a central bank to act as a lender and market-maker of last resort removes the foundations to a banking system. A failure of the real-time gross settlement processor in a payment system brings the system and all connected systems to meltdown. A stroke incapacitates a nervous system. And hyperinflation

reduces a price system to a set of primitive and inefficient bilateral barter operations. In each case, the system stops being able to fulfil its function properly and consistently in a systemic event.

Standard methodology for modelling risks treats systemic risks as being mainly extreme shocks from outside the system drawn from some distribution – for example, the payment system would grind to a halt in the event that an asteroid hit the processor. But while the asteroid would certainly constitute a risk to the system, it is more fruitful to focus on endogenous risk, where the risk is both to the system and amplified by the system. One example is from John Maynard Keynes in his 1936 book:

'By a cyclical movement we mean that as the system progresses in, e.g. the upward direction, the forces propelling it upwards at first gather force and have a cumulative effect on one another but gradually lose their strength until at a certain point they tend to be replaced by forces operating in the opposite direction; which in turn gather force for a time and accentuate one another, until they too, having reached their maximum development, wane and give place to their opposite.'

This is the SRC's approach: to view systemic events as being mainly endogenous, with the trigger for a crisis possibly being exogenous though not by itself extreme. On that basis, systemic risk may be defined as the risk of a systemic event occurring, where a systemic event is defined by the occurrence of positive feedback loops within the given system that adversely affect the proper functioning, the stability and, in extreme cases, the structure of the overall system itself, with resulting costs to the wider real economy of which the system is a subcomponent.

The idea is neatly captured in a quotation from the science fiction film, *The Matrix Reloaded*:

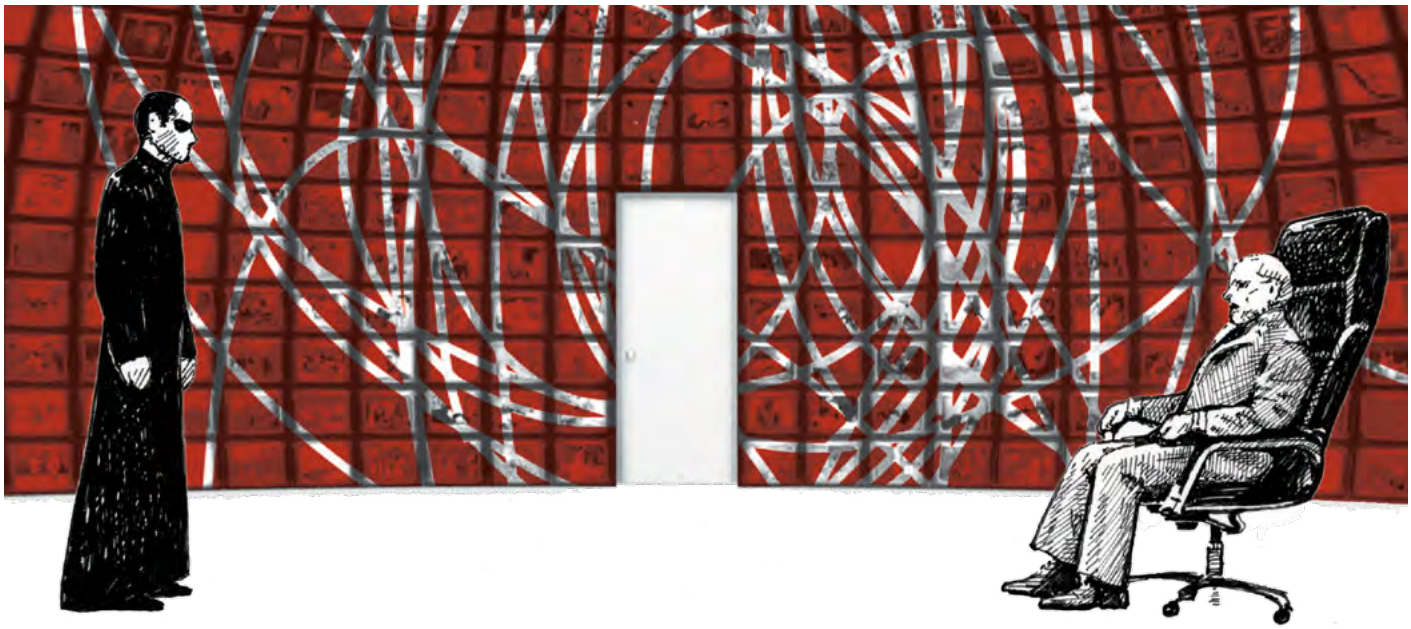
Neo: 'There are only two possible explanations: either no one told me or no one knows.'

The Architect: 'Precisely. As you are undoubtedly gathering, the anomaly's systemic, creating fluctuations in even the most simplistic equations… an anomaly that if left unchecked might threaten the system itself.'

Feedback loops and amplification mechanisms

Within the financial system, a small event can turn into a major crisis – a systemic event – while a much larger shock may whimper out into nothing. Behind those shocks that become systemic events is the presence of mechanisms that amplify and/or accelerate the impact through the rest of the financial system. Amplification mechanisms are the ways in which endogenous risk manifests itself in the financial system and translates into concrete events.

There are a number of features inherent in the financial system that can amplify a small event into a major crisis. They include balance sheet issues, such as levels of leverage and liquidity; constraints on the way that institutions behave that are imposed either by regulators or the institutions themselves; and the way in which



market participants react to each other in times of both relative calm and stress.

For example, it has been estimated that the losses in the US subprime mortgage market, which triggered the global financial crisis, were roughly equivalent to an equities market fall of 2%. The vast majority of equities market losses of 2% do not lead to any major instabilities, while the subprime losses led to huge downwards spirals given the distribution of losses, the balance sheets, liquidity holdings and interconnections of the market participants, and the lack of common knowledge about who held what and how they were interconnected.

Both regulators and institutions place constraints on how market participants are supposed to behave. Those rules are often motivated by 'microprudential' or internal considerations, such as moral hazard or adverse selection. For example, there is a wide range of constraints on the amount of risk an institution can hold, how it can refinance itself and on the collateral it must hold.

Unfortunately, in the spirit of the fallacy of composition, while these rules are meant to guarantee sound microprudential behaviour, they can create dangerous positive (reinforcing) feedback loops. One example would be cases where a fall in asset prices triggers an obligation to raise cash by selling more assets, which pushes prices down further.

In the run-up to the global financial crisis, AIG – the US-based international insurance company – became through its AIG Financials subsidiary the world's largest seller of credit protection in the form of credit default swaps, helped by its AAA rating. In the summer of 2008, AIG's credit rating was downgraded, obliging it to raise capital to post additional collateral at the height of the crisis. This triggered a vicious feedback loop that ultimately led AIG to seek a bailout by the US Federal Reserve.

Analyses based on the idea of endogenous risk show how small shocks like this can snowball into extreme outcomes, which are more destructive than is warranted by the fundamentals of the problem (a phenomenon known as 'overshooting'). This happens purely because of reinforcing feedback loops originating within the system, without the need for extreme exogenous shocks, provided latent imbalances have been allowed to build up. The outcome for risk in the system as a whole can therefore be fundamentally different from that resulting from the risk management decisions of individual institutions.

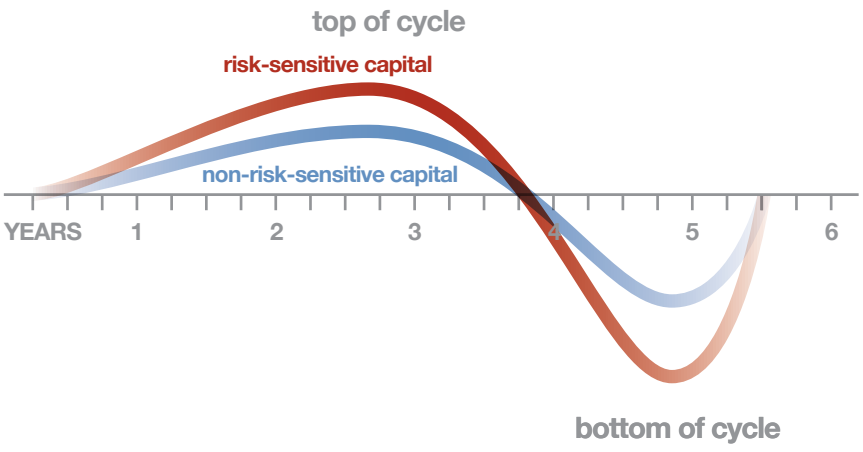
We have seen that feedback loops are directly affected by the nature of the regulatory policy environment, which can encourage 'pro-cyclicality', a process that is positively correlated with the economic cycle. Bank capital and leverage are two examples of a pro-cyclical process in which risks builds up during stable periods. Banks tend to have surplus capital when the economy is booming, while capital levels drop during recessions. Likewise, economic agents have a tendency to borrow too much during good times and borrow too little in downturns.

As Figure 3 illustrates, pro-cyclicality is often created by the various amplification mechanisms built into the financial system, and is encouraged by risk weighted capital, mark-to-market accounting and the fact that the strength of financial regulations tends to erode in boom times and come back with a vengeance during and right after crises. Amplifying pro-cyclical feedback loops can also comprise loss and margin spirals, in which fire sales destroy capital and increase risk, which in turn forces further sales, closing the loop.

These feedback loops can operate both in the build-up phase of a crisis (years 1-4) and in the crisis phase (years 4-6). In practice, the loops tend to build up slowly over long periods and to accelerate when reversing in a crisis.

The SRC's co-director Jean-Pierre Zigrand (2015) has just published a comprehensive survey of such feedback loops, documenting how the acceleration mechanisms work and how policy can either amplify or reduce these effects. ■

Figure 3:
Amplification mechanisms lead to pro-cyclicality



Perceived risk and actual risk

Most financial models are implicitly based on the assumption that risk is generally created by an outside natural or man-made disaster – what many would call an 'act of God' and which economists call an 'exogenous shock'. In reality, risk within the financial system is primarily created by people interacting with each other – endogenous risk.

In this kind of analysis, much of what takes place in a financial system is caused by the interaction of all the players in the market, whether they are financial institutions, traders, regulators or policy-makers, all of which are pursuing their own objectives. These players continually study and react to the financial system, changing its nature in the process. In other words, the financial system is not invariant under observation.

Most of the time, individual economic players behave in a way that cancels out shocks: for example, the same event may prompt some to buy an asset and others to sell it. Systemic risk is realised when this no longer happens because the players start behaving in a harmonious way; the distress of one player triggers behaviour that causes distress in other players, who then further spread trouble.

In other words, individual economic players react to some particular event, and their actions in turn affect

their environment through a network of feedback loops and amplification mechanisms. Endogenous feedback between the behaviour of market participants can suddenly and unexpectedly create a vicious cycle, causing a crisis.

Incorporating endogenous risk in the analysis of financial systems leads to situations where the system cycles between virtuous and vicious feedbacks. When things are good, market participants are optimistic and buy, which endogenously increases prices, with a bubble feeding on itself. This eventually goes into reverse, and negative news feeds on falling prices, with the markets spiralling downwards.

This manifests itself in the difference between the risk reported by most risk forecast models – 'perceived risk' – and the actual underlying risk that is hidden but ever present. As a bubble is building up, **perceived risk** is low and falling, while **actual risk** is increasing. After the bubble has burst and **prices** have snapped back close to fundamental values, the actual risk falls, but because the observed volatility increases, so does perceived risk (Danielsson et al, 2012a).

We can illustrate this phenomenon with the Millennium Bridge where after the opening, engineers established that the swaying caused by positive feedback loops arose when there were more than 156 pedestrians on the bridge. The build-up of risk with the Millennium Bridge happened under the radar screen. The bridge was very stable with 156, but adding just a few more pedestrians would produce the wobble. In other words, perceived risk was very low at 156 while the actual risk of a wobble was highest since all it took was a few more pedestrians stepping onto the bridge than stepping off.

Figure 4 illustrates this phenomenon graphically in a financial context: the **blue line** shows the evolution of prices, starting low and increasing at an ever more rapid rate, peaking and then collapsing and remaining constant thereafter. This is typical of a bubble, where it is said that 'prices go up by the escalator and come down by the elevator'.

The **red line** shows perceived risk: how market participants view risk when using the industry's typical risk forecast models. Prices increase when perceived risk – such as forecast volatility – falls. When market participants observe increasing prices and falling risk, they are encouraged to continue buying, an example of a 'momentum strategy'. In the short run, this becomes a virtuous circle of ever increasing prices and lower risk.

Eventually, when traders realise that there is nothing fundamental behind these high prices, they all sell at the same time, causing prices to collapse. Because the fall in prices leads to an increase in perceived volatility, risk forecast models report sharply increasing risk.

Figure 4 illustrates a further challenge in the existence of non-linearities, namely that small changes in a risk driver that determines actual risk can lead to violent market reversals.

The **green line** shows what happens to actual risk, which builds up before market prices shoot up, eventually indicating a constant high probability of a crash in the near future. Eventually, as the market collapses, so does actual risk.

This means that perceived risk sends the wrong signals in all states of the world. Before the crisis, it is biased downwards, giving a too optimistic view of the world; after the main crisis event, it becomes too high, making everyone too pessimistic and curtailing risk-taking at exactly the wrong time. This is one manifestation of the phenomenon of 'pro-cyclicality' – where the behaviour of market participants and policy authorities amplifies the volatility of the financial system – rather than the more desirable phenomenon of 'counter-cyclicality'.

Figure 4:
Endogenous bubble

The relationship between perceived and actual risk is the subject of several SRC research projects. For example, one study analyses the benefits of trading strategies that go against the perceived risk of bubble momentum (Ergun and Stork, 2013). The results suggest that such counter-cyclical trading strategies can mitigate large negative shocks to investors in financial markets.

A comprehensive analysis of the nature of financial risk and implications for risk management and policy-making is the subject of a new study by the SRC's co-director Jon Danielsson (2015b). ■

Financial networks

Networks can accelerate and amplify the way that shocks reverberate through the financial system. They can arise, for example, from balance sheet links across financial institutions, such as counterparty risk. This can happen within as well as across countries, as the global financial crisis has made clear.

Networks can also be formed through trading patterns. One example is the ex post realisation that fund managers hold very similar – and often narrow and illiquid – portfolios or have exposures to undiversified risk factors, such as in the quant crisis of 2007. Another example consists of the inter-market connections established in modern fragmented markets by high frequency traders, which transmit price changes to hundreds of markets and products, such as exchange-traded funds and financial options.

The nature and extent of the interrelationships of markets and market participants influence the manner by which the positive feedback loops grip the entire system. Just like risky holdings, interrelationships also build up over time, often under the radar. The network matters in at least two respects.

First, the structure of the network determines how large the build-up of risky exposures is in the first place. For example, if a financial institution can easily pass on some risks to other parts of its network, it is encouraged to take on larger positions.

Second, ex post, the way a local shock is transmitted through a networked financial system is again greatly determined by the structure of the network, irrespective of the size of the exposures accumulated beforehand. Jason Donaldson and Eva Micheler model how negotiable instruments can help to absorb shocks to the financial system (Donaldson and Micheler, 2014).

It can be challenging to draw practical recommendations for policy-makers by studying the network structure of the financial system, especially when using publicly available data. Furthermore, without a deeper understanding of the economics of the market situation and the commercial and legal nature of the relationships, such analysis often just seems to suggest that everybody is connected to everybody, with some of the links stronger than others, and with links sometimes coming and going quickly.

A study by SRC researchers Christian Julliard and Kathy Yuan, conducted with colleagues at the Bank of England, bypasses this problem with a unique state-of-the-art model for capturing the dynamic evolution of the UK's banking network (Denbee et al, 2014). The analysis uses network theory to understand the strategic interaction of banks and the systemic implication of an individual bank's behaviour over the period 2006-10.

The researchers find that most systemic risk is driven by a small number of banks, but not necessarily by the ones that are the largest borrowers or those most likely to default. Their study generates a tool for evaluating 'shock multipliers' in the financial system to which more careful supervision or more stringent regulation could be applied.

This research models the banks' liquidity holding decision as a simultaneous game on the interbank borrowing network. In equilibrium, the contributions of each bank to the network liquidity level and liquidity risk are distinct functions of its centrality in the system. Moreover, a wedge between the equilibrium that a benevolent planner would choose and the market equilibrium arises because individual banks do not internalise

the effect of their liquidity choice on other banks' liquidity benefit and risk exposure. The authors show that the network can act as an absorbent or a multiplier of individual bank shocks.

Bringing their model to real UK interbank data provided by the Bank of England, the authors find evidence for a substantial and time varying network risk over the period 2006-10. In the pre-crisis period, until August 2007, there is a large network liquidity shock multiplier. This implies a tendency for the network to amplify shocks through the system. Essentially firms are borrowing to lend, and their decisions are self-reinforcing: the system is overheating and liable to exogenous shocks.

The network multiplier drops sharply at the outset of the crisis following the run on Northern Rock in August 2007, and the network becomes more diffuse, as banks try to limit their exposure to the most risky nodes. While there is a temporary reversion back to the previous trend, from the collapse of US investment bank Bear Stearns on 11 March 2008 until well into 2009, the multiplier is more or less zero – there is basically no additional risk coming from the network structure. The risk of the system as a whole behaves as if it were a collection of separate individuals.

After the crisis, when the Bank of England was implementing its programme of 'quantitative easing', the network liquidity multiplier becomes smaller than one, implying a lower network potential for generating liquidity, but also a lower level of volatility of aggregate liquidity. The network structure is acting to reduce risk, as bank behaviour has moved from self-reinforcing to reserve substituting. The network has become highly directed towards one node – the central bank itself.

This research makes an important contribution to so-called 'macroprudential' policy-making, which aims to improve the soundness of the financial system as a whole. By simultaneously exploiting the most direct network connections in the financial system – the payment system – coupled with an economic model of strategic bank behaviour, policy-makers can identify the specific points of vulnerability in the system and test policy prescriptions. ■

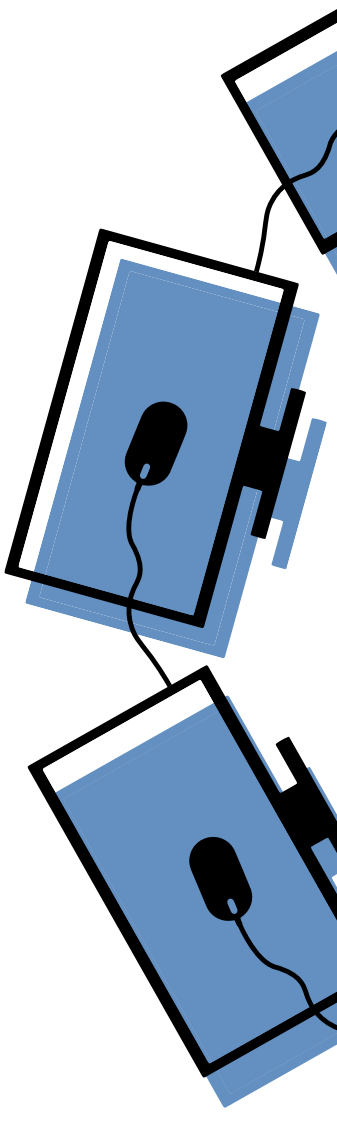
Network structures are not themselves exogenous. Some bilateral connections are freely chosen while others are mandated. For example, the push towards clearing through central counterparties (CCPs) significantly alters the network structure, not least with CCPs becoming some banks' largest counterparty risk. Little academic research has gone into the modelling of CCPs, and less still on their effect on systemic risk once the interactions with clearing members, traders, central banks and the general public have been considered. This is an area of analysis on which the SRC is working.

Central counterparties

The difficulties of CCP modelling stem from the fact that the essence of a CCP is the interconnectivity of the agents and that, as a result, network modelling takes on a crucial role. It is known that CCPs affect netting efficiency in markets, and the SRC is studying the further implication of this in terms of endogenous risk. Indeed, if collateral needs across securities and CCPs is not netted out, then the loss on one contract that would normally be netted out by a gain on another one will now create a margin call.

A 2010 study by the SRC's co-director Jean-Pierre Zigrand looks at the impact of moving trading onto CCPs. He considers the potential of CCPs to alter the network structure of the financial system by changing the interconnections between financial institutions, and thereby potentially increasing systemic risk.

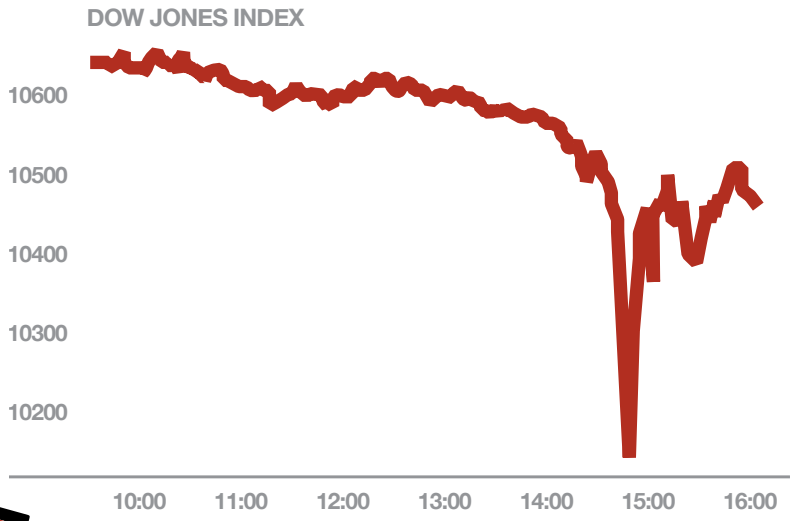
Over and above the relevant question of the quantity of collateral needed in a world with multiple CCPs and compulsory central clearing, CCPs may reduce counterparty risk or at least push it into the open. But they may also create stronger feedback loops if CCPs are not interoperable across products. Those stronger feedback loops can represent a systemic fragility. Further modelling efforts need to be undertaken to gauge the strength of this effect and to provide indications as to the extent to which CCPs reduce systemic risk 'net-net'. ■

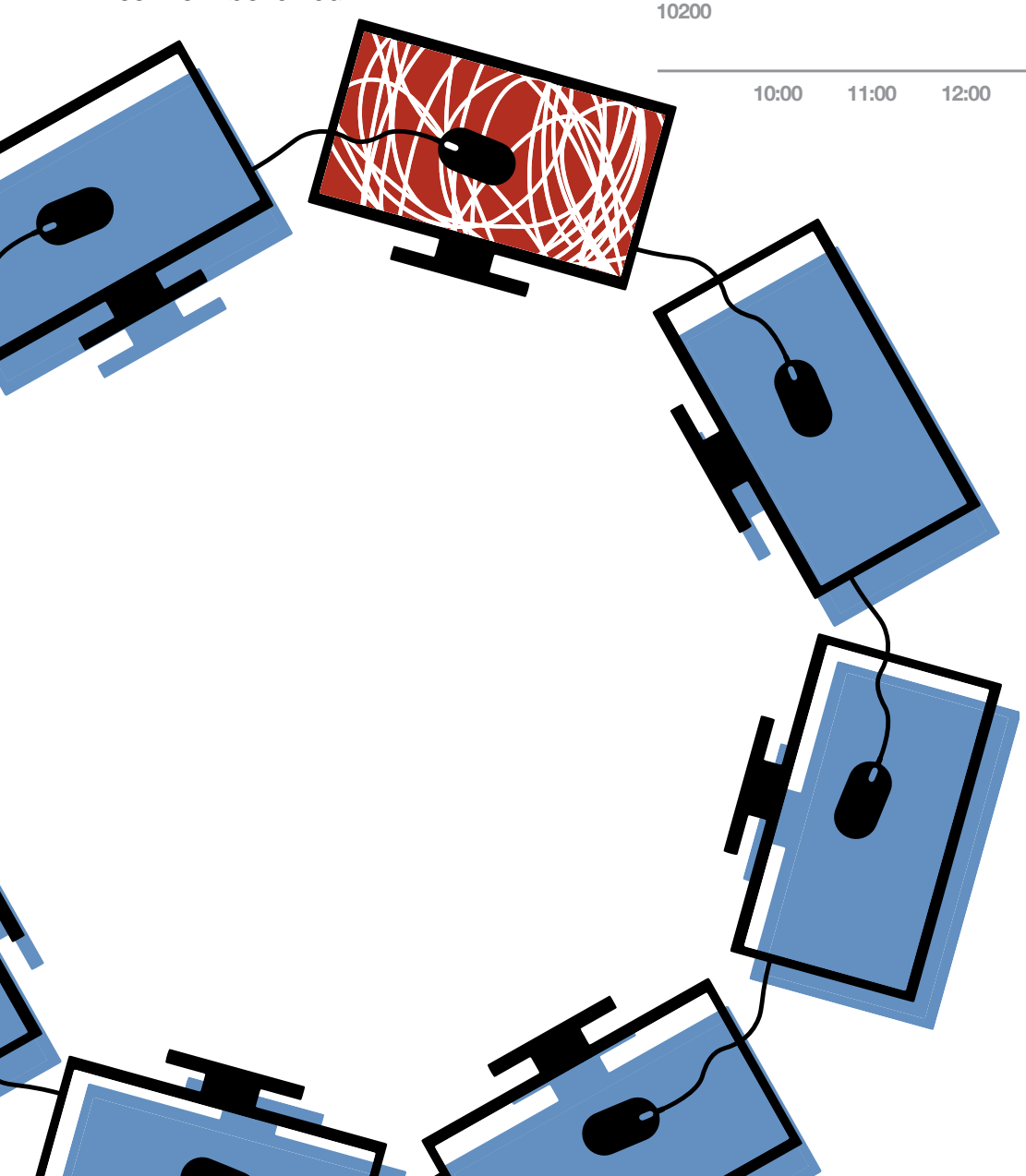


Computer-based trading

One area that can be viewed as a laboratory for endogenous risk and feedback loops is computer-based trading (CBT) – and in particular the special category of high frequency trading (HFT) – which is taking over much of the trading in liquid financial markets. These trading activities can alter the characteristics and the dynamics that, in turn, feed into the values and price signals guiding investment behaviour.

Figure 5:
Flash crash, 6 May 2010





This phenomenon has raised concerns among investors and market commentators. Some highlight the algorithms that follow simple rules at lightning speed, which means that human traders are bound to lag behind. Another concern is that robot computers follow these rules mechanically, without any sense of discretion or common sense.

An example of the potential dangers of CBT is the May 2010 'flash crash' of the US stock market, when it fell almost 10% in a matter of minutes and recovered just as quickly (see Figure 5). A joint report by two US regulatory authorities – the Securities and Exchange Commission and the Commodity Futures Trading Commission – identified a single institution selling a large number of E-Mini futures contracts on the S&P 500, prompting HFT programmes to start trading aggressively, which in turn encouraged the selling institution to sell even more given the impression of an active and liquid market.

The stress then spiked further when the crash contaminated the markets

for shares and exchange-traded funds (ETFs). The slide was eventually halted when algorithms were switched off and bargain-hunters started flooding into the market. Further uncertainty is created for future events by the arbitrary fashion by which the regulator decided to cancel some of the trades, meaning that next time around traders may be more cautious about stepping back in.

The work of the SRC's co-director Jean-Pierre Zigrand and SRC research associate Charles Goodhart has played a significant role in shaping thinking in Europe about CBT, notably through the recommendations of a UK government report (Government Office for Science, 2012).

In particular, the report cast doubt on a number of widely held views on how HFT works and formed the basis for rethinking the nature of policy interventions, notably the Markets in Financial Instruments Directive, the EU legislation that governs how financial service markets operate. The original European Commission proposal for trading halts in volatile markets – 'minimum resting times' – to regulate HFT was dropped, and the report's proposal of time stamps based on synchronised atomic clocks across trading venues was adopted.

This work is currently being extended by four SRC researchers, who are studying liquidity shocks in HFT environments by modelling their life cycle with a survival model (Danielsson et al, 2015b). ■

Systemic risk: dangers and policy responses

Society faces a difficult dilemma when it comes to systemic risk. We want financial institutions to participate in economic activity and that means taking risk. We also want financial institutions to be safe. These two objectives are mutually exclusive and that gives rise to a difficult policy challenge.

A well-functioning and appropriately regulated financial market makes an essential contribution to overall economic wellbeing.

Financial crises have serious consequences for both the functioning of the financial system and the wider economy, not least the need to mobilise substantial resources to stabilise and mend the system, including resources directly or indirectly financed by taxpayers. Ultimately, problems in the financial system can spread to the real sector, posing a danger to economic growth (Buch and Neugebauer, 2011).

One example is the lack of financing opportunities for small and medium-sized enterprises (SMEs), especially in continental Europe, where banks are by far their most important funding source. SRC researcher Katja Neugebauer is taking a closer look at firms' financing constraints in two current projects.

The first is examining the impact of the decline in cross-border banking on firms' financing constraints, using the European Central Bank's Survey on Access to Finance of Enterprises in combination with data from the Bank for International Settlements (Bremus and Neugebauer, 2014).

The second is investigating the appropriateness of currently used measures of firms' dependence on external finance, which are usually drawn from cash flow statements. Using a unique survey conducted in seven European countries during the financial crisis, this allows for checking the validity of these measures at the industry level (Eppinger and Neugebauer, 2014).

In a perfect world, it might be thought desirable for any build-up of systemic risk to be identified early enough to enable policy-makers and market participants to respond and avert a crisis. But while a safer financial system has many benefits, it is also vital for the system to deliver its role of financing risky economic activity, perhaps providing mortgages to households or lending to SMEs. The two objectives of stability and risk cannot be fully satisfied at the same time, opening up the need for intelligent interventions and ex post resolutions based on careful research into systemic events.

One possible avenue for identifying the build-up of systemic risk is if perceived risk is unusually low, leading to 'Great Moderation'-type economic environments. This motivates the work of the SRC's co-director Jon Danielsson and two SRC research associates in a 2015c paper, where they consider the long-run historical connection between volatility, the incidence of serious types of crisis and economic performance.

Two key policy objectives

The key question for policy-makers is how to limit the build-up of systemic risk and contain crisis events when they happen, balancing the need for an efficient financial system with the desire to avoid disastrous systemic outcomes. The SRC is addressing this question by focusing on two objectives.

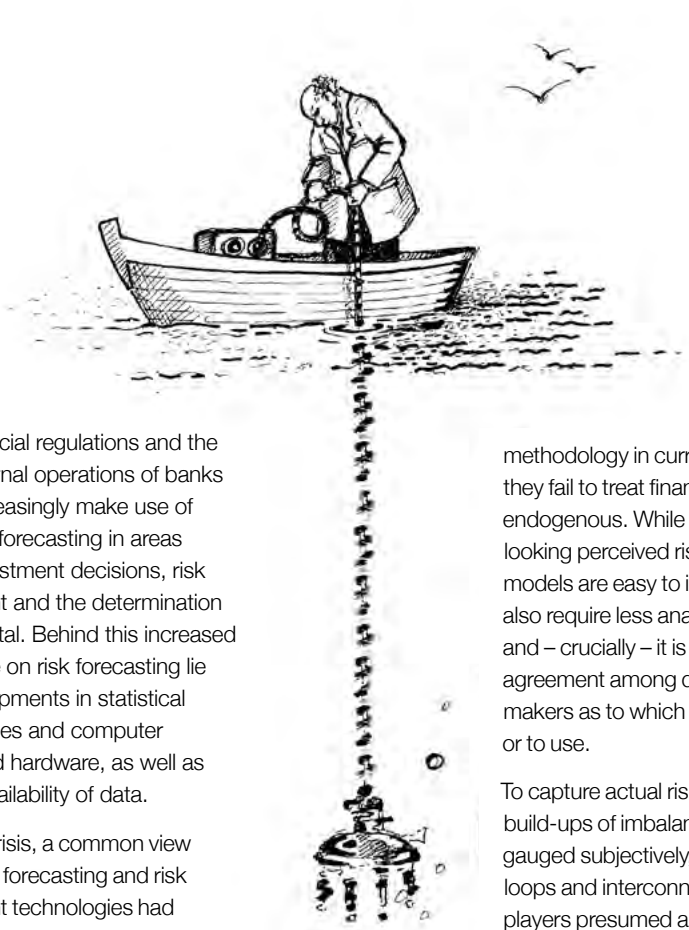
The first objective is improving the functioning of financial markets so that they better serve the needs of the economy as a whole. Some market activities and regulations contribute positively to financial stability and to the quality of markets. Other market activities and regulations do the opposite, even if they may be perceived individually as helping to reduce risk. SRC research is studying these mechanisms and identifying ways to reduce the trade-off as much as possible.

The second objective is raising awareness of the potential risks to the financial system as a whole. Policy-making that focuses on individual institutions while ignoring their interactions (based on the assumption that shocks arrive from outside the system) may fail to meet its objectives. Indeed, narrowly focused measures may even perversely increase systemic risk.

SRC research aims to develop a set of tools for policy-makers to adjust regulations to achieve the twin goals of ensuring the efficiency of the financial system and mitigating the incidence and severity of financial crises. While it is not possible to eliminate systemic risk or the incidence of crises entirely, the objective should be a more resilient financial system that is less prone to disastrous crises while still delivering benefits for the wider economy and society. ■

Models of financial risk are at the heart of supervision as well as the financial sector's self-monitoring. These models are essential for the functioning of financial markets and it would be impossible to manage risk without them. But there is a tendency by both financial institutions and supervisors to overstate their reliability and underplay their dangers.

Identifying and forecasting risk



Financial regulations and the internal operations of banks increasingly make use of risk forecasting in areas such as investment decisions, risk management and the determination of bank capital. Behind this increased dependence on risk forecasting lie rapid developments in statistical methodologies and computer software and hardware, as well as the wider availability of data.

Before the crisis, a common view was that risk forecasting and risk management technologies had matured to such an extent that we could effectively prevent extreme outcomes in financial markets. In other words, we had reached a level of permanent low volatility in financial markets. The crisis demonstrated the folly of such thinking: just about every risk forecasting model failed miserably and the crisis caught almost everybody by surprise.

After the crisis, risk forecasting is even more important, given the fundamental role it plays in reforms to financial regulations and in macroprudential policy. So it is not surprising that there have been many proposals for better risk forecast methodologies. Yet despite widespread criticism of risk models for both theoretical and practical failures, especially during the financial crisis, it is puzzling that most policy authorities are still determined to ground regulation heavily in risk models based mainly on exogenous shocks.

In particular, a fundamental problem of almost every risk forecasting methodology in current use is that they fail to treat financial risk as endogenous. While (largely backward-looking perceived risk) statistical models are easy to implement, they also require less analysis and less data, and – crucially – it is easier to reach agreement among disparate decision-makers as to which model to prescribe or to use.

To capture actual risk, the hidden build-ups of imbalances need to be gauged subjectively, the feedback loops and interconnections between players presumed and a set of plausible scenarios determined. There is currently no authority that would be able to elucidate agreement among diverse regulators – and exogenous risk methodologies are continuing to be the workhorses precisely because they do not allow as inputs the unverified and subjective ways in which endogenous risk actually builds up.

The study of risk forecasting and the development of risk testing methods is a significant focus of the SRC, and the hope is that some endogenous risk methodologies will find acceptance among policy-makers. For example, SRC researchers have been working on analysing the robustness of risk forecast models on which new macroprudential regulations and market risk regulations are based (Danielsson et al, 2014a).

The study provides empirical evidence that even within the set of accepted exogenous risk methodologies, predictions can be hugely disparate. This finding may be significant not only in terms of evaluating current tools, but also in reducing resistance to endogenous risk methodologies. While they rely on views of the build-up of risk and its violent emergence through feedback loops, with different views yielding different risk assessments, similar discordance appears even within exogenous risk models, and therefore the perceived advantage of exogenous risk models may in fact be mistaken.

The Basel committee has made important changes to the way it wants market risk forecasting to be done. SRC researchers have been analysing the proposals, first in a policy commentary by Jon Danielsson (2013b) and since developed into a working paper (Danielsson and Zhou, 2015). The results indicate that market risk under Basel III would be less accurately measured and forecast than in the previous Basel II regime. Jon Danielsson in a 2015a commentary studied the impact of the the Swiss central bank abandonment of its euro exchange rate ceiling, finding the fallout from the decision demonstrates the inherent weaknesses of the regulator-approved standard risk models used in financial institutions. These models under-forecast risk before the announcement and over-forecast risk after the announcement, getting it wrong in all states of the world.

This issue is also discussed by SRC researcher Lerby Ergun in a 2015 working paper, and in his joint work with Jon Danielsson in 2015a working paper on the pitfalls with worst case analysis. ■

Model risk of risk models

Systemic risk analysis, financial regulations and the internal operations of financial institutions heavily depend on statistical risk models. In spite of that, little is known about the reliability of such models.

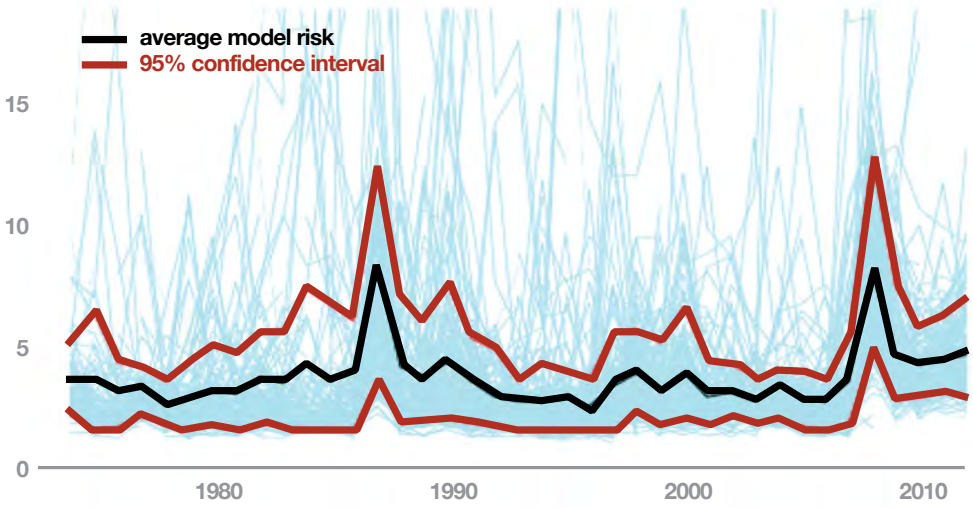
The greatest need for models is in the forecasting of extreme risk or 'tail risk', especially during periods of financial crisis and extreme market turmoil. But this is the area where risk models are least reliable statistically because the effective sample size of comparable events is very small. At worst, there might be one observation or even zero when considering events not yet seen. Furthermore, since the build-up to a critical level is not observable, timing is difficult also.

Several SRC researchers have been looking at the question of model risk – the degree to which competing generally accepted risk forecast methods disagree. Two SRC reports (Danielsson et al, 2014a, 2014b) find that model risk is usually quite low, but it sharply increases in periods of turmoil and crisis, suggesting that the models provide poor guidance to risk during crisis, a finding that is consistent with the perceived risk/actual risk view of the world. This can be seen in Figure 6, which shows the level of model risk in risk forecast models for US equities over the past three decades.

Over the past half-century, there have been fewer than ten episodes of extreme international market turmoil. Each of these events is essentially unique, and apparently driven by different underlying causes. Trying to get an overall idea of the statistical process of events during those episodes with fewer than ten episodes of turmoil, all with different underlying causes is virtually impossible. While it might be possible to construct a model fitting nine crisis events in a row, there is no guarantee that it will perform well during the tenth.

Nor does it seem likely that much information about price dynamics during turmoil can be obtained by using the non-crisis data that makes up the bulk of available information. There is ample evidence that market dynamics are very different in times of crisis.

Figure 6:
The level of model risk in risk forecast models for US equities



Market lore suggests that in a crisis, traders rely more on simple rules of thumb – such as 'all stocks have a beta of one' (they all move with the market as a whole) or even 'cash is king' – than in more nuanced normal times, and that such rules can be self-fulfilling in the short term, leading to a lack of diversity in decision rules. This is supported by research showing that correlations go to one during crises because of incentives to trade out of risky assets into safe assets when risk constraints are binding, causing feedback between ever higher risk and sharper constraints (Danielsson et al, 2012b).

Such considerations provide the fundamental limit to what existing risk forecast methodologies can be expected to achieve, since such models are likely to perform the worst when they are needed the most, both when it comes to forecasting a crisis and how markets behave during a crisis. But this only applies to risk forecasting as implemented in the state-of-the-art models of today. Considerable work, at the SRC and elsewhere, is focused on improving risk forecast methodologies at a more fundamental level, aiming to capture the hidden build-up of endogenous risk that only materialises at the worst times, during a crisis.

A potentially fruitful avenue is to identify the hidden feedback loops and latent triggers that ultimately result in a systemic crisis. Among the SRC research projects directed towards this objective are studies of the long-run connection between volatility and crisis (Danielsson et al, 2015c) and work with the securities lending and Totem databases (see pages 29-31). A further SRC study proposes a model in which the risk forecast method learns from its historical performance, adapting the model in real time to rectify historical mistakes (Boucher et al, 2014). ■

Every model is wrong, some models are useful. When it comes to regulation by models, should we aim to use the same models across the entire financial system or encourage model diversity?

Risk models: harmonisation or heterogeneity?

It is standard and fruitful practice in economics to rely on the 'rational expectations hypothesis'. But this approach seems to offer greater insights in normal times or in stationary settings when rational expectations can be viewed as being the limiting outcome of a learning process. It is less useful in non-stationary market environments suffering from a variety of externalities and inefficiencies where exceptional and unique stressed times can occur that have never been observed in this form before.

A 'rational expectations equilibrium' is a market clearing equilibrium in which agents possess the 'true model' – that is, the true mapping from a realised but unobservable state of the world to a set of observed variables, chiefly prices. Since agents are assumed to know the true model, they can rationally learn from observed variables by going through the following mental exercise: 'given that the observed price or other variable is so and so, I can infer that the unobservable variables driving the economy – and generating the price in the first place – must have been such and such.' The agent will then act on this new-found information. The mapping is rational if, after having acted on the information, market variables behave just as the true model would have predicted.

In terms of risk modelling, if agents do possess this true mapping, and if they agree on the prior probabilities governing the underlying states of the world, then they unambiguously know the probabilities of various market events happening in the future. If agents have had different experiences and have accumulated different information sets over time, then they may still be able to add to their information by inverting the price mapping. If not, then prices are not informative for this particular agent.

It can also happen that even though

agents have learned over time from their own experience, prices are so informative that they would have had the same information set simply by observing prices: this case is the one of a fully revealing rational expectations equilibrium.

One notable danger of basing financial regulations on the outputs of statistical risk forecast models is the logical implication of such an approach: that there is one knowable and 'correct' model and that regulators should therefore be concerned when different banks' risk models do not give the same risk assessments for the same assets. Both the Basel Committee and the European Banking Authority have indicated that they are troubled by such model heterogeneity and are seeking to rectify the problem, as discussed in a policy commentary by the SRC's co-director, Jon Danielsson (2013c).

Requiring all actors to have the same risk assessments may well be the wrong conclusion in such unique situations. There are a number of reasons for this. First, even in a rational expectations equilibrium, prices may not be fully revealing and therefore different agents have different rational risk models. In fact, some agents may be sitting nearer the market events and have a strictly better risk model because they have strictly finer information.

Second, let us move away from the assumption that agents have been able to learn over time the true market mapping – as is required in rational expectations equilibrium models. If the economy is also subject to frictions or pecuniary externalities, then moving towards model harmonisation could in such circumstances further destabilise the financial system by making it more pro-cyclical. This is an issue of model accuracy, since in practice it would seem that all models are simplifications of the real world, which means that they are wrong by definition – that is, 'not rational' in the sense of rational expectations equilibrium.

If the authorities pick one modelling approach over another, they may just as easily be backing the wrong horse, a model that is less accurate or that leads to larger pro-cyclicality if implemented, affording financial institutions and the financial system less protection in the future. These predictions do emanate from formal models that have been studied at the SRC.

For this reason, it is generally better for financial institutions to develop their own models internally, subject to regulatory scrutiny. This is more likely to lead to a healthy competition in model design and more protection for the financial system, because model quality will improve over time. A supervisory-mandated model is much more likely to stagnate and become ossified, leading to less model development and ultimately less protection.

If the authorities end up backing a given risk model, and some years down the road when the next crisis happens, analysts may find that a key contributor to the crisis was the wrong model promoted by the authorities. This means that responsibility has been transferred to the governments, making a stronger case for bailouts.

Regulatory involvement in model design directly affects the probability of bailouts and if it is not carefully thought through, it may increase moral hazard. This means that it may be better to leave model development to the financial institutions, letting them take responsibility while encouraging innovations in modelling.

But there is a further and potentially more damaging issue: moving towards model homogeneity leads to excessive pro-cyclicality. If each bank develops its own models, and models are different across the industry, when the next shock arises some banks may view it positively and buy the underlying asset, while other banks take the opposite view and sell. In aggregate their actions would cancel out, resulting in more stable markets where extreme movements are less likely than in markets where regulations themselves contribute to pro-cyclicality.

But if the banks are forced to have the same models, they will all analyse the shock in the same way, and react in the same way, amplifying price movements, all buying or all selling. In a worst-case scenario it causes extreme price movements. It also undermines market integrity because it encourages predatory behaviour by other market participants not bound by the models.

Even if the supervisor is fortunate enough to pick the best model, it will still harmonise bank reactions unless the financial institutions' policy functions can be decoupled from the risk models during periods of stress. Otherwise, model homogeneity is pro-cyclical and undermines market integrity. ■

To deliver their objectives of maintaining financial stability and preventing and mitigating the impact of financial crises, policy-makers in central banks, regulatory authorities and finance ministries strive to design laws, rules, regulations and other devices, especially in reaction to a costly event. Since the global financial crisis, they have launched a large number of policy initiatives, some of which may yield real benefits in terms of controlling the build-up of systemic risk.

Policy initiatives to reduce systemic risk

Others, however, may perversely increase systemic risk. Laws, rules and regulations that were drawn up ostensibly to bolster financial stability and limit the build-up of risk can often become a channel for amplification mechanisms that have precisely the opposite effect. This occurs when multiple rules have inconsistent objectives and interact in unpredicted ways. Often these perverse consequences can remain hidden until it is too late, and this can occur in particular when policies are drafted hastily in response to a crisis.

Policy-makers operate under specific mandates and with incomplete information. The new financial regulations they design can often contain embedded 'constraints' and devices that can coordinate actions of otherwise seemingly unconnected agents. Such rules often look to be a sensible step in the right direction, but which lead to unintended consequences in more stressed situations and contribute to amplification mechanisms once all indirect effects are taken into account.

Such indirect effects can lead to feedback loops, undesirable coordination and a lack of diversity within the market. Designing a robust regulatory regime is difficult because it is hard to predict how participants' individual motives will come together to produce overall behaviour in the market. In particular, so-called 'representative agent' models used widely by economists are by design unable to guide policy-makers in this regard.

Unfortunately, many policy rules may be effective in preventing some types of risk while at the same time creating new, perhaps hidden, sources of risk. These include capital regulations that enable financial institutions to report healthy capital levels while actually holding excessively small and decreasing levels of effective capital.

They also include poorly conceived banking regulations that can lead to the emergence of a 'parallel banking system' that itself can come with its own vulnerabilities – what former US Federal Reserve chairman Ben Bernanke in 2012 called the 'diverse set of institutions and markets that, collectively, carry out traditional banking functions – but do so outside, or in ways only loosely linked to, the traditional system of regulated depository institutions'.

None of this implies that no remedial actions ought to be undertaken for fear of the potential unintended consequences. Rather, it suggests that research into policy effects ought to incorporate – even if only tentatively – the system as a whole, with all its imperfections, to capture its indirect and feedback effects and minimise the occurrence of unintended consequences. Even the ambiguity under which policy-makers operate – the fact of not being sure which model is the right one – can be coherently modelled and taken into account in the first place. The modelling and estimation of ambiguity is a fascinating task on which the SRC is working.

The new agenda of macroprudential policy

Since the global financial crisis, the idea of designing macroprudential policy to reduce the systemic risk within the financial system as a whole has been a central focus of attention for regulators and central banks.

While not yet clearly defined, the macroprudential agenda captures the desire of society for robust rules to prevent crises and to cope with them when they do happen, acting as a countervailing force to the natural decline in measured risks in a boom and the subsequent rise in measured risks in the following collapse. Macroprudential regulation is the complement to 'microprudential' regulation, which seeks to improve the soundness of individual financial institutions.

The development of the macroprudential agenda is very much in the early stages, and the SRC sees its involvement with that discussion as a fundamental objective. Particular focuses for research include the systemic importance of individual institutions (in terms of their size, leverage and interconnectedness with the rest of the system), whether macroprudential tools are sufficient enough to have much of an impact, and whether they can withstand the political pressure for pro-cyclicality and are genuinely counter-cyclical or only create the appearance of counter-cyclicality.

Furthermore, systemic risk arises from – and is worsened by – a series of externalities. Each player disregards the effects of its risky choices on others, both when taking on risk as well as when implementing mitigating actions. Externalities arise even within the international context.

One current example is the bank-sovereign-main street loop in the eurozone, where bank weaknesses called for sovereign bail-outs, which in turn weakened the sovereigns and main street, further weakening state guarantees and national product, which fed back on banks, and so on. The lack of international coordination and fiscal union means that any one country disregards the adverse consequences of underproviding for financial soundness and resilience which that country's actions have on its neighbours. Macroprudential policy – ideally implemented at a global level – is required to internalise the externalities and improve efficiency and systemic resilience.

Political scientists see the weakness of the 'counter-cyclical political constituency' as one of the key obstacles to sustaining macroprudential policy in the face of political resistance from those benefitting from asset price appreciation. As part of this agenda, the SRC is investigating the impact of various communication strategies that central bankers and regulators can use to provide greater public legitimacy to macroprudential intervention. SRC researchers are developing various survey experiments to assess the impact of these communication strategies on public opinion in the UK and elsewhere. ■

'The effect of the people's agreeing that there must be central planning, without agreeing on the ends, will be rather as if a group of people were to commit themselves to take a journey together without agreeing where they want to go; with the result that they may all have to make a journey which most of them do not want at all.' Friedrich Hayek, 1944

One particular concern is that it is the world's central banks that have been given the task of developing and deploying tools to limit the build-up of systemic risk and its potentially disastrous consequences of financial instability and economic distress. The hope is that the credibility acquired from conquering inflation in the 1980s and 1990s will rub off on the new agenda of macroprudential policy.

Dangers for central banks

SRC researchers fear the opposite: that the fuzziness of the macroprudential agenda and the interplay of political pressures may undermine the reputation of central banks and threaten the effectiveness of monetary policy. In assuming responsibility for macroprudential policy, central banks risk their hard-earned reputations for effective monetary policy (Chwieroth and Danielsson, 2013).

In fighting inflation, central banks have one explicit tool at their disposal – interest rates – and an unambiguous and easily measured objective – inflation. There are no equivalents in macroprudential policy. Instead, policy-makers have a wide-ranging collection of often-conflicting tools and an even more baffling set of measures designed to capture systemic risk and financial instability. This ambiguity makes it difficult to build the necessary political consensus for employing the macroprudential toolkit.

The implementation of macroprudential policy, especially in times of crisis, inevitably involves a wide array of institutions, including the fiscal authority. This increases both the politicisation and access for divergent viewpoints, which permits any critic to use macroprudential ambiguity to argue that a different measure or different tool is more appropriate. The direct involvement of the fiscal authority gives critics even more leverage. The more avenues that divergent interests have for influencing policy-makers, the more scope there is to inhibit policy implementation.

The politicisation of macroprudential policy leads to countervailing pressures. Financial regulators may be biased towards non-intervention because they would face political pressure against tightening during a boom. It is often politically difficult to take measures that reduce short-term economic growth in the interests of fending off a bust that many think will not happen. This is a common problem in financial regulation, creating the widespread phenomenon of 'pro-cyclicality' – when the behaviour of market participants and policy authorities amplifies the volatility of the financial system.

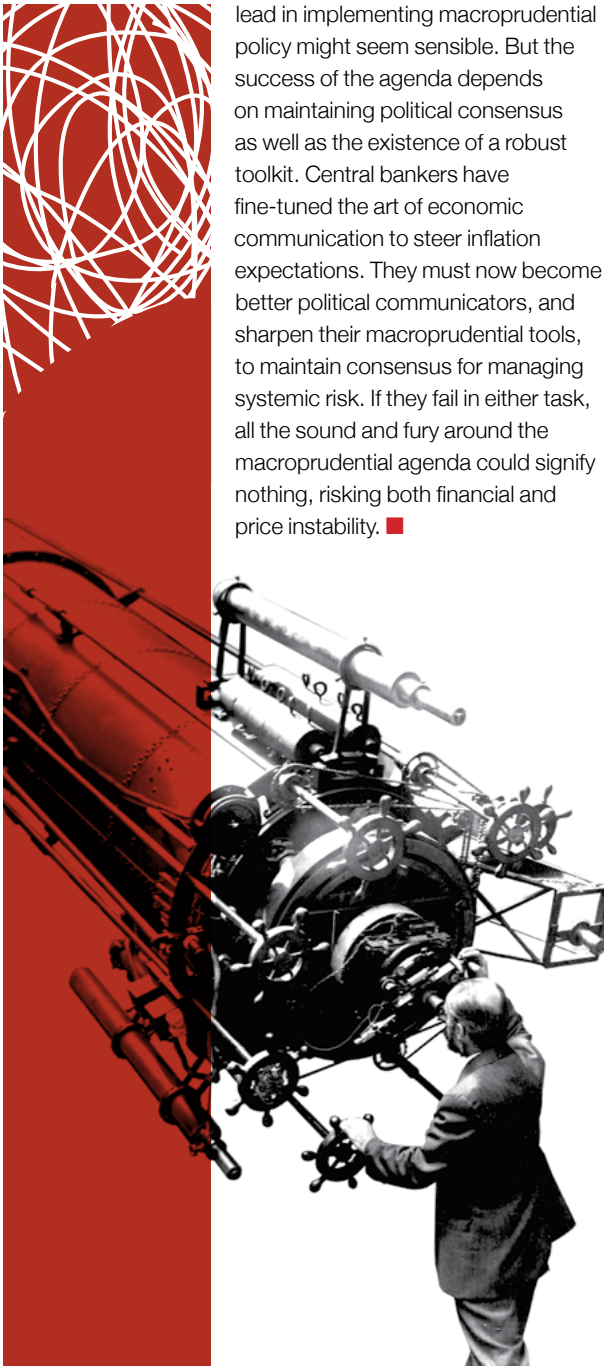
On the other hand, especially after a crisis, regulators may lean towards premature intervention because they fear being criticised for failing to spot a bubble. But the desire to prevent future crises at all costs could put severe constraints on investment and the capacity for growth.

The macroprudential agenda is hard to disagree with: who can object to measures that prevent the build-up of imbalances that will cause significant economic harm? No wonder then that the macroprudential agenda currently enjoys significant political support, especially as memories of the crisis are fresh and policies have only been implemented sparingly.

But at some point in the future, macroprudential policy will have to be implemented more widely and receive political support in a more positive environment, where memories of the last crisis have faded and people are enjoying the short-term benefits of the bubble. Political support then is likely to be much weaker than now.

As a practical matter, the macroprudential agenda seems set up for failure in many countries. The technical uncertainties and institutional designs give sufficient room for significant political objections to gain traction. Since any implementation is likely to run into strong political objections, anything that gives credence to those objections is problematic.

Having the central banks take the lead in implementing macroprudential policy might seem sensible. But the success of the agenda depends on maintaining political consensus as well as the existence of a robust toolkit. Central bankers have fine-tuned the art of economic communication to steer inflation expectations. They must now become better political communicators, and sharpen their macroprudential tools, to maintain consensus for managing systemic risk. If they fail in either task, all the sound and fury around the macroprudential agenda could signify nothing, risking both financial and price instability. ■



A financial transactions tax?

‘It is generally agreed that casinos should, in the public interest, be inaccessible and expensive. And perhaps the same is true of Stock Exchanges.’

‘Speculators may do no harm as bubbles on a steady stream of enterprise. But the position is serious when enterprise becomes the bubble on a whirlpool of speculation. When the capital development of a country becomes the by-product of the activities of a casino, the job is likely to be ill-done. The measure of success attained by Wall Street, regarded as an institution of which proper social purpose is to direct new investment into the most profitable channels in terms of future yield, cannot be claimed as one of the outstanding triumphs of laissez-faire capitalism – which is not surprising, if I am right in thinking that the best brains of Wall Street have been in fact directed towards a different object.’

John Maynard Keynes, 1936

The global financial crisis has revived an idea that goes back to John Maynard Keynes: using transaction taxes to discourage short-term speculative trades. Such trading is often blamed for causing excess volatility in financial markets. The Nobel laureate James Tobin gave his name to the tax more than 40 years ago, when he proposed it as a measure to ‘throw some sand in the wheels of speculation’, specifically for currency trading. The idea has been extended to all forms of financial transactions.

In September 2011, the European Commission proposed a harmonised financial transaction tax for the EU, for the purpose of stabilising financial markets and raising additional tax revenue from financial institutions. The proposal is being implemented by 11 EU member states, whereas other member states do not share the belief that the tax is beneficial.

SRC researchers are actively engaged in developing a deeper understanding of the economic trade-offs involved in the taxation of financial transactions. By curtailing ‘noise trading’, Tobin taxes can in principle reduce the excess volatility of financial markets. But by reducing the amount of informed trading, such taxes might also harm market quality.

A 2014 study by SRC researchers Albina Danilova and Christian Julliard finds that if the goal is to dampen market volatility, a tax on financial transactions might actually be counterproductive. By impeding the ability of the price to incorporate new information, it allows mispricing relative to fundamentals to last longer and when corrections eventually occur, these will be sudden and large.

Market participants will seek to recover the costs incurred by the tax, and therefore will require larger departures of prices from fundamental values as a precondition for trading. Consequently, only relatively larger information shocks will induce trading. This means that price volatility is reduced in calm times and raised in hectic times. Hence, a Tobin tax would increase the fragility of financial markets.

An empirical study involving SRC researcher Andreas Uthemann measures the impact that a Tobin tax would have on the price volatility, volume and informational efficiency of stocks traded on the New York Stock Exchange (Cipriani et al, 2014). In particular, the authors construct a market microstructure model of asset trading and estimate it using intraday transaction data.

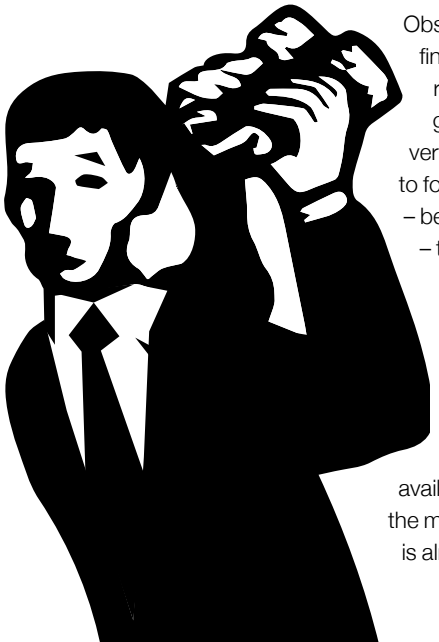
They find that a Tobin tax should be responsive to the liquidity situation of the affected markets. A flat tax in particular, if applied to all traded stocks irrespective of their individual characteristics, can be potentially quite damaging to the proper functioning of the price mechanism. ■

In economic policy-making circles around the world, significant effort is currently being invested in empirical techniques to identify systemic risk. Yet much of this work, which is based on studying directly observable outcomes in financial markets, may not be able to identify systemic risk until it is too late to take action.

Systemic risk: what can data reveal?

Market prices have two fundamental roles: they reflect the current valuation of assets but they are also imperatives to action. Much of the data used for the empirical modelling of systemic risk is generated by financial markets, and therefore reflects the opinions of market participants as to future profitability and risk.

While such data capture the current state of the financial system, they may not provide good guidance as to the future. One reason is that to the extent market participants fit backward-looking statistical models for forecasting risk to such data, so these outcomes reflect perceived risk and not actual risk.



Observed outcomes in financial markets may reflect the reality on the ground, but may not be very useful when it comes to forecasting systemic risk – before a crisis happens – thereby enabling the authorities to take corrective action.

Ultimately, this perverts empirical work on forecasting systemic risk. If available data reflect the market consensus, it is almost by definition reactive. Some of the work done at the SRC incorporating insights from endogenous risk suggests that simple and widely available market-based indicators – such as the so-called VIX volatility index, spreads on credit default swaps and off-the-shelf market risk methods like 'value-at-risk' – react only after a crisis is underway.

This suggests the importance of looking deeper for data that are useful for the identification and forecasting of systemic risk. Looking at a simple and commonly available market-based indicator extracted from a restricted number of financial security prices is not sufficient to capture the build-up of imbalances.

One avenue that the SRC is exploring is to analyse confidential data sets collected by policy authorities, such as the joint work by SRC researchers Christian Julliard and Kathy Yuan with colleagues at the Bank of England (Denbee et al, 2014). Another is work with Markit, a leading supplier of financial information services, to explore the build-up of potential fragilities in a few sub-markets that may create instability in the financial system.

SRC research in collaboration with Markit is underway using two large-scale proprietary datasets – one covering the securities lending market; and one covering the 'over-the-counter' (OTC) derivatives market. ■

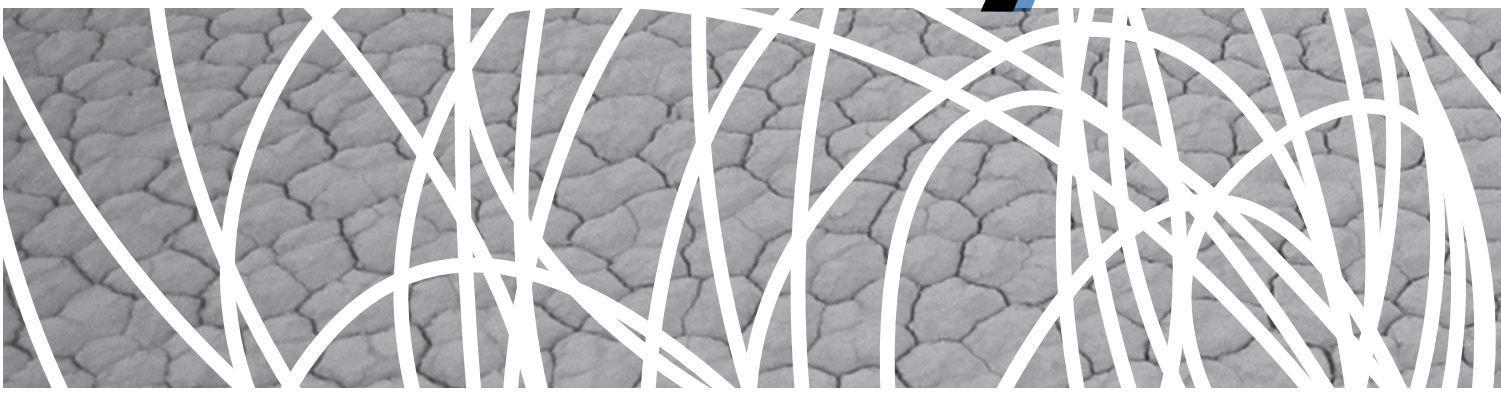
One of the main ways that financial institutions obtain liquidity is by means of securities lending, where financial assets are lent out or used as a pledge for borrowing. The market for securities lending has grown rapidly in recent years, with more than $2 trillion worth of securities estimated to be on loan at any given time.

Securities lending

Securities lending can facilitate access to liquidity through several means. For example, securities can be used as collateral to gain liquidity in the form of cash or highly rated bonds, thus allowing the holder to avoid having to liquidate securities in a fire sale. This also reduces the cost of trading and promotes price discovery by providing liquidity to market-making operations in the capital markets.

At the same time, securities lending can be a source of systemic risk. One way is via the excessive reinvestment of cash collateral associated with securities lending transactions, which can lead to maturity mismatches and eventual runs. An example is the case of US insurance company AIG, which caused such extreme liquidity risk that not only was its own survival threatened but also the health of the entire financial system.

The Markit securities finance data set covers over 13 trillion of global securities transactions over the past 12 years, enabling SRC researchers to understand the evolution of global liquidity, especially at the height of the crisis in the fall of 2008. Furthermore, the database can be used to identify how global liquidity provision is affected by central bank announcements and policies. The successful conclusion of this research will enable macroprudential regulators to tailor liquidity provision more effectively, both during crises and in more routine stimulus, reducing the cost to the taxpayer while simultaneously increasing the efficiency of macroprudential policies. ■

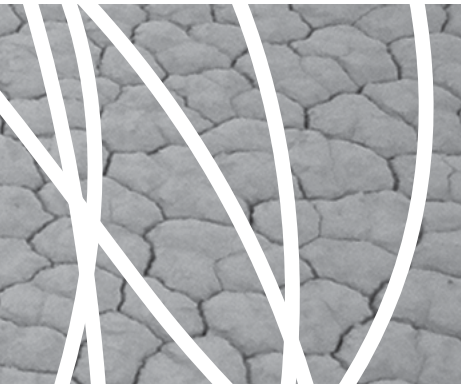


When financial institutions want to know if their derivatives pricing models are reliable they use Totem. Academic analysis of totem data promises to answer fundamental questions about information cascades, model risk and the nature of liquidity.

Totem

Totem is a service that Markit provides to banks to validate their proprietary derivative pricing models, identifying and quantifying risks that originate from mis-specified models. A large source of market uncertainty during the crisis from 2007 was the inability to value derivative securities. This lack of robustness leads to substantial uncertainty concerning the correct prices for products such as collateralised debt obligations (CDOs). In turn, this has systemic consequences.

SRC researchers are using the Totem database to develop a better understanding of systemic risk in several different ways. One example is a study of whether quantitative analysts know when they don't know: in other words, do analysts have an idea of how well their models are able to price complicated derivative contracts? ■



Legal dimensions of systemic risk

The financial system is underpinned and shaped by law, which makes it difficult to think about systemic risk without considering the legal system. Indeed, law and finance are so inseparably linked that it is next to impossible to imagine a financial system that operates without law. Law supports the financial system in a number of ways, including issues around contracts, ownership rights and regulation.

First, law enables market participants to shape their relationship through contracts. The content of these contracts is determined by the parties who will each aim to shape the outcome in their respective interest. In some areas of the financial system, there are standard forms for contracts that market participants either adopt outright or modify to suit their requirements. Contracts are mechanisms that help to balance interests between parties by setting up a framework that can be enforced by courts or forums of the parties' choosing. Contracts can be private or regulated.

The legal system is one of the most important mechanisms for exposing hidden endogenous risk. Financial contracts are often very complicated, with untested legal terms. In crisis times, this risk manifests itself through various avenues. For example, while the financial system is global, the legal system is local; and court proceedings that address the same financial contract can result in conflicting decisions. Furthermore, the complexity of contracts on financial risk that tends to materialise during a crisis means that the enforceability of the contracts only becomes visible at that time.

One example is the ownership treatment of assets by custodians (see below). Another is how the 'flip clause' in a trust deed in the Lehman Brothers insolvency proceedings against investors were treated differently by two court systems (see page 33). Just a handful of words in the contracts might determine whether assets fell into the Lehman Brothers estate or were available to counterparties (Braithwaite, 2014).

While each standard financial instrument may have a small face value, the use of standard terms multiple times over internationally means that they can have a very real impact on the global economy. When there is considerable uncertainty as to how a court system might address terms and resolve conflicting claims, judicial expertise is required. Very few judges have experience with complex financial contracts. This can lead to significant legal risk, which manifests itself in the worst state of the world during a crisis. In other words, how courts treat complicated financial instruments

represents yet another form of hidden endogenous risk.

Similarly, financial institutions might get into a situation in which they are unable to comply fully with authorities in different countries. If they satisfy one authority, they consequently violate the rules of another.

Ownership and custody chains

The law makes it possible for investors to acquire and exercise ownership rights in financial assets. Investors are allocated rights to interest payments or dividends, voting rights and other governance rights through legislation, regulator policy or the terms of a financial instrument contract. Law also enables investors to enforce those rights against issuers. Property rights can help to protect investors when a counterparty becomes insolvent.

In recent years, a market structure has evolved that leads to securities being held indirectly through chains of custodians. These chains yield many benefits to the financial intermediaries who have embedded themselves in them. But many investors do not understand the risks associated with custodians holding assets.

Custody agreements often allow custodians to use investors' assets for their own business purposes. In times of crisis, when counterparties fail, securing assets back for investors is difficult. After all, the legal framework made up of bilateral custody contracts is a fragile one. A domino exercise is required to retrace steps of assets before investors can get them back. So investors must carefully monitor their assets and the terms of their agreements.

Work by SRC researcher Eva Micheler considers how custody chains can operate as a source and amplifier of risk affecting the value of securities with potentially systemic implications. One of her studies shows that the current market infrastructure systemically prevents investors, both shareholders and bondholders, from exercising their rights against issuers (Micheler, 2014a). Equity and debt securities are now normally held through a chain of custodians. These custodians are connected with each other through contract law. There is also legislation determining the relationship between custodians and their clients.

The research shows that custody chains have become independent from investors and issuers. Neither issuers nor investors are able to control the length of the chain or the content of the legal arrangements that govern the custody chain. Custodians are connected through a series of bilateral links that are independent of each other. This erodes the rights of investors. The study illustrates this by reference to the liability of custodians for their services and by reference to the ability of custodians to contract with sub-custodians on terms that are independent from the terms that they have entered into with their customers.

Custody chains affect securities markets at a very fundamental level. Securities are a bundle of rights that investors have against issuers. Market participants assume that these rights are enforceable against the issuer. There is always a risk that an issuer defaults and becomes unable to meet claims. Otherwise, however, the market is entitled to expect that its infrastructure will make it possible to enforce claims where an investor takes the view that the issuer does not comply with the terms of an issue.

If the enforcement of claims is significantly compromised this can affect the value of securities. Investors will only enforce claims if the cost of enforcement is outweighed by the benefits. If the market infrastructure is set up in a way that makes enforcement systematically very expensive, investors will refrain from enforcing claims and that has implications for the value of those claims. This can have systemic implications.

Custody chains not only affect security values in the portfolios of investors. They also cause problems for issuers. They pose a significant hurdle preventing individual and institutional investors from exercising rights against issuers when they wish to do so and as a result deprive issuers of oversight from the shareholders.

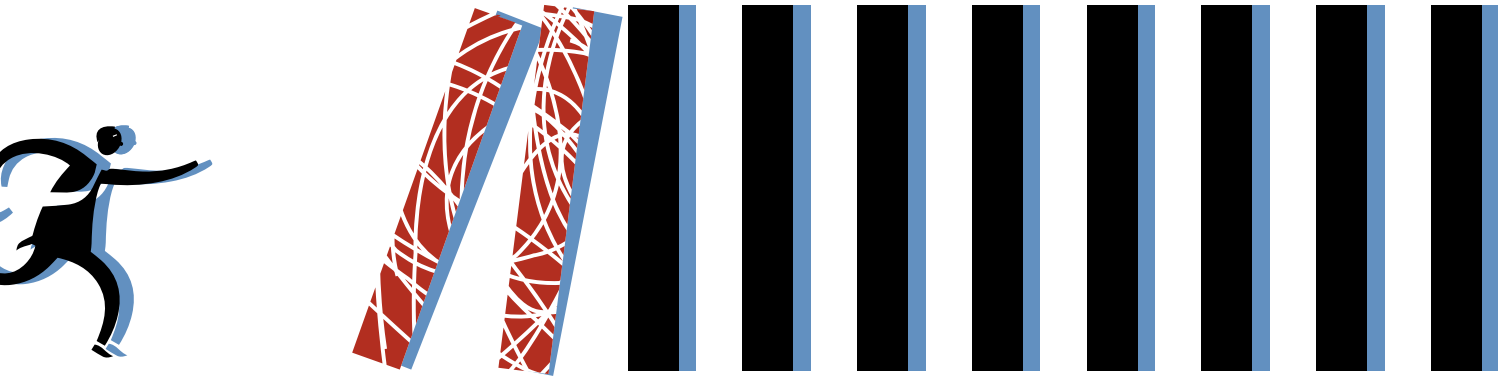
This problem cannot be overcome by contract law, corporate law or property law. The thesis of the study is that structural reform is required to reduce the number of intermediaries that operate between issuers and investors. A central, direct and transparent mechanism should be created through which investors hold securities. The research observes that in the past incumbent market participants have lobbied intensively to preserve the existing structure and predicts that they are likely to oppose any proposed changes.

A further study by Eva Micheler (2014b) shows that holding securities through chains of intermediaries compromises the ability of investors to exercise their rights, a problem that is not remedied by the Geneva Securities Convention. She argues that research should be carried out to determine if a mechanism can be created that enables ultimate investors to hold securities directly.

Further work on creating a harmonised set of rules at a functional level will not improve legal certainty, reduce systemic risk or enhance market efficiency. The problems associated with the current framework are a function of the process of intermediation itself. Legal risk, systemic risk and market efficiency are all adversely affected by the number of intermediaries operating in this context. This is an area where law cannot help but structural reform can. It is worth investigating if a framework can be created that allows for securities to be held directly by ultimate investors.

Law as a tool of financial regulation

In the context of systemic risk, law is used as a tool to regulate financial institutions. The aim is to set up a framework that renders financial



institutions robust against risk. Financial regulation puts in place mechanisms that are designed to discourage excessive risk-taking. Law can help to contain and manage risk.

Law, however, can also be a source of risk. Unregulated activities of high volume and interconnectedness – such as shadow banking – can lead to systemic risk. Legal rules can also have unintended consequences for the parties of a contract or the legislature and the market as a whole. The regulators can overlook the fact that certain contracts allocate risk in a systemically problematic way. But following the global financial crisis, regulators have been more keen to provide guidelines.

Contracts can also be a source of risk with potentially systemic implications. For example, the Basel Committee has endorsed the use of new financial products called 'contingent convertible bonds' – known as CoCos – as a cushion for market shocks. CoCos are private and public contracts outlining the terms for which an investor's money will be used to fund an issuer's capital in times of distress. Regulators, banks and investors alike have welcomed their use since they were first introduced on a large scale by Lloyds Banking Group in 2009. But it remains to be seen whether these instruments live up to their expectations or if the terms of the bonds align in a way that amplifies risk within the system.

Domestic and international law

The national – as opposed to cross-border – nature of legal systems can be significant amplifiers of systemic risk. The bankruptcy of Lehman Brothers in 2008 highlighted the challenges faced by litigants in recouping their property. There is no single international insolvency law. Each jurisdiction has its own laws in relation to bankruptcy and insolvency.

The complexity of the Lehman Brothers operations, products and network of international litigants made the litigation unprecedented. The bank was 'international in life and national in death'. A powerful example of the differences in meaning, effect and outcome when particular structures are tested against the insolvency laws of different countries can be found in the 2011 parallel Lehman Brothers proceedings in the US and UK courts.

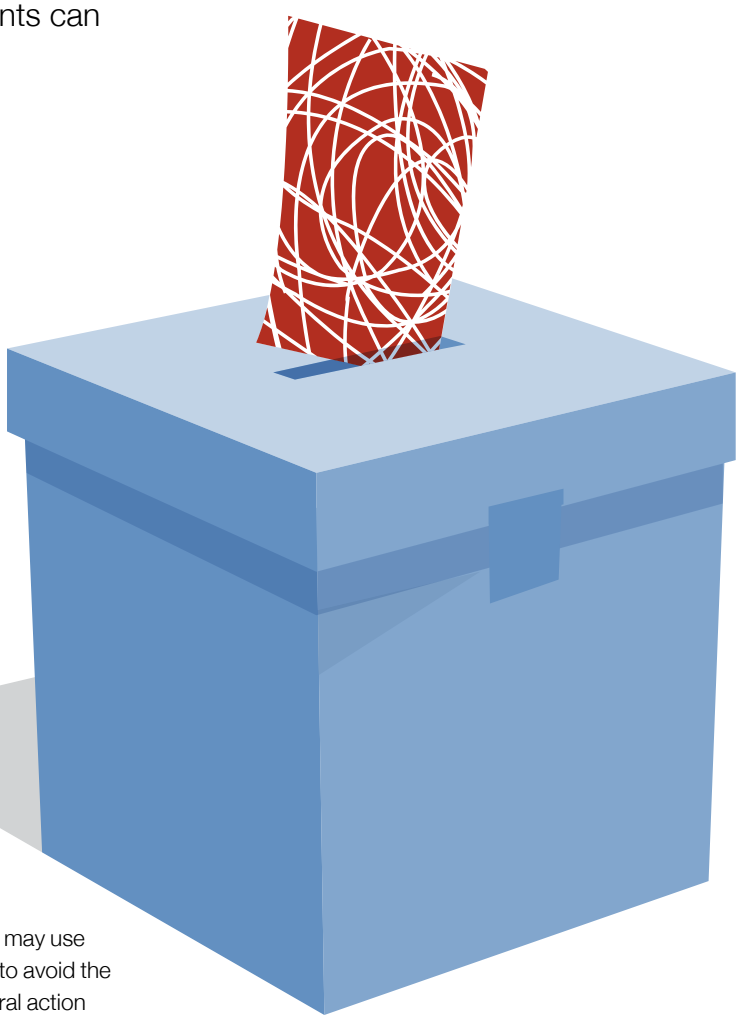
The collapse of Lehman Brothers also demonstrated that precedents that are set in the aftermath of catastrophic events affect the financial system in a way that reaches far beyond that particular insolvency, to worldwide users of standard form documents, the global financial markets and the common law itself. Seen in this light, the case law around Lehman Brothers is a significant, but under-appreciated, side effect of the global financial crisis (Braithwaite, 2014).

Are court systems able to cope with the complexity of financial contracts? The English court's ability to deal with complex financial contracts was highlighted in the Lehman Brothers cases. *Perpetual Trustee* [2011] UKSC 38 in particular showed the power and flexibility of the UK common law system in comprehending and accommodating new and complex contracts with existing common law. The common law system enabled many proceedings to be heard or case managed by the same judge (Mr Justice Briggs), who brought expertise, consistency and expediency to the entire process.

It is essential that future financial regulation reduces the different treatment of assets, taxation and property rights. Only when a known or uniform approach exists will systemic risk be curbed. Clear and internationally coordinated laws will remove uncertainty from the financial system. ■

Political dimensions of systemic risk

A key question for policy-makers is how to limit the build-up of systemic risk and contain crisis events when they do happen. But the interaction between the political system, financial regulators and market participants can itself create endogenous feedback loops.



Before a crisis, politicians are likely to celebrate the build-up of excesses and attempt to prevent any effective action by the regulators. After a crisis, they may want to demonstrate their toughness by clamping down excessively on the financial system. This leads to pro-cyclicality.

SRC research is seeking a better understanding of the policy-making process that encourages laws that may not have been fully thought through. One potential reason for that lies in politicians' short-term electoral horizons. Another is the horse-trading that imposes many rules on a single law, which ends up being approved without any detailed debate about their precise intended consequences. SRC researchers are studying the political origins of risk, specifically how rules of decision-making influence the distribution of risk among different parties.

In many instances, political scientists see the global governance of systemic risk as reflecting the interests of leading states. More critically, some view its fundamental origin to lie in an Anglo-American project towards market-friendly regulation. One need not adopt this more critical view to accept the proposition that leading states and their regulators may use international coordination to avoid the competitiveness of unilateral action and to create an attractive market for their financial industry.

Thus, systemic risk may arise from an unfortunate mix of special interest lobbying, regulatory capture, revolving doors, dysfunctional political institutions, and elite and mass public belief systems. For example, SRC researchers are investigating the consequence of rising social expectations about crisis prevention and mitigation. As citizens have become more demanding of governments since 1945, those that are perceived to be unresponsive to the consequences of crises for income, employment and wealth have been the most likely to lose their hold on political power.

Yet these 'great expectations' of governments may provide a socio-political origin for systemic risk. Societies expect crisis mitigation politics and in response, governments intervene to avoid political punishment. The problem is that they do so with increasingly large distributional consequences, potentially producing moral hazard and undermining long-run financial stability (Chwieroth and Walter, 2013, 2014, 2015).

The political embeddedness of systemic risk

The political embeddedness of systemic risk invites questions about how that happens and why. One thing that seems clear is that capitalism has many organisational faces and takes many institutional forms, in which finance plays different roles. As a result, some capitalist systems are more prone to producing crises than others. What is interesting is that when different financial systems integrate, banks in the more careful systems suddenly develop two faces: one high-risk, often oriented towards finance outside the domestic economy; and one retaining much of the low-risk profile it had before.

Financial integration in Europe, together with deregulation and liberalisation of the financial sector, have made the once very sharp boundaries between different sub-types of banks considerably more permeable. During the eurozone crisis, it became abundantly clear that even the once 'conservative' German banks had exposed themselves to risky US financial instruments and to sovereign debt in weaker eurozone member states. The latter risk was facilitated by EU rules stipulating that for the purpose of bank capital calculation, sovereign debt is risk-free.

While the purpose of such a rule is to subsidise government borrowing, it has the unfortunate consequence of making banks look safer than they actually are. This meant that European banks had to be rescued – directly through a bank bailout or indirectly through a bailout of the governments whose bonds they held.

This tension between national regulation (and therefore national profiles of financial risk) and the internationalisation of finance beyond regulatory frameworks is a central part of the political economy of systemic risk.

A second key issue is how the 'real' economy (as opposed to the money economy on its own) produces risks. SRC researchers have worked on how different labour market institutions, against the background of a single nominal interest rate by the European Central Bank (ECB), produced a pro-cyclical monetary policy, and institutional traps that make it very difficult to get out of that pro-cyclical policy (Hancké, 2013).

Imagine a monetary union, like the eurozone, consisting of two economies of roughly equal size (call them DE and RE, for Germany and its satellites and the rest of Europe). Both economies evolve on their own in interaction, but are subject to a single interest rate that reflects, to keep things simple, the ECB's inflation target.

For a variety of endogenous and historical reasons, DE's inflation rate is slightly lower than RE's – say, 1.5% as opposed to 2.5%. The perverse effect is that the real interest rate, the difference between the single nominal interest rate set by the ECB and the inflation rate in the country, now will be too low in RE, thus fuelling inflation in RE and pushing economic activity down in DE.

In the second period, the inflation differential between DE and RE will therefore increase – and the pro-cyclical difference in real interest rates in the two countries will increase with that. This process repeats itself until the monetary union breaks – unless RE can do what it needs to bring inflation down, for example, by imposing wage moderation, while DE slowly increases its inflation rate in parallel.

The sad irony is that in the real world, the two economies are endowed with exactly the opposite institutions to what they need: DE has the institutions to keep inflation low or bring it down when it is rising – strong labour unions and central wage coordination – while RE lacks them. DE is, in fact, constrained to keep inflation rates low since economic growth depends disproportionately on a competitive real exchange rate rather than allowing them to rise in a symmetric adjustment process across the entire monetary union.

Despite its origins in a volatile financial sector abroad, much of the eurozone crisis was precipitated by these dynamics between pro-cyclical monetary policy and divergent domestic institutions that exacerbated small differences in economic performance between different economies within the monetary union.

Different political systems also seem to be related to different ways of producing financial risk. For example, the collapse of the so-called Keynesian welfare state, which guaranteed stable, slowly rising incomes for the vast majority of the population, has imposed constraints on governments to provide other means through which the bottom two-thirds of the income distribution can see their incomes rise in real terms.

Access to credit in a burgeoning housing market has become one of those means. But that also implied that housing prices became a crucial parameter in a country's economic wellbeing, regardless of the underlying economic fundamentals.

This preoccupation with access to credit, mortgage policies by the banks and housing prices has become far more important in the highly deregulated Anglo-Saxon economies with a strong financial sector, where the safety net and welfare arrangements have been hollowed out. It is considerably less of a destabilising factor in continental European economies, where the broad social compact that has governed since the Second World War has remained more intact.

In addition, the electoral system may have an impact. It is probably not a coincidence that economies such as the United States and the UK, where growth is credit-led, were at the core of the financial crisis, while export-led economies such as Germany and other continental countries, were often lagging far behind. Credit-led economies have a majoritarian electoral system, in which narrow interest lobbies, be they homeowners or financial institutions, can have a disproportionate impact on policy in their favour.

Export-led economies, in contrast, often have an electoral system based on proportional representation, in which many different interests in an economy are balanced through the political system. To some extent, this suggests, endogenous risk is also politically endogenous. ■

Further reading

Bernanke, Ben (2012) 'Some Reflections on the Crisis and the Policy Response', Fed chairman's speech at the Russell Sage Foundation and Century Foundation Conference on 'Rethinking Finance', New York. **http://www.federalreserve.gov/newsevents/speech/bernanke20120413a.htm**

Black, Julia (2013) 'Seeing, Knowing, and Regulating Financial Markets: Moving the Cognitive Framework from the Economic to the Social', LSE Law, Society and Economy Working Paper No. 24/2013. **http://www.lse.ac.uk/collections/law/wps/WPS2013-24_Black.pdf**

Boucher, Christophe, Jon Danielsson, Patrick Kouontchou and Bertrand Maillet (2014) 'Risk Models-at-Risk', SRC Discussion Paper No. 6. **http://www.systemicrisk.ac.uk/publications/discussion-papers/risk-models-risk**

Braithwaite, Jo (2014) 'Law after Lehmans', LSE Law, Society and Economy Working Paper No. 11/2014. **http://eprints.lse.ac.uk/55834/**

Bremus, Franziska and Katja Neugebauer (2014) 'Don't Stop Me Now: The Impact of International Banking on Firm Financing', mimeo.

Buch, Claudia and Katja Neugebauer (2011) 'Bank-specific Shocks and the Real Economy', *Journal of Banking and Finance* 35 (8): 2179-87.

Chwieroth, Jeffrey and Jon Danielsson (2013) 'Political challenges of the macroprudential agenda'. **http://www.voxeu.org/article/political-challenges-macroprudential-agenda**

Chwieroth, Jeffrey and Andrew Walter (2013) 'From low to great expectations: banking crises and partisan survival over the long run'. **http://www.voxeu.org/article/banking-crises-and-political-survival-over-long-run**

Chwieroth, Jeffrey and Andrew Walter (2014) 'Financial Crises and Political Turnover: A Long Run Panoramic View'. **http://personal.lse.ac.uk/chwierot/images/Panoramic.pdf**

Chwieroth, Jeffrey and Andrew Walter (2015) 'Great Expectations, Veto Players, and the Changing Politics of Banking Crises', SRC Discussion Paper No. 28. **http://www.systemicrisk.ac.uk/publications/discussion-papers/great-expectations-veto-players-and-changing-politics-banking-crises**

Cipriani, Marco, Antonio Guarino and Andreas Uthemann (2014) 'Tobin Taxes and the Informational Efficiency of Financial Markets: A Structural Estimation', mimeo.

Danielsson, Jon (2013a) *Global Financial Systems: Stability and Risk*, Pearson.

Danielsson, Jon (2013b) 'The new market-risk regulations'. **http://www.voxeu.org/article/new-market-risk-regulations**

Danielsson, Jon (2013c) 'Towards a more pro-cyclical financial system'. **http://www.voxeu.org/article/towards-more-procyclical-financial-system**

Danielsson, Jon (2015a) 'What the Swiss FX shock says about risk models'. **http://www.voxeu.org/article/what-swiss-fx-shock-says-about-risk-models**

Danielsson, Jon (2015b) 'The Nature of Risk', mimeo.

Danielsson Jon, Lerby Ergun and Casper de Vries (2015a) 'Pitfalls in Worst Case Analysis', mimeo.

Danielsson, Jon, Kevin James, Marcela Valenzuela and Ilknur Zer (2014a) 'Model Risk of Risk Models', SRC Discussion Paper No. 11. **http://www.systemicrisk.ac.uk/publications/discussion-papers/model-risk-risk-models**

Danielsson, Jon, Kevin James, Marcela Valenzuela and Ilknur Zer (2014b) 'Model risk and the implications for risk management, macroprudential policy, and financial regulations'. **www.voxeu.org/article/model-risk-risk-measures-when-models-may-be-wrong**

Danielsson, Jon, Stathi Panayi, Gareth Peters and Jean-Pierre Zigrand (2015b) 'Liquidity Resilience', mimeo.

Danielsson, Jon and Hyun Song Shin (2003) 'Endogenous Risk', in *Modern Risk Management: A History* edited by Peter Field, Risk Books.

Danielsson, Jon, Hyun Song Shin and Jean-Pierre Zigrand (2012a) 'Endogenous Extreme Events and the Dual Role of Prices', *Annual Review of Economics* 4: 111-29.

Danielsson, Jon, Hyun Song Shin and Jean-Pierre Zigrand (2012b) 'Procyclical Leverage and Endogenous Risk', available at: **www.riskresearch.org/?paperid=39#papercontent**

Danielsson, Jon, Marcela Valenzuela and Ilknur Zer (2015c) 'Volatility, Crises and Economic Growth', mimeo.

Danielsson, Jon and Chen Zhou (2015) 'Why Risk is So Hard to Measure', SRC Discussion Paper No. 36. **http://www.systemicrisk.ac.uk/publications/discussion-papers/why-risk-so-hard-measure**

Danielsson, Jon and Jean-Pierre Zigrand (2008) 'Equilibrium Asset Pricing with Systemic Risk', *Economic Theory* 35: 293-319; earlier version available as Financial Markets Group Discussion Paper No. 561. **http://www.lse.ac.uk/fmg/workingPapers/discussionPapers/2006.aspx**

Danilova, Albina and Christian Julliard (2014) 'Information Asymmetries, Volatility, Liquidity, and the Tobin Tax', SRC Discussion Paper No. 24. **http://www.systemicrisk.ac.uk/publications/discussion-papers/information-asymmetries-volatility-liquidity-and-tobin-tax**

Denbee, Edward, Christian Julliard, Ye Li and Kathy Yuan (2014) 'Network Risk and Key Players: A Structural Analysis of Interbank Liquidity', Financial Markets Group Discussion Paper No. 734. **http://www.lse.ac.uk/fmg/workingPapers/discussionPapers/home.aspx**

Donaldson, Jason and Eva Micheler (2014) 'How Negotiable Instruments Can Mitigate Systemic Risk'. **http://jrdonaldson.com/Papers/Donaldson-Micheler-Negotiability.pdf**

Ergun, Lerby and Philip Stork (2013) 'Tail Risk Reduction Strategies', in *Rethinking Valuation and Pricing Models: Lessons Learned from the Crisis and Future Challenges* edited by Carsten Wehn, Christian Hoppe and Greg Gregoriou, Academic Press.

Ergun, Lerby (2015) 'Depression and Euphoria Risk in Asset Returns', working paper.

Eppinger, Peter and Katja Neugebauer (2014) 'External Financial Dependence Across European Countries in the Global Financial Crisis', mimeo.

Friedman, Milton (1980) 'Video recording: Money and Inflation', Harcourt Brace Jovanovich, made by WQLN.

Government Office for Science (2012) 'Future of Computer Trading in Financial Markets: An International Perspective'. **https://www.gov.uk/government/publications/future-of-computer-trading-in-financial-markets-an-international-perspective**

Hancké, Bob (2013) *Unions, Central Banks and EMU: Labour Market Institutions and Monetary Integration in Europe*, Oxford University Press.

Hayek, Friedrich (1944) *The Road to Serfdom*, Routledge.

Hayek, Friedrich (1956) 'The Dilemma of Specialization', in *The State of the Social Sciences* edited by Leonard D. White, University of Chicago Press.

Keynes, John Maynard (1936) *The General Theory of Employment, Interest and Money*, Macmillan and Co.

Micheler, Eva (2014a) 'Custody Chains and Remoteness – Disconnecting Investors from Issuers', SRC Discussion Paper No. 14. **http://www.systemicrisk.ac.uk/publications/discussion-papers/custody-chains-and-remoteness-disconnecting-investors-issuers**

Micheler, Eva (2014b) 'The Transfer of Intermediated Securities and Legal Certainty', in *Transnational Securities Law* edited by Thomas Keijser, Oxford University Press.

Minsky, Hyman (1982) *Can 'It' Happen Again? Essays on Instability and Finance*, M E Sharpe.

Tobin, James (1978) 'A Proposal for International Monetary Reform', *Eastern Economic Journal* 4(3-4): 153-59.

Zigrand, Jean-Pierre (2010) 'What Do Network Theory and Endogenous Risk Theory Have to Say about the Effects of Central Counterparties on Systemic Stability?', Banque de France Financial Stability Review No. 14 – Derivatives – Financial Innovation and Stability. **http://www.banque-france.fr/fileadmin/user_upload/banque_de_france/publications/Revue_de_la_stabilite_financiere/etude18_rsf_1007.pdf**

Zigrand, Jean-Pierre (2014) 'Systems and Systemic Risk in Finance and Economics', SRC Special Paper No. 1. **http://www.systemicrisk.ac.uk/publications/special-papers/systems-and-systemic-risk-finance-and-economics**

Zigrand, Jean-Pierre (2015) '50 Shades of Systemic Risk', mimeo.

Biographies

Jean-Pierre Zigrand
Co-Director

Jean-Pierre Zigrand holds a PhD in economics from the University of Chicago and is Associate Professor of Finance at the LSE. His research interests cover general equilibrium asset pricing, financial intermediation and delegation, continuous time asset pricing, market crashes and foundations of arbitrage.

Jon Danielsson
Co-Director

Jon Danielsson holds a PhD in economics from Duke University and is Associate Professor of Finance at the LSE. His research interests cover systemic risk, financial risk, econometrics, economic theory and financial crisis.

Tomaso Aste
Co-Investigator

Tomaso Aste is Reader in Computational Finance and Head of the Financial Computing & Analytics Group at University College London. His research interests concern the investigation of complex systems and complex materials by combining network theory and statistical methods to decode the properties of these systems and to extract information concerning their organisation.

Julia Black
Co-Investigator

Julia Black is Pro Director for Research at the LSE. She completed her first degree in Jurisprudence and her DPhil at Oxford University. Her primary research interest is regulation. She has written extensively on regulatory issues in a number of areas, and has advised policy-makers, consumer bodies and regulators on issues of institutional design and regulatory policy.

Jeffrey Chwieroth
Research Associate

Jeffrey Chwieroth is Professor of International Political Economy, Department of International Relations, LSE. His research interests are in the international political economy of money and finance, specifically the political consequences of financial crises, sovereign wealth funds, financial globalisation, the International Monetary Fund, emerging markets, and economic norms and ideas.

Lerby Ergun
Research Officer

Lerby Ergun works on the empirical aspect of systemic risk in the financial system. His PhD thesis mainly focuses on, but is not exclusive to, studying the extreme behaviour of financial markets.

Bob Hancké
Co-Investigator

Bob Hancké is Associate Professor of Political Economy at the LSE. Previous appointments were at the Wissenschaftszentrum Berlin, and as a PhD candidate at the J.F. Kennedy School and Center for European Studies at Harvard University, and at MIT. His research interests are political economy of advanced capitalist societies; the political economy of transition economies; institutions and macroeconomic policy; and labour relations.

Christian Julliard
Co-Investigator
Christian Julliard is an Associate Professor in the Department of Finance and a senior research associate of the Financial Markets Group (FMG), LSE. He is also a research affiliate of the International Macroeconomics and Financial Economics programmes of the Centre for Economic Policy Research (CEPR), and an associated editor of *Economica*. His research interests are in macroeconomics, asset pricing, applied econometrics, international economics, networks, and market microstructure.

Eva Micheler
Co-Investigator
Eva Micheler is Reader in Law at the LSE and a Universitätsprofessor at the University of Economics in Vienna. Before joining LSE, she was also a TMR fellow at the Faculty of Law at the University of Oxford. Her research interests are the law of investment securities in England, Germany, Austria and Russia, the law of corporate finance, in particular the law of equity finance.

Kyle Moore
Research Officer
Kyle Moore completed his PhD at the Erasmus School of Economics. His research interests include extreme value theory and asset pricing. The aim of his SRC work is to apply novel ideas along with unique datasets to analyse potential sources and channels of systemic risk in the financial sector.

Katja Neugebauer
Research Officer
Katja Neugebauer is interested in all aspects of international banking, with a special focus on bank risk and contagion. She is also interested in firms' financing constraints and the real effects of international banking. She holds a PhD in Economics from the University of Tübingen.

Philip Treleaven
Co-Investigator
Philip Treleaven is Professor of Computing at University College London. He is also Director of the UK PhD Centre for Financial Computing. His research and teaching interests cover financial services (e.g. computational finance and algorithmic trading) and the creative industries (e.g. anthropometrics surveys using 3D body scanners).

Andreas Uthemann
Research Officer
Andreas Uthemann's research interests include financial economics, market design, and regulation. He did his undergraduate studies at Humboldt University, Berlin, and his doctoral studies at University College London, both in economics.

Romesh Vaitilingam
Editor
Romesh Vaitilingam is a writer and media consultant, and is the author of numerous articles and several successful books in economics, finance, business and public policy, including *The Financial Times Guide to Using the Financial Pages* (FT-Prentice Hall), now in its sixth edition (2011). In 2003, he was awarded an MBE for services to economic and social science.

Kathy Yuan
Co-Investigator
Kathy Yuan received her PhD in economics from MIT. Prior to this, she worked briefly in the Emerging Markets Trading Desk at J. P. Morgan (now JPMorgan-Chase). She is Professor of Finance at the LSE and a member of the Financial Markets Group (FMG), the Centre for Economic Policy Research (CEPR) and has recently received a Houblon-Norman Fellowship at the Bank of England.

Systemic Risk Centre

SYSTEMIC RISK: WHAT RESEARCH TELLS US AND WHAT WE NEED TO FIND OUT

Dimitri Vayanos
Professor of Finance, Head of Department of Finance, LSE

"Systemic risk has emerged as one of the most important areas of study for anybody interested in and concerned with the financial system. Therefore, the Department of Finance at the London School of Economics is delighted to have the opportunity to host the Systemic Risk Centre (SRC).

"The two directors of the Centre, Jon Danielsson and Jean-Pierre Zigrand, in their capacity as Associate Professors in our Department, were among the first academic researchers to study systemic risk, long before the global financial crisis that started in 2007. Since establishing the Centre two years ago, they have continued their academic work, and this magazine clearly demonstrates the excellent research being done on the question of systemic risk, in the SRC and LSE."

Tim Frost
Director and Founder, Cairn Capital, and Governor of LSE

"The world expects LSE to apply itself to understanding the causes of society's biggest problems. Few problems are bigger or require more understanding than the risk inherent in our financial system, so the world will be delighted but not surprised that Danielsson and Zigrand have incubated and delivered the Systemic Risk Centre at the LSE. We now look forward to the SRC's insights, intuition and innovation as we prepare for more financial instability ahead."

Published by
Systemic Risk Centre
The London School of Economics and Political Science
Houghton Street
London WC2A 2AE

SRC

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

1965 - 2015 50 E·S·R·C 50 YEARS SHAPING SOCIETY

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE